

From Theory to Practice: A review of co-design methods for humanitarian energy ecosystems

Benjamin L. Robinson^{*}, Alison Halford^{*}, Elena Gaura

Centre for Computational Science and Mathematical Modelling, Coventry University, Priory Street, Coventry, CV1 5FB

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ABSTRACT

Our planet is currently in the midst of a global humanitarian crisis. Yet, there is a widening gap between over 80 million displaced people and the political will to meet their needs. Improving energy access in the displaced setting to build capacity and resilience requires meaningful integration of the needs of communities throughout the design, delivery and evaluation process within the socio-technical energy system. This paper aims to explore the ways in which co-design is conceptualised and applied, from an interdisciplinary perspective, within the socio-technical framing. We do this by first conducting a rapid review of relevant co-design literature to understand theories, typologies and identify methods of best co-design practice in the Humanitarian Energy sector. Second, we present the Humanitarian Engineering and Energy for Displacement project as a co-design case study for Humanitarian Energy using Technology Implementation Model for Energy (TIME) as a framework for analysis.

Our rapid review resulted in the typology of the Spectrum of Co-Design, a mapping of differing conceptualisations of co-design showing their positioning and interactions. Our results show that by exploring if and how conceptual frameworks, such as TIME, adds value to practitioner orientated humanitarian programming this can make a significant contribution to future proofing energy systems that seek to deliver inclusive, sustainable and just transitions. We highlight specific learnings from HEED around the disconnection between perceptions of key stakeholder roles, misunderstandings of energy access and use, and building trusting partnerships through the creation of meaningful rectification pathways.

“Aid theorists point to a persistent performance gap as long as the system remains centralised and bureaucratic, the relationships between donor and implementer, aid provider and recipient remain controlling and asymmetrical, and partnerships and interactions remain transactional and competitive, rather than reciprocal and collective. What is less clear, however, is what a more inclusive, diverse and distributed sector would actually look like, and how precisely it can be achieved”

[1]

1. Introduction

Despite Sustainable Development Goal 7 committing member countries of the UN and development partners to work towards ensuring ‘access to affordable, reliable and sustainable energy for all’ by 2030,

access to sustainable, cost-effective and efficient energy is still denied to over a tenth of the world's population [2]. In addition, 3 billion people, primarily in Africa and Asia [3], use biomass as their primary fuel for cooking and heating, which is linked to severe health, environmental and financial impacts, as well as exacerbating issues of gender inequality and access to education [4]. The absence of robust energy structures and services to deliver sufficient energy for the needs of communities is widening the gap between the growing number of displaced peoples and the political willingness to meet the needs of the displaced. Moreover, this is set against the under-explored and under-researched nature of energy access in the humanitarian context [5].

The Humanitarian Energy (HE) sector is undergoing a transition from an output of humanitarian relief to a core element of strategic sustainable humanitarian response in the context of the United Nations Sustainable Development Goals [6] guided by the UN-led steering group: the Global Platform for Action on Sustainable Energy in

^{*} Corresponding authors.

E-mail addresses: ben.robinson@coventry.ac.uk (B.L. Robinson), ad4480@coventry.ac.uk (A. Halford), csx216@coventry.ac.uk (E. Gaura).

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Displacement Situations (GPA, [7]). For the purpose of this review we define HE as 'a range of clean energy sources across all contexts of Forcibly Displaced People (FDP), including refugees, internally displaced people, asylum-seekers and their host communities' (p.7) [8]. HE programs include creating energy access, facilitating the energy transition (for example, greening existing humanitarian energy systems) and improving energy efficiency (for example, upgrading the existing micro/on/off-grid systems to respond to the needs of FDPs and humanitarian actors). The sectoral transition to alignment with the Sustainable Development Goals is partly due to the efforts of organisations championing humanitarian energy access (and services) as a key component in bridging the gap between short-term humanitarian aid and long-term development in protracted conflicts, such as the Moving Energy Initiative [9], Sustainable Energy for All [10], Dutch Coalition for Humanitarian Innovation [11], the Netherlands Development Organisation [12], and EnDev [13]. Indeed, since 2015, when an estimated 90% of displaced peoples in camps lacked access to electricity [14], there has been some progress in deploying and delivering modern, safe energy systems [15,16,17].

Policy approaches on HE, such as the Comprehensive Refugee Response Framework and the Global Compact on Refugees [18,19], are also contributing to the improved delivery of energy to displaced people. Yet, without addressing the short-term nature of humanitarian budgets and funding, there will continue to be insufficient funding to invest significant capital in ethical, sustainable and just humanitarian energy solutions (EnDev, 2021), even if there is a resulting long term saving [20]. Alongside funding and policy evolution around improving access to energy, the HE sector is increasingly exploring meaningful methods of engaging FDPs in co-designing energy systems and services [21] so that the failures of the wider international development sector in rigidly focusing on technocentric energy solutions are not replicated in HE [22,23]. As supported by Belliveau [24], who argues that a dependency on technological solutions may indeed widen the gap between humanitarian practitioners and the people in need. Furthermore, Sovacool et al. [25] argue that socio-technical systems are critically necessary to achieve energy for all. However, some humanitarian actors see co-design methods as conceding power to affected people, losing control of key decision-making processes [26]. Thus, technical energy product deployment benefits from being co-joined with social methodologies that can capture the complex socio-cultural, environmental and financial contextual factors (which often conflict with the technical capabilities of energy systems) [27]. These social methodologies revolve around understanding the behavioural decisions of technology users to go beyond the humanitarian principles of 'do no harm' by actively involving key stakeholders, especially FDP or end-users, across the energy value chain.

With this in mind, we define the intersection of technical and social methodologies as socio-technical systems where one element does not override the other. **Socio-Technical Systems** in HE must take into account: complex contextual factors that override technical capabilities, the unique displaced context, right to work, 'camp economy', the inability to move outside designated spaces, the perceived temporary nature of displaced settlements, as well as feeding into systems and services that promote the productive uses of energy. A key element of working within the socio-technical system framework is **co-design** - the integration of displaced people's needs and aspirations into all elements of the project cycle to determine how cooking, heating, lighting, cooling, and mobility needs are met with modern, sustainable and efficient energy services in an ethical, sustainable and just transition.

