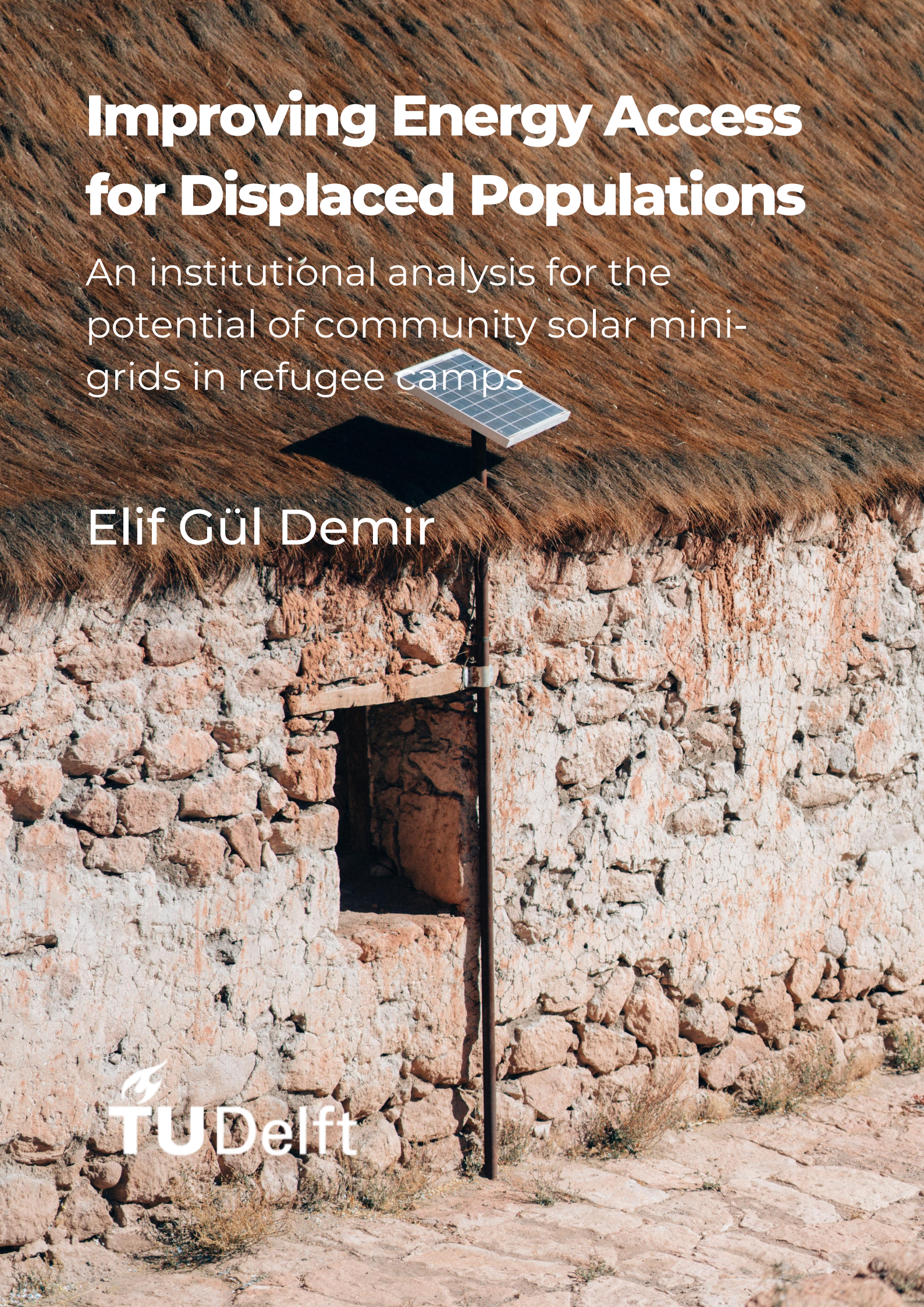
Improving Energy Access for Displaced Populations

An institutional analysis for the potential of community solar mini-grids in refugee camps



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IMPROVING ENERGY ACCESS FOR DISPLACED POPULATIONS: AN INSTITUTIONAL ANALYSIS FOR THE POTENTIAL OF COMMUNITY SOLAR MINI-GRIDS IN REFUGEE CAMPS

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I had the opportunity to be involved in the foundation Energy for Refugees for which we funded, designed, and installed a grid-connected solar PV system for the Moria refugee camp in Lesvos, Greece in July 2019. On the second day at the camp, one of the camp residents gave us a tour of the camp and helped us communicate with other residents by translating between English and Pashto -and even Turkish that he learned from his stay in Turkey. We were offered food and help while installing the system several times and even had a chance to have dinner with two Afghani families -simply because they wanted to help in any way possible under harsh circumstances.