Arguably, in HE, there is no universally accepted definition of co-design that synthesises the myriad of approaches (co-creation, co-production, participatory, community engagement, inclusivity, localisation and their subsets) and the voice of FDPs. Moreover, the epistemic underpinning of co-design is male north European, as with many systems in the humanitarian sector, resulting in co-design frameworks struggling to dismantle the traditional structures of power (in which

they are created to dismantle) [28]. This could be perceived as another example of maintaining control through hidden structures [29,30]. Instead of promoting this epistemic understanding, in this paper, we critically engage with a central research question that explores the ways co-design is conceptualised and applied from an interdisciplinary perspective. This includes identifying how to address knowledge hierarchies around socio-technical energy design systems. We will start by asking what theory exists to inform co-design in an FDP setting and how this theory correlates with methods of best practice in the Humanitarian Energy sector. We will then look to understand the relationship between existing co-design methods and identify the significant gaps in co-design methods across academic and practitioner ways of working. We will conclude by reflecting on the experiences of the Humanitarian Engineering and Energy in Development (HEED) project as a case study in co-designing and translating learnings to future co-design projects in HE.

This paper will make three contributions to knowledge in the following ways: 1) Critical analysis of co-design frameworks to identify methods that will aid sustainable, inclusive and ethical energy transitions in the humanitarian sector. 2) Using HEED as a case study, demonstrate the extent to which applying an energy mapping tool can benefit the design and deployment of energy systems in the displaced setting. 3) Be evidential on the lived experience of implementing a co-design strategy to show the connections and disconnections between theory and practice. Understanding the theoretical and applied relevance of conceptual frameworks, as well as how those working in the humanitarian sector implement co-design in the field, will lead to best practice around participation and empowerment to foster inclusive, fairer and culturally respectful energy transitions.

The structure of this paper is as follows: Section 2 outlines the rapid review methodology and the methodological approach for the retrospective analysis of the HEED project [31]. Section 3 introduces a number of co-design frameworks for socio-technical systems, including a research review of co-design theory across a number of sectors and a research review focused on methods of best practice in co-design, especially in the HE sector. This section also presents the Spectrum of Co-design model, key in understanding how the different elements of co-design interact. Next, Section 4 presents the retrospective analysis of the HEED project based on primary evidence collected from HEED team members. Finally, Section 5 summarises the key learnings presented in this paper.

2. Methods

The methodology followed for this research consists of two phases:

1. Conduct an online rapid review of the existing HE academic literature, identifying methods of best practice across the spectrum of co-design and potential research learnings.
2. Conduct a retrospective analysis of methods of co-design in the Humanitarian Engineering and Energy in Displacement project based upon methods identified in the rapid review.

Phase 1 is a rapid review of the literature identifying and critiquing state of the art co-design theory and practice across a range of relevant sectors identified by the authors. Phase 2 discusses a novel theoretical approach, the Technology Implementation Model for Energy (TIME), as a means of analysing co-design methods within the socio-technological system. This model will then be applied to the Engineering and Physical Sciences Research Council (EPSRC) Global Challenges Research Fund (GCRF) funded Humanitarian Engineering and Energy for Displacement (HEED) project. These methodological steps look to operationalise the existing co-design theory and provide critical evidence that can be used to inform future HE programs.

2.1. Phase 1: a rapid review

For this research, we consider a rapid review the most appropriate tool to produce an overview and analyse the literature that foregrounds the findings without forgoing academic rigour. A rapid review is often utilised in the health sector to quickly identify and critique specific or narrow literature groups in time-limited settings [32,33,34]. A working definition presented by Tricco et al. [33] is, “a rapid review is a type of knowledge synthesis in which components of the systematic review process are simplified or omitted to produce information in a short period of time” (p. 2). Thus, a rapid review is an exhaustive, transparent, and repeatable search of multiple databases, grey literature, and hand-searching but does not necessarily conduct a quality appraisal or meta-analysis. The rapid review method, like systematic reviews, are subject to critique around researcher bias, transparency and reflexivity [32]. Software tools, such as JBI tools or REVMAN, are useful in addressing bias for systematic literature reviews on topics with a large body of work. However, with little agreement on the definition or methodology of rapid reviews, it is challenging to find a uniform

approach to addressing bias, particularly when drawing upon qualitative data [35]. Thus, we acknowledge our own conscious and unconscious bias (as primarily European researchers presenting methods for working in the global South) and positionality as academic researchers will inform the analysis of papers selected [36].

The rapid review started by identifying sector leading organisations. These included: the Humanitarian Policy Group at the Overseas Development Institute, University of Oxford Refugees Study Centre, HEED at Coventry University, the Moving Energy Initiative, Practical Action, UNHCR, NORCAP, Energising Development, SNV. As the body of work on humanitarian energy and co-design is so small, we decided to include every paper that contained keywords and phrases relating to humanitarian energy. We also draw upon our knowledge of the broader humanitarian sector to include in the search HE programs with a research element, along with academic and grey literature, to address the concern that a rapid review may result in minimal results to analyse. Similarly, although we restricted the literature search by date to focus on HE literature from 2011 to 2021, we did not restrict the number of search databases. The review, in the first instance, was driven by the academic

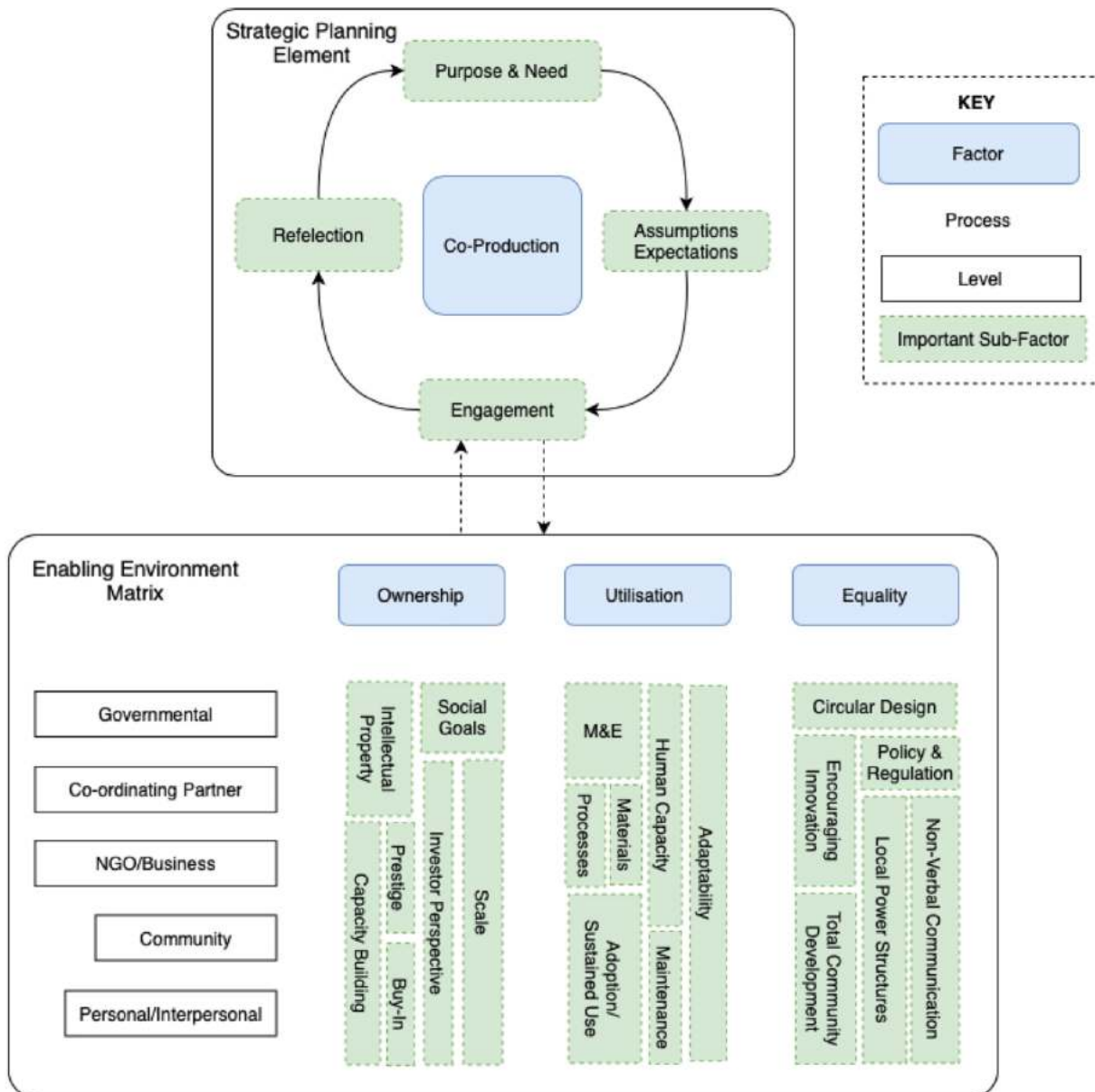


Fig. 1. Technology Implementation Model for Energy [39].

publications with search terms: “Humanitarian Energy”, “Humanitarian AND Energy”, “Energy AND Displacement” in a range of literature databases (Scopus, Web of Knowledge, Science Direct). However, it returned very limited relevant results. Due to the embryonic nature of research on energy and co-design in the humanitarian sector, there is a gap in literature. The next stage was focused on grey literature (briefing papers and policy documents) outlining state of the art co-design sector practice. We recognise that this rapid review may lack the breadth of a full systematic review in capturing co-design strategies outside of the selected literature groups. Still, we feel this did not impact the rigour of the literature search.

2.2. Phase 2: TIME to co-design - evidencing lived experience

For this review to move past theoretical frameworks and typologies, we have included a retrospective analysis of the GCRF EPSRC Humanitarian Engineering and Energy for Displacement (HEED) project framed by the Technology Implementation Model for Energy (TIME) [37].

This framing translates conceptual co-design methods to actionable improvements across the project cycle, from design to evaluation, taking into account the relevant TIME factors and sub-factors as a framework for retrospective learning (see Fig. 1). TIME provides a structured framework that streamlines the retrospective analysis, developing reflectivity and dismantling hierarchies of knowledge whilst also holding systems and practices to account. Moreover, TIME directly addresses perceptions around building energy programs with key stakeholders as partners, rather than as individual elements of the project cycle, as well as introducing concepts outlined in state of the art review. We chose TIME over other evaluator frameworks as the framework is specifically designed with co-design underpinning its core principles. In contrast, other frameworks allude to co-design but are not central to their successful use. TIME is also conceptualised from other frameworks (such as logframes, theory of change, market maps, the responsible research and innovation framework, health-based behavioural change models, design philosophies such as appropriate technology and social enterprise [38]) building on their underlying premiss in order to mitigate some of the limitations of these frameworks. For example, as outlined by Robinson et al. [38], where they fully outline the significance of this new method, Logframes exacerbate historical power inequalities by centralising decision making processes whilst TIME looks to give equal decision making power to all key stakeholder groups.

In addition, this paper introduces TIME (Fig. 1) as a framework for humanitarian energy, which previously has been successfully applied to wider energy-based international development projects [37,38,39]. We collected our primary qualitative data through a focus group and informal discussions held with UK based researchers from Coventry University who worked on the HEED project. The participants represented a broad range of career stages, from early career researchers to established academics who had been involved with HEED either at the beginning of the project (2017) or had joined during the scoping fieldwork in 2018. The average time spent on the project was three years. The focus group was conducted in August 2021 and had ethical approval from Coventry University.

Focus groups are particularly useful in understanding how participants create meaning as a shared discourse and facilitate critical interrogation on how groups construct collective narratives when experiences and attitudes may differ, despite encountering the same event [41]. Unlike individual interviews, focus groups allowed us to explore group dynamics within and between individuals [40]. Yet, there is a concern that whilst focus groups generate collective discussion that situates topics contextually, at times, individual voices may monopolise the discussion, which in turn can alter the group dynamic. There is also the potential for imposed group consensus, where participants will modify and shift their views to remain with a perceived dominant discourse. In acknowledging how focus groups are to an extent performative, this requires us to see responses as socially constructed that

reflect a particular context and informed by structures of power that emerge from positions of privilege. One way we could have addressed these limitations would be to include the voices of the displaced, which would have added an alternative perspective on the co-design process. Instead, using a broadly phenomenological method, we chose a semi-structured, open question approach that explored how researchers understood and perceived concepts of co-design and how that had been applied to HEED. Allowing questions to act as prompts, we could acknowledge the partiality of experience, both their own and others, resulting in an equal exchange or what Rubin and Rubin [42] call a ‘conversational partnership’.