That desire to give back has stayed with me long after my time in the camp and motivated me to study improvement of energy access in refugee camps for my thesis. I would like to thank my committee members, university staff, and interviewees for making this research possible. Rolf, I appreciate your understanding through my research. Thomas, your feedback on my research design and methods was very useful. I cannot thank Daniel enough, who guided me through every step of the process. Marja Brand and Wouter Backx, thank you so much for your kindness and guidance through difficult times. Lastly, I thank all the interviewees from humanitarian energy field who have been so welcoming and helpful in sharing their valuable insights with me.

For someone who has been away from home since the age of 14, moving to the Netherlands was still a challenging experience. I'm lucky that I've met amazing people here who made it feel like home, especially my friends at CoSEM and Energy for Refugees. A special thank you goes to my friends in Turkey whose presence gave me strength for the last two years. Ayşe, you make me feel grounded and calm even in the face of adversity. I feel lucky to have you in my life for better or worse, always. Dilara and Tuğçe, your motivation speeches and constant support make me smile through stressful times. I'm grateful to know that we always have each other's backs. Merih, I couldn't ask for a better person to go through a thesis process in the middle of a pandemic and literally anything that life may throw at us. Thank you for always believing in me even when I didn't. Lastly, mom and dad, I cannot thank you enough for loving and supporting me unconditionally my whole life. You two made all this possible, I love you.

Elif Gül Demir
Delft, October 2020

EXECUTIVE SUMMARY

Implementation of a community solar mini-grid for a refugee camp is a complex polycentric issue with multiple levels of decision-making bodies coordinating production, provision, financing, and monitoring activities bringing together several actors such as humanitarian and development organizations, nation states and local governments, partnerships, funders, private sector actors, research organizations, and camp and host communities. The questions such as who should initiate, develop and manage an energy project, which actors should be involved in, how the operations and maintenance activities that needs be carried out in a displacement setting are not readily answered. This research aimed to answer the following research question:

Main Research Question

To what extent can community-based governance approaches for solar mini-grids provide energy access in refugee camps?

The research is exploratory in nature since this topic has not been studied in the literature, which brings out qualitative research as an approach. Case study was selected as the strategy to conduct qualitative and exploratory research that this thesis is concerned with. The information gathered from desk research and semi-structured interviews are presented in the related elements of the IAD framework and assessment framework. The Kigeme refugee camp in Rwanda is selected since it has political and managerial stability, ongoing initiatives to improve energy access, and data available for analysis. The Institutional Analysis and Design (IAD) framework with integration of multiple levels of analysis in constitutional, collective-choice, and operational level is used. A community level analysis of humanitarian energy governance is done through desk research and semi-structured interviews. Additionally, the drivers and barriers for community solar mini-grids are discussed with experts to better understand the potential of such systems in displacement settings and transformed into an assessment framework for decision-makers to utilize.

The energy governance in the Kigeme refugee camp is analyzed by applying the IAD framework with multiple-levels of analysis that is tailored to represent global and camp-level rules-in-use. It is observed that the level of energy access differs among households, community facilities, and enterprises. There is a lack of regulatory framework detailing how a particular energy use can be supplied with available options of national grid, diesel mini-grid, and solar micro-grid. In addition, the lack of technical expertise and dominance of UNHCR in decision-making processes about energy provision activities results in ineffective use of funds. With recent projects, the technical expertise is used to promote community involvement,

market-based financing mechanisms, and improved policy making. The inclusion of refugee community in planning, decision-making, and implementation phases of the project is thought to will help to provide electricity to all refugee households.