The sample was purposeful, with the criteria for recruitment being participants who were decision-makers in the conceptualisation of co-design. Whilst project partners (Scene and Practical Action) were critical in the delivery and deployment of the programme, researchers from Coventry were instrumental in developing the theoretical framework, in this case, theory of change, which informed the knowledge production of co-design protocols and processes. Due to COVID_19 and the uncertainty of meeting face-to-face, the focus group was conducted online with five participants and lasted for 90 min. In keeping with current literature, focus groups should be between 4 and 8 participants [43,44,45], which is also a manageable number for discussion on a digital platform, for example, the optimum amount of people that can be seen and engage meaningfully on one screen at the same time [46].

We coded our resulting data in Nvivo12 [47] using a high-level deductive analysis method, incorporating the existing TIME framework to collate themes broadly. These themes identified key areas in which project improvements could have been made by applying the theory to practice and where theoretical improvements can be made in learning from applied practice.

2.2.1. TIME for co-design in humanitarian energy

The state of the art technology implementation model The Technology Implementation Model for Energy (TIME) focuses on working towards poverty alleviation in low income and humanitarian settings [37]. TIME builds upon the local participation element of the Humanitarian-Development-Peace Nexus [48], which looks to de-risks energy access operations through a deeper understanding of complex contextual factors that commonly act as barriers to successful technology use. The model has already been applied to a number of energy projects in the wider International Development sector, these include a range of GCRF projects [39] and Practical Action Nepal's USD2M Results Based Financing Project (Funded by Energising Development) [38]. The derivation and subsequent iterations of TIME based upon the various applications is presented in Robinson [39]. TIME is a step away from complex quantitative metrics to a co-produced values-based planning approach that can significantly contribute to co-design methods in HE.

The two elements of TIME are the Strategic Planning Element (SPE) and the Enabling Environment Matrix (EEM). The SPE contains four sub-factors (Purpose & Need, Assumptions & Expectations, Engagement, Reflection) seen through the lens of co-production. This lens considers not only what the end-user adds but what the other key stakeholders can add to the end users as one key stakeholder does not drive the process; it is a collaboration between all key stakeholders – a core element of the co-design process.

The EEM expands the engagement sub-factor to define the roles and responsibilities of each key stakeholder group (Governmental, Coordinating Partner, NGO/Business, Community, Personal/Interpersonal) and their interactions in the context of three factors, which influence behavioural change: Ownership, Utilisation (People & Systems and Material Resources), Equality. Each key stakeholder group's results (or perceptions) are individually mapped onto the EEM, resulting in 5 EEM perspectives. These five perspectives highlight discrepancies in roles to show how the key stakeholder groups interacted with one another through overlap in the EEM perspectives and the ways key stakeholders can influence the behaviours of the intended beneficiaries.

When combined with the visual mapping mechanisms used to present results, this produces a powerful accessible to development practitioners and policymakers.

3. Findings: co-design frameworks for socio-technical systems

The following section outlines a range of research theories, typologies, and practitioner methodologies that aim for co-designed humanitarian energy programmes throughout the various stages of the project cycle. These models, that are ascribed as co-design, co-production, co-creation, and participatory (depending on the sector), look to take into account the voices of the technology end-users and other invested energy stakeholders in an effort to increase the inclusivity of energy programs and in some cases, allow FDP to be the protagonists in their own stories.

3.1. State of the art in co-design for humanitarian energy

Literature on co-design, developed by academics and practitioners, approaches the concept from a perspective of improving project accountability whilst also ensuring that projects respond to the needs of the targeted communities or individuals. This position raises questions such as, how is the humanitarian sector accountable to the people they protect? Do co-design practices promote accountability for humanitarian actors, beneficiaries or funders? These questions, amongst others, frame our critical analysis of our co-design ‘practice’ review for HE as well as the understanding that high-level conceptual frameworks evolve when practised.

We have categorised our results and discussion of the rapid review by

four levels of practitioner co-design: no co-design (Level 0), Community Engagement (Level 1), Inclusivity (Level 2), and Localisation (Level 3) – as presented in Fig. 2 (also accompanied by the equivalent academic methods and categorisations of co-design) (as illustrated by Fig. 2). These four methods, in increasing increments, promote the voice of FDPs across the project cycle to transfer decision making power away from traditionally western or global north partners. Co-design processes are significantly affected, both positively and negatively, by technology-based solutions implemented with little contextual knowledge [49]. This could be especially disconcerting for FDPs when set against the trust required to overcome existing bias around the historical colonialist narrative.

3.1.1. Level 0 – no co-design

As co-design is considered a method of working, we must account for the “no co-design” case, which we have defined as Standardised Response Programs (for practitioners) and Contextually Disconnected Design (for academics). These methods result in design without a current contextual understanding of the community, designing systems that reinforce cultural tropes and knowledge hierarchies, or in short design, for a theoretically imagined community. Whilst this may be appropriate for short-term humanitarian response, this method is usually unsuitable for protracted crises and does not typically align with Sustainable Development Goal development pathways.

3.1.2. Level 1 – community engagement or participatory methods

The first level of co-design is community engagement and/or participatory methods. This level captures the minimum co-design method where community members or individuals are consulted as

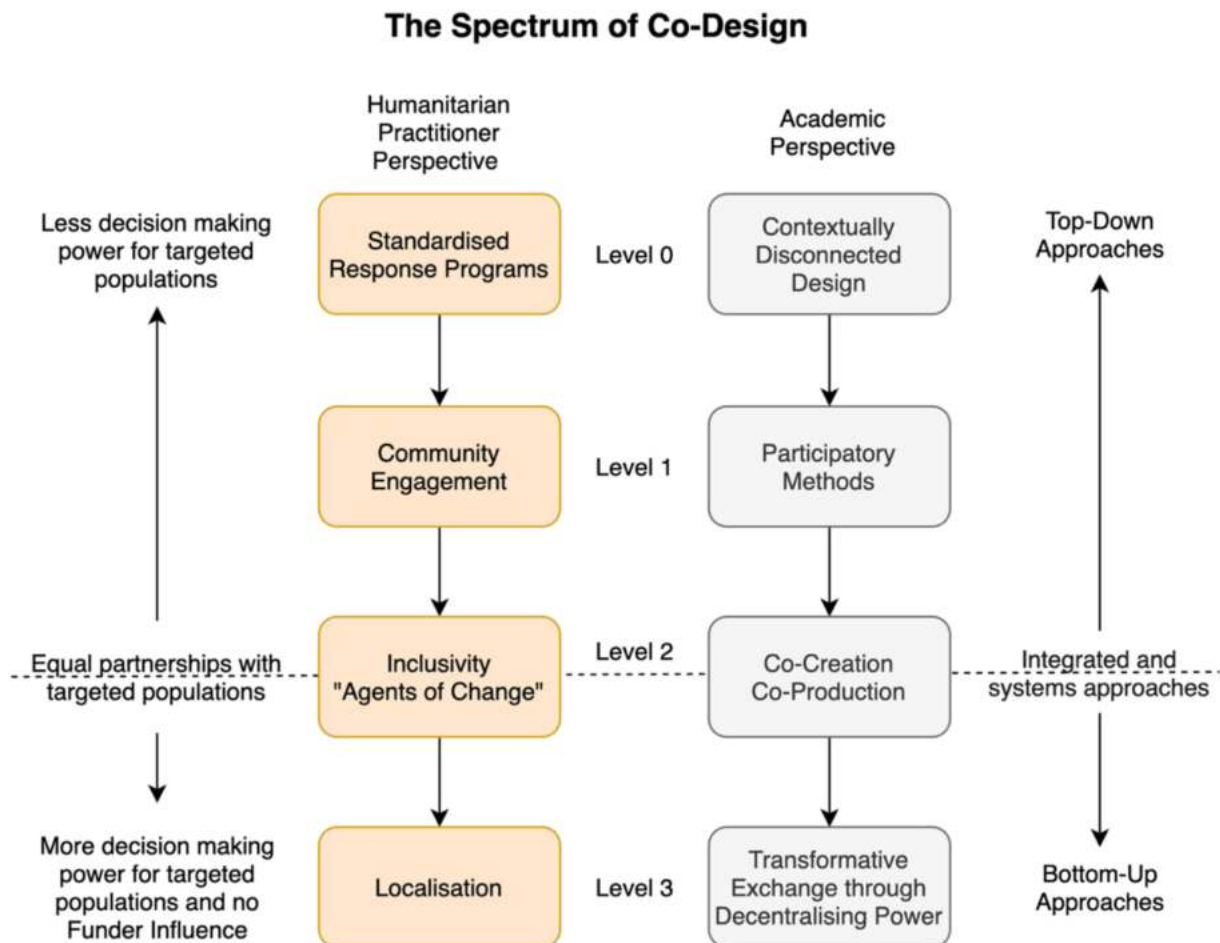


Fig. 2. The spectrum of co-design in socio-technical systems.

customers on their needs, aspirations and desires, including working within the existing socio-cultural, environmental, and financial systems of focus communities. As outlined by the Humanitarian Policy Group [50], the categorisation for methods of community engagement are informed by the type of crisis, degree of collectivism, the extent of integration in government coordination and humanitarian architecture, the type of leadership and co-ordinating mechanism, range of activities, timeline of implementation, scale of response and finance. The Humanitarian Policy Group [50] suggests community engagement is a coordination challenge where contextual variations define community engagement in the response design. Moreover, they also stress the importance of a coordinated inter-agency inter-sectoral approach to community engagement. A systems approach can more effectively provide adequate and targeted humanitarian response rather than negatively impacting other sector responses. Yet, this report also states that the participation of displaced communities in the design and implementation of the community engagement strategies is not a priority for humanitarian actors, “in no context did affected people feel they were involved enough in the planning of projects” (p.20) [50].

There is a significant implementation gap between policy and practice when including affected voices in collective communication and community engagement. Before ascribing methods as community engagement or participatory, projects should give a critical account of whether co-design principles were ‘designed for’, ‘designed with’ or ‘designed by’ (p3) [51]. In conceptualising a typology of international development approaches to co-design, particularly in disaster relief and management, Diaz et al. [51] suggest that traditional ‘top-down’ approaches to design are being replaced by ‘design for’, which appear more participatory but still positions community members as clients and failing to dismantle power structures that exclude community engagement in meaningful decision-making. This suggests participatory elements in the humanitarian response may be revolving around modifying strategy based upon feedback rather than co-creating responses with affected peoples. For example, in Uganda, efforts by a local radio station to generate a platform for refugees and local government to share concerns as ‘Voice of the Voiceless’ is not co-design but a method of reflection, as participants were not involved in the creation of the programme [52]. Level 1 of co-design gives the project creators the power to understand the complex socio-cultural, environmental and financial contextual issues that may be barriers to implementation or delivery. Instead of a coalescence of ideas between project and community, this method focuses on consulting with targeted populations, which links more broadly into human-centred design methods in the health sector [53,54].

3.1.3. Level 2 – inclusivity or co-creation/production – FDPs as agents of change

Level 2 is where the methods of co-design work towards inclusivity, understand FDPs as agents of change through mobilising local resources and existing community-based structures to support HE projects [55]. Rosenberg-Jansen et al. [56] frame inclusive methods for sustainable humanitarian energy services as where technologies for the long term, refugees and local communities act, with beneficiary agency and market-based solutions as the core pillars of an inclusive response. Unsurprisingly, this model sees the people with the most knowledge about the energy needs of the displaced in protracted humanitarian responses as the displaced people themselves. To shift from reinforcing displaced people as recipients of humanitarian aid and move towards communities being agential: “inclusive programmes understand that refugees and local host communities are agents of change rather than simply beneficiaries” (p. 990) [55]. Rather than reproducing displaced communities as homogeneous, this level of co-design recognises diversity of experience, making inclusivity across the project cycle of central importance if energy is to be seen as a primary service by humanitarian agencies.

NORCAP [48] states if energy access is key for achieving the humanitarian-development-peace nexus, then participation of affected

people is central to this success. Many corporate funding organisations are interested in evolving the basic participatory elements into co-creation or co-production strategies by “pivoting away from donations towards co-creation of sustainable, market-based models with non-profit organisations, to ensure long-term lasting impact” [48]. The market based models targeted at FDPs includes market chain strengthening through demand and supply side subsidies, market creation, various humanitarian logistic innovations [57] and the inclusion of market based financial mechanisms such as carbon financing, block-chain [58] and mobile banking. Other market mechanisms aimed at Humanitarian Agencies look to promote the solarisation of humanitarian activities. Whilst market-mechanisms as a method of inclusion may de-risk humanitarian energy services for humanitarian agencies, Level 2 can promote the continuities of colonial development and racism, especially in the African context [59] and increase the financial burden of energy services for FDPs.