The factors that affect the success of community solar mini-grids are compiled by evaluating the findings from the study of the Kigeme refugee camp, and literature review on common-pool resource management and community mini-grids. An assessment framework is created that describes these factors as technological, institutional, economic, and social factors. Technological factors that need to be considered by decision-makers are identified as sizing of the system capacity, technical expertise, and monitoring activities. Institutional factors identified are the lack of regulatory framework, definition of ownership, and knowledge sharing. Economic aspects that impact community solar mini-grids are funding, private sector involvement, and financing. Social factors that need to be taken into account are community involvement and social capital. The research shows several opportunities for humanitarian organizations to involve camp communities and private sector so that energy needs can be met in a sustainable and cost-effective way. Long-term planning and funding play can be ensured by strengthened relationships with funding partners. The lack of data on global and camp levels requires more research to explore opportunities to meet energy needs. To improve the sustainability of energy services, more coordination will be needed between refugees, local governments, humanitarian organizations, and private sector actors -which opens up the possibility for public-private partnerships. Eventually, the energy system should help to facilitate the sustainable development of displaced communities.

This thesis contributed to the newly accelerating body of humanitarian energy literature by utilizing an institutional analysis framework to analyze the complex network of actors involved in decision-making process for energy provision in the Kigeme refugee camp. In addition, an assessment framework is created that lists technological, institutional, economic, and social factors that need to be taken into account by decision-makers so that the community-based solar mini-grids would be successful. Future research can focus on multi-country analysis to better understand similarities and differences of energy provision in different camps. The IAD framework can be applied to other camps and the outcomes of the policy-making processes can be used to check whether the local context affect the outcomes and update the assessment framework accordingly. A field study can be conducted in camps to better understand the energy use of camp residents and evaluate the applicability of solar mini-grids with community participation. Finally, after analyzing the institutional arrangements and exploring to what extent community solar mini-grids are applicable in camp settings, next step is researching the design of such systems. The principles of community-based approaches for camp management can be consolidated with the framework for comprehensive energy infrastructure design.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS

ADB	Asian Development Bank
AfDB	African Development Bank
ARE	Alliance for Rural Electrification
CPR	common-pool resource
CRRF	Comprehensive Refugee Response Framework
CoSEM	Complex Systems Engineering and Management
DFI	Development financial institutions
DFID	The UK Department for International Development
DRC	Democratic Republic of Congo
ECOWAS	Economic Community of West African States
EDP	Energias de Portugal
ENDEV	Energy for Development
ESSP	Energy Sector Strategic Plan
FAO	Food and Agriculture Organization of the United Nations
FCDO	The UK Department for Foreign, Commonwealth Development Office
GCR	Global Compact on Refugees
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GOGLA	Global Off-Grid Lighting Association
GPA	Global Plan of Action
HEED	Humanitarian Engineering and Energy for Displacement
IAD	Institutional Analysis and Design
IASC	Inter-Agency Standing Committee
ICRC	International Committee of the Red Cross
IDP	Internally Displaced Person
ILF	International Lifeline Fund
IMF	International Monetary Fund
IOM	International Organization for Migration
IRENA	International Renewable Energy Agency
kWh	kilowatt-hour
LPG	liquid petroleum gas
MEI	Moving Energy Initiative
MIDIMAR	Ministry of Disaster Management and Refugee Affairs
MINEMA	Ministry in Charge of Emergency Management
MININFRA	Ministry of Infrastructure
MSF	Médecins Sans Frontières
MW	Megawatt
NFI	non-food item
NGO	Non-governmental organization
NRC	Norwegian Refugee Council
NWOW	New Way of Working
OCHA	United Nations Office for the Coordination of Humanitarian Affairs

PAYG	pay-as-you-go
PPA	power purchase agreement
PV	photovoltaic
RCM	Refugee Coordination Model
RE4R	Renewable Energy for Refugees
REC	Refugee Executive Committee
RWF	Rwandan Franc
SAFE	Safe Access to Fuel and Energy
SDG	Sustainable Development Goal
SEforALL	Sustainable Energy for All
SES	Social-Ecological System
SIDA	Swedish International Development Cooperation Agency
SNV	Stichting Nederlandse Vrijwilligers
SPIU	Single Project Implementation Unit
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNGA	United Nations General Assembly
UNHCR	United Nations High Commissioner for Refugees
UNICEF	United Nations Children's Emergency Fund
UNIDO	United Nations Industrial Development Organization
UNITAR	United Nations Institute for Training and Research
UNRWA	United Nations Relief and Works Agency
WASH	water, sanitation and hygiene
WFP	World Food Programme
Wh	watt-hour

Part I

THESIS DEFINITION

1 INTRODUCTION

This chapter provides an introduction to the research conducted for the thesis. Section 1.1 presents background information on energy access in refugee camps within humanitarian aid operations and discusses solar mini-grids as a viable option to meet energy needs. Section 1.2 defines the problem as governance of solar energy projects in refugee camps. Section 1.3 describes the objective of the research as exploring the potential of community solar mini-grids in refugee camps. Section 1.4 defines the scope of the research. Section 1.5 provides the main research question and sub-questions to be answered. Section 1.6 describes the analytical foundation of the research. Section 1.7 argues for the social and academic relevance of the research topic. The chapter concludes with Section 1.8 which provides an outline of the report.