3.1.4. Level 3 – localisation – transference of funding to local actors

The third level of co-design is Localisation. Localisation was conceptualised as one of several workstreams set out by the ‘Grand Bargain’ in 2016. This UN secretary General sponsored model sought to engage local civil society and improve efficiency in humanitarian responses by transferring 25% of humanitarian funding to local partners [60]. The transfer of funding to local partners facilitates a certain autonomy (75% of funding is still outside of their control) and addresses constraints of traditional methods of working in the humanitarian setting. Localisation, as a method of working, is currently being championed by the START Network (<https://startnetwork.org/about-us>) and NEAR (<https://www.near.ngo>), who both look to transfer skills and funding to local humanitarian and civil society organisations. Despite COVID-19 resulting in more humanitarian agencies transferring funding to local organisations, only 13 of 62 signatories of the Grand Bargain met this 25% target in 2021 [26,52,60]. The Grand Bargain has resulted in a significant policy shift, but it appears this is yet to be realized in material reality.

For Localisation to succeed, “capacity-strengthening projects should also target the staff of donor organisations and make them aware of the rights of local organisations to negotiate the terms of such programmes” (p. 7) [52]. A paradigm shift is required in thinking, capacity building should identify the existing capacity of local actors and shape response around these existing resources with the donor organisation pivoting around these needs and extending their own capacity when needed. Shifting from capacity-building to capacity sharing means building links between international, national and local actors that connect the levels of humanitarian response. Yet, there must be a balance of care as localisation can be seen as forcing displaced people to be self-sufficient (forced agency), resulting in host nations minimising or relinquishing responsibility for care [52].

3.1.5. Emerging approaches for co-design in humanitarian energy

To clarify the connectivity and overlap of existing co-design methods, this state of the art review has conceptualised the spectrum of co-design, as shown by Fig. 2. However, there are other emerging approaches not captured by our spectrum of co-design. These include humanitarian practitioner and academic researcher partnerships with elements of private sector engagement. These approaches aim to transfer a significant proportion of funding to local humanitarian and civil society actors where local actors lead project design, implementation, and evaluation elements. We recognise that this represents the conceptual ideal of co-design methods. The field-level reality can often be disconnected from theories of methods of best practice, and even if equitable partnerships are the goal, FDP engagement, inclusivity or decision-making power may continue to be low. To work towards the next level of co-design then central issues with the current co-design methods, such as the lack of post-program/project support to FDPs, requires more consideration. Likewise, more focus is needed on addressing

difficult and complex negotiations around how post-program sustainability is ensured once the funding for the project is ended. As explored by Unsworth [61], co-design and innovation methods share many of the structural barriers to successful implementation. Additionally, this mapping process has also helped the authors to understand the relationship between co-design and innovation, where incremental innovation is required to move down to the next level of co-design, and a disruptive or paradigm innovation would skip co-design levels.

State of the art data collection mechanisms academic researchers use for co-design is traditionally underpinned by qualitative research methods (particularly ethnographic and phenomenological approaches) [62,63]. Academia tends to focus on using these existing data collection mechanisms coupled with analysis frameworks for gaining insights into qualitative data for specific purposes. Whilst these existing qualitative methods and accompanying analysis frameworks provide the foundation of the co-design academic discourse in the humanitarian setting, the central question is around how, and critically when, these are implemented. For example, Robinson et al. [37] provide a detailed analysis of the lived experience of rural Nepali households focusing on the behavioural mechanisms to promote adoption and sustained use of improved cookstoves. Yet, this process was conducted as a snapshot evaluation at the end of the project. Whilst this retrospective finding had importance for the co-ordinating and funding partners, it was of little use to the beneficiaries of that specific program. However, if Robinson et al. [37] had conducted this process across the project cycle reacting to the changing needs of key stakeholders, this would have been a co-design process where the voices of all key stakeholders shaped the project as it evolved, transferring this method from the participatory to the co-creation level. This conceptual future of co-design in the humanitarian energy sector embeds the voices of all stakeholders, including that of the FDP in the humanitarian context, into the programmatic inputs, processes, outputs, outcomes and impact resulting in a constant narrative between key stakeholders and the facilitating or coordinating partner(s).

4. Findings: theory to practice – evidencing lived experience

First, we thought our co-design methods were well beyond the state of the art, and we trusted them. Second, we didn't think that there were any special attributes that would affect the co-design phase of the project just because we are working with the refugee camps. Now, those assumptions, both of them were gravely flawed. Absolutely and bitterly flawed

(Respondent, A)

To demonstrate the usefulness of TIME as a tool in conceptualising co-designed projects, the Humanitarian Engineering and Energy for Displacement (HEED) was used as a case study to illustrate ways to implement a more holistic understanding of methods, challenges, and best practice. Led by an interdisciplinary team from Coventry University, with delivery partners Scene and Practical Action, HEED aimed to understand the energy needs and aspirations of Congolese refugees in three camps in Rwanda (Gihembe, Kigeme, and Nyabiheke) and internally displaced people (IDPs) forced to leave their homes as a result of the 2015 earthquake in Nepal [64]. Over the project lifetime, half the people HEED employed were refugees or internally displaced people [65].

The project's overarching aim is to understand the energy needs and aspirations of forcibly displaced people that could aid the transition from needs-based energy solutions to energy interventions that embed self-determination and self-reliance for displaced people and their host communities. The objectives of HEED centred around 1) Build into the project ways to address the lack of local understanding of solar systems, a gap in skills required for maintenance and long-term sustainability of interventions. 2) Engage communities in conversations around ownership and self-governance before interventions to secure sound and

effective energy utilisation after deployment. 3) Use culturally sensitive approaches to system design by drawing upon community knowledge. Over the project's lifetime, HEED collected qualitative and sensor monitoring data to aid decisions and policies about energy services. For example, in Nepal, individual energy appliance monitors documented electricity usage, costs, and sufficiency in grid-connected sub-metered scenarios, while in Rwanda, sensors collected data on cookstoves, solar mobile lanterns, and communal lighting use and utility. In addition, the 1000 survey responses collated from across populations in four camps became an evidence base that addressed the lacuna of energy data in the displaced setting.

HEED developed through a series of workshops with energy stakeholders, including displaced communities, energy design protocols that respond to and embed the lived experience in the displacement setting. This led to the piloting of five community co-designed energy interventions using socio-technical frameworks. In Khalte, Nepal, the interventions were seven advanced solar streetlights, which were handed over to the community in December 2020. In Nyabiheke refugee camp, Rwanda, HEED installed a standalone solar system for a community hall and 40 solar mobile lanterns; in Kigeme, a PV-battery micro-grid for two nursery buildings and a playground; eight solar streetlights and four advanced solar streetlights in Gihembe. The interventions were handed over to international humanitarian agencies Alight and World Vision in January 2021 but are still managed by the community leaders. It is important to note that HEED was not the only energy project working in this space as another larger-scale project funded by the IKEA Foundation and in partnership with Practical Action, the Renewable Energy for Refugees project (RE4R) operated in the same Rwandan refugee camps and at similar times. Whilst its aims were not centred around co-design, this project did produce research around how rethinking other aspects of project design, deployment, and maintenance can improve access to energy in the displaced setting that will positively impact significantly on the life choices and opportunities of refugees [15,66–69].

Drawing upon data collected in a focus group of HEED researchers based at Coventry University, the findings were analysed through TIME's Strategic Planning Element (SPE) and the Enabling Environment Matrix (EEM). As previously stated, the SPE four sub-factors: Purpose & Need, Assumptions & Expectations, Engagement, and Reflection, are critical frames when planning for co-design. The EEM expands the category of engagement to define the roles and responsibilities of key stakeholder groups around ownership, utilisation and equality. This section looks to first, demonstrate the extent to which applying an energy mapping tool can benefit the design and deployment of energy systems in the displaced setting. Second, be evidential on the lived experience of implementing a co-design strategy to show the connections and disconnections between theory and practice.

4.1. Purpose/need

HEED sought to bring the voices of key stakeholders into the design process to create solutions that would more accurately capture the energy needs of the IDPs/Refugees in the camp setting. This understanding of co-design evolved over the duration of the project (which is explored further in the [Reflections](#) section). Activities that facilitated engagement with camp-based refugees and key energy stakeholders, such as Energy 4 Displacement and Energy 4 End-User workshops, alongside qualitative surveys with end-users, informed system design [70] and integrated co-decision making about deployment and types of energy interventions, for example: 'streetlights having plug sockets so that people can have free access to electricity. I know that was because the community had voiced their need for having free sockets' (Respondent, C). Providing a platform for participants to discuss with the project team their energy needs and inform system design corresponds with Level 1 (Fig. 2).

4.2. Assumptions/expectations

SPE as a model allows for critically interrogating assumptions, first around key stakeholder roles, and the second exploring the relationship between energy access and energy use. In the case of HEED, applying SPE during the project planning would have helped the team deconstruct and challenge cultural tropes and unconscious bias around working in the humanitarian space, more so, 'when nobody in the team that wrote the proposal has ever met or visited any of the communities, we ended up working with' (Respondent, B).

4.2.1. Key stakeholder roles

Whilst there was an expected language barrier between key stakeholders working across countries, what was less expected was the language barrier between different academic disciplines, as well as the implementation partners. This resulted in miscommunications around expectations of the co-design process, which at times risked destabilising partnerships due to contested views on how to engage participants to achieve the project's aims. For example, there were challenges in how the team and partners understood specific specialised terminology and, more broadly, practices, such as how the Ethical Approval process translated into the fieldwork. Moreover, expectations around ways of working between the academic, practitioner and private sector partners (who were contracted to build some energy systems) differed.

4.2.2. Energy access & energy use

The HEED team assumed that improving access to energy for participants in the camp would automatically result in increased energy use. However, as much of the initial co-design work was focussed on participants and camp leaders' aspirational energy futures, it also reproduced an understanding of energy use based on the HEED teams expectations of how participants understood energy systems.

We failed to provide a sufficiently realistic impression of how the systems are going to be used to enable the Community to brainstorm as to whether or not they are making the right choices [...], but we didn't know any better either, so I think it was our failure as the design team to enable that community to really, really take informed decisions

(Respondent, A)

After installing the energy interventions, the communities may have a clearer understanding of how to use the energy systems, but they also lacked the basic infrastructure to utilise the resulting energy access. In the case of Kigeme Refugee Camp, this was rectified by the HEED team pivoting to community energy demand and donating laptops, iPads and a projector. In Nyabiheke Refugee camp plastic chairs were provided so that the community hall could be used in the evenings. The projector was subsequently used to start a micro-business showing films in the evenings, initiating thinking on how to use the energy created by the off-grid systems creatively.

More generally, the question of how to realign these assumptions and expectations resulted in two evolving strategies:

Very direct and intense involvement between us as the academic team and the communities through their representatives

(Respondent, A)

Working with small groups of people time after time and several rounds on sort of apparently lateral issues. So, we recovered in the course of the project by paying much more attention and being much more embedded in the communities

(Respondent, A)

Working with communities in precarious environments presents challenges in establishing and maintaining relationships of trust. For

instance, the camp in Nepal was a more recent temporary construction, but in Rwanda, participants had resided in the camps for considerable times, the average being 16 years [71]. As participants and local representatives in Rwanda were less likely to be relocated, this should have helped in relationship building, but attendance at workshops was voluntary. Rather than a continuous evolution of that relationship between the UK-based and in-country key stakeholders, HEED had to reset exercises such as capacity building or knowledge sharing each time for participants. Co-design requires the ability to implement rectification pathways at all project stages, as HEED team member states: 'You should never ever engage in codesign when there is no rectification pathway' (Respondent, A).

4.3. Participation/engagement

Key in any successful co-design method is not only in how key energy stakeholders are engaged but also in the strategic aims of the engagement strategy. TIME's EEM focuses on how projects address three factors central to the success of any engagement strategy: ownership, utilisation, and equality.

4.3.1. Ownership (through capacity sharing)

By engaging with methods of co-design, this prompted the HEED project to consider concepts of ownership in more detail, which included how these systems would have to function independent of (and post) EPSRC Funding: 'I think also the idea of co-design was to develop through this process in the refugees a sense of ownership so that once the project is over, they actually feel responsible and part of the systems that were deployed' (Respondent, B). The inclusion of a capacity building (or sharing) element disrupts conventions as this process aims to disconnect refugee communities from wider humanitarian power structures, which may be replicating cultural hierarchies and positions of privilege. Sharing information between key energy stakeholders in a core concept of co-created or co-produced (level 2) energy projects as it dismantles inequality of access and/or ownership of knowledge and facilitates learning exchange. Whilst HEED looked to engaging refugees and IDPs as community mobilisers in the maintenance of the technical solar systems, simultaneously, these same people shared with HEED insights into understanding of the lived experience within a complex contextual environment.