1.1 BACKGROUND INFORMATION

1.1.1 Increase in the number and duration of forced displacement situations

More and more people are forced to leave their homes as a result of persecution, conflict, violence, human rights violation, and natural disasters. According to United Nations High Commissioner for Refugees (UNHCR) data, the global forcibly displaced population increased from 43.3 million in 2009 to 79.5 million in 2019 as shown in Figure 1.1 (UNHCR, 2020). Some of the crises that led to this increase in forced displacement are the conflicts in Syria, Ukraine, Afghanistan, Iraq, Libya, Somalia; the displacement crises in South Sudan, Yemen; the arrival of refugees and migrants to Europe, the influx of stateless refugees from Myanmar to Bangladesh, and the outflow of Venezuelans (UNHCR, 2020). 17.2 million people were forcibly displaced because of natural disasters, mostly in the countries struck by conflicts in 2018 (OCHA, 2019). The number of people fleeing their homes is expected to increase as the effects of climate change become more prevalent and root causes of conflicts are not addressed (OCHA, 2019).

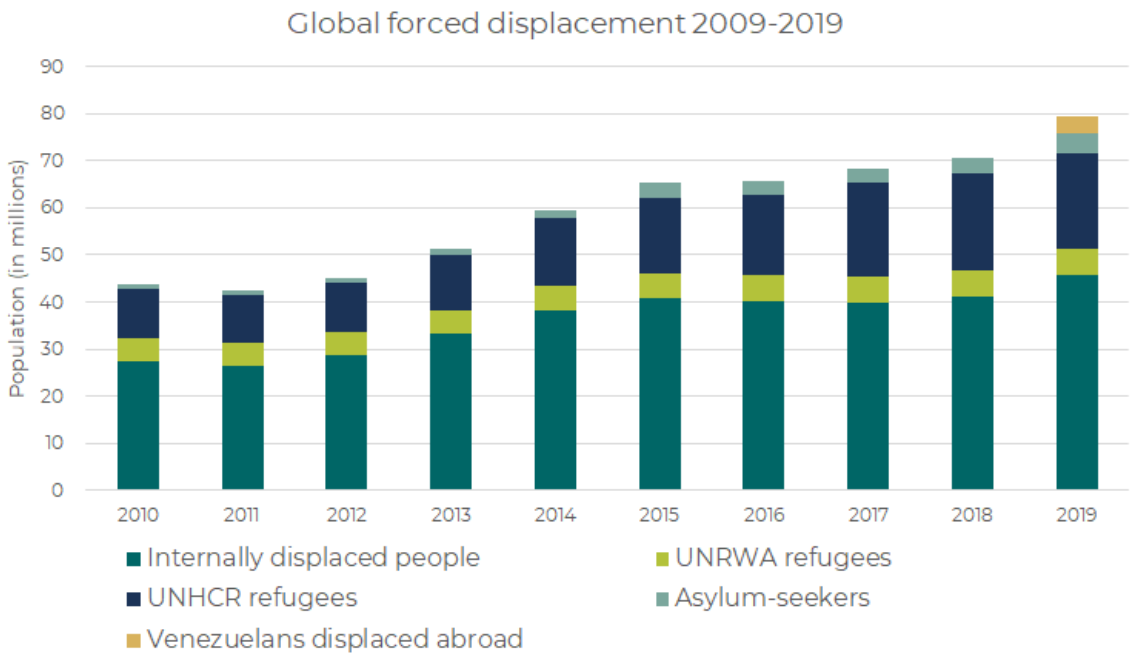

Figure 1.1: The number of forcibly displaced people between the years 2009 and 2019, adapted from UNHCR (2020).