4.3.2. Utilisation

HEED looked to the existing power structures and systems of ownership in the camps to maximise usage and utility of the energy as the camp context is heavily regulated financially, economically and socially. By utilising local power structures, HEED shifted towards relinquishing hidden power ideologies and confronted their own knowledge vulnerabilities as European researchers in the camp setting. Despite those measures, in some cases, there was still some under-utilisation of the energy technologies, for instance, certain locations of streetlights. Further conversations with those residing near the lights found that: 'We realized that, in a poll, some of the locations actually encroach on people's porches, and so other people were hesitant in using those sockets, which obviously meant underutilization of the resources' (Respondent, C). By acknowledging and responding to these vulnerabilities, HEED started to address the power asymmetry and understand that the communities have the contextual knowledge that is often instrumental in the level of impact a project can achieve. In short, researchers working on HEED became knowledge receivers as well as knowledge givers.

4.3.3. Equality

When working with co-design methods within the humanitarian setting, the HEED team encountered prevailing power structures, meaning the way power and authority manifests in organisations, practices and societal norms, which can exacerbate inequalities both in

the camp and between the camp and wider society. The process of identifying the site for the micro-grid in Kigeme Refugee Camp illustrates this:

Myself, a couple of other people, and UNHCR officer (responsible for energy provision) moved from one hill to the next visually survey opportunities for the solar panels. We looked for a place that is not creating any problems and does no harm. There were only a few buildings that could be identified, believe it or not, in a whole, I don't know how many thousand people camp, there was only three buildings that were allowed to be connected in a microgrid. So, where is the community in this decision?

(Respondent, A)

4.3.4. Reflection

Lastly, the SPE model recognises the value of reflective practice in the co-design process. Engaging in reflection moves the researcher from acknowledging positionality, how social location frames our position in the world in relation to others, and towards becoming reflexivity. The reflexive researcher makes explicit intersecting power relations, challenges unequal power in the research process and understands it is not an individual reflection but a collective action with others. The focus group provided a retrospective platform for HEED researchers to reflect together on what consists best practice around future co-design methods, processes and strategies. First, during a project the understanding of co-design *evolves*. Co-design, as outlined by Section 3, has multiplicity that results in a number of definitions, depending on how project coordinators frame the process and disciplinary standpoints. Initially, HEED researchers envisaged co-design as consulting communities on the best technical solutions. They then conceptualised co-design as overlapping processes between researcher and end-user needs as the project progressed. By the end of the project, co-design was seen as embedding iterative co-design processes from the outset, involving all key stakeholders in the decision making, not only as end-users of the technology.

I've actually been trying to shift away from using the word co-design now to co-create [...] it's about having a voice or input throughout the entire life of the intervention

(Respondent, B)

The question the HEED team then proposed was how do we take this one step further to post-deployment and long-term management of these technical energy solutions, linking into the ownership factor as well as concepts presented by Robinson [72], where co-design methods must evolve to enable FDPs to be "protagonists of their own stories".

The second reflection is centred around **building trusting partnerships** not only with project partners but also with the FDPs themselves. For example, after the camp communities felt the systems needed protecting, HEED employed FDPs as security guards to look after the systems, which built community trust in the project while actively responding to the evolving needs and aspirations of the FDPs. The iteration of ideas and the flexibility to react to the changing needs and contextual realities of FDPs is a quality needed by the project partners who, when lacking in these qualities, can create structural barriers to the project's success. A central element of building trusting project partner relationships is being transparent about project failings and accepting collective responsibility rather than assigning individual blame.

I've never been on a project that's been quite so transparent about its failings, and I think that is one of the solutions. It's having the confidence to say this is not going the way we want. Let's step away from it and see where we are in this and not blame the community and not blame the technical but say what have we done as researchers to contribute to that

(Respondent, D)

Finally, **looking to future HE projects**, earlier consultation with all key stakeholders in the camps may have resulted in less divergence between the assumptions of the research team and the lived experiences of camp-based refugees. HEED team members also stress the need for further exploring concepts of flexible architectures and minimum viable product, where low-cost prototypes are deployed not only as proof of concept but also allow end-users to better understand what the impact of these energy technologies may be.

5. Conclusion & research gaps

Throughout this paper, we have argued that the underdeveloped nature of socio-technical systems developed for HE has resulted in a lack of understanding in the sector on how different co-design methods are implemented by and between various key energy stakeholders. In response to this lack of understanding, we presented the Spectrum of Co-design (Fig. 2), which looks to solidify and clarify the interaction of co-design concepts to understand how different co-design methods interact and collate. However, we recognise that this spectrum is incomplete as new and disruptive co-design methods need to take each sector forward and connect the siloed sub-sectors of HE. We suggest leaving behind bottom-up or top-down initiatives in this process of developing new methods when taking forward the key learnings from this paper.

To demonstrate the extent to which applying an energy mapping tool can benefit the co-design and deployment of energy systems in the displaced setting and be evidential on the lived experience of implementing a co-design strategy, we utilised TIME as a tool for our retrospective analysis. This provided a tried and tested method [37,38,39] for a multi-level interrogation of factors to aid the co-production of energy programmes with all key stakeholders. The usefulness of the TIME is shown by the systematic process for multi-stakeholder engagement, which mitigates issues such as miscommunication of purpose, the misalignment of assumptions and expectations, as well as building ownership through the IDPs and refugee communities. Implementing TIME at the beginning of the HEED co-design process may have mitigated many of the issues discussed in Section 4. Nevertheless, as evidenced by the lived experience of HEED team members, the logistical constraints of conducting co-design methods in complex environments that see FDPs decision processes and power structures are often stymied by the realities of field implementation. We also highlighted the ways the co-design methods evolve as HEED project members are forced to deconstruct their assumptions when utilising local power structures. Whilst, this process illustrated the evolutionary nature of co-design, it also reinforced the legitimacy of the co-design spectrum by showing how projects can step between levels.

By utilising a formative and evaluative co-design framework, such as TIME, future projects will be able to navigate some of the issues faced by the HEED project through clearer understanding of the interception of purpose and need, deciphering the different assumptions and expectations, aligning stakeholder priorities in the engagement process, and engaging in reflective practice. This will create trusting and equitable partnerships that function with lines of open communication as a step towards transformative knowledge exchange and away from many exploitative and extractive research practices. Finally, as stated throughout the paper, the need for reflective practice, iterative course correction, acknowledging failings and developing a deep understanding of the complex contextual factors remain critical to creating significant and sustained impact.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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