Of 79.5 million forcibly displaced individuals, 45.7 million are internally displaced people (IDPs), 4.2 million are asylum-seekers, and 26 million are refugees, and 3.6 million are displaced Venezuelans that are included in this year's statistics (UNHCR, 2020). UNHCR is responsible for 20.4 million refugees whereas 5.6 Palestinian refugees are under United Nations Relief and Works Agency's (UNRWA) mandate (UNHCR, 2020). For the rights and safety of displaced populations, and especially for refugees, it is important to know the differences between these terms (UNHCR, 2020). Asylum seekers are people who seek international protection and whose request for sanctuary has not been processed by the country they submitted their claim to. IDPs are people who are forced to leave their homes because of violence, natural or human-made disasters while staying within the borders of their country of origin. IDPs have the rights and freedoms as other citizens and remain under the protection of their government. Refugees are people who fled their country of origin because of conflict or persecution. Protected under international law, refugees must not be expelled to their country of origin if their lives or freedom are at risk.

Normally three solutions are proposed to end a forced displacement situation: voluntary repatriation to the country of origin, local integration, and resettlement to a third country (UNHCR, 2020b). These options proved useful in the past but recently their effectiveness is questioned as their implementation becomes difficult (UNHCR, 2020). In recent years, humanitarian crises started to last longer and require more resources (OCHA, 2019). In 2019, almost 16 million people were in a protracted refugee situation, meaning that at least 25,000 refugees from the same country were in exile for at least five years (UNHCR, 2020b). This represents 78% of the refugee population with a steep increase of 12% compared to the previous year (UNHCR, 2020b). Nine situations were already classified as protracted in 2018 as they lasted

longer than five years (OCHA, 2019). The problem is that these populations can neither go back to their country of origin nor are granted asylum from their country of target in a short amount of time. According to UNHCR (2020b), the freedom of movement, legal employment, protection, and access to education can be hindered in protracted refugee situations.

1.1.2 Refugee camps: From minimum standards to essential needs

When necessary, camps are established with the purpose of providing emergent and secure spaces for refugees and internally displaced people (Bulley, 2014). It is important to recognize that not all refugee settlements can be identified as refugee camps. Jacobsen (2001) categorizes three different refugee settlements: self-settlements, organized settlements, and camps. Self-settlement happens when the refugee community settles to a location with no legal status and formal protection (Jacobsen, 2001). Organized settlements are initiated by UNHCR but later handed over to the government of the host country (Jacobsen, 2001). Camps are usually in rural areas and administered by the host government, the UNHCR, international organizations like the International Committee of the Red Cross (ICRC), the International Organization for Migration (IOM), the Norwegian Refugee Council (NRC), or non-governmental organizations (NGOs) (Jacobsen, 2001). For the purposes of this research, camps are chosen as the settlement type of focus as they have clearly defined administration structures.

The assistance provided in refugee camps by UNHCR consists of shelter, emergency relief items, water and sanitation, food, healthcare and counseling, and registration and legal aid (UNHCR, 2020d). These services are categorized as minimum emergency standards, which if not guaranteed, is fatal for vulnerable populations. The minimum standards approach might work in the immediate aftermath of a crisis but considering that the average lifetime of a refugee camp is 18 years (Grafham and Lahn, 2018), it is expected that the needs of refugees will increase as camps become more permanent places. That's why Jamal (2000) argues that UNHCR should move from "minimum emergency standards" to "essential human needs" in protracted situations. Essential needs comprise of initiatives to improve life quality within camps, provide refugees with tools for empowerment, invest in enhancing skills and capabilities of communities by training. The essential needs approach guarantees a safe and dignified life since they are more flexible in terms of the time and context and also allow for sustainable development of refugee communities, which has become one of the main aims of humanitarian agencies (Bulley, 2014). Such an approach brings out topics that are overlooked in minimal standards approach such as energy access.

1.1.3 Energy access in refugee camps

Energy access is "the ability of end-user to utilize energy supply that is usable for the desired energy services" (Bhatia and Angelou, 2015). Energy access has been measured as a binary variable (presence or absence of access) until Bhatia and An-

gelou (2014) introduced a new multi-tier framework to categorize energy access with five tiers. The authors also identified three different uses of energy for households, productive use, and community uses as shown in Figure 1.2. For example, for households, Tier 0 means no electricity, Tier 1 refers to lighting and phone charging with a minimum daily capacity of 12 watt-hour (Wh) whereas Tier 5 encompasses lighting, phone charging, television, fan, and very high-power appliances with a minimum capacity of 8.2 kWh. The tier of energy access has a significant impact on the sustainable development of communities. This index is used as a guideline to assess the research and projects conducted on energy access in refugee camps.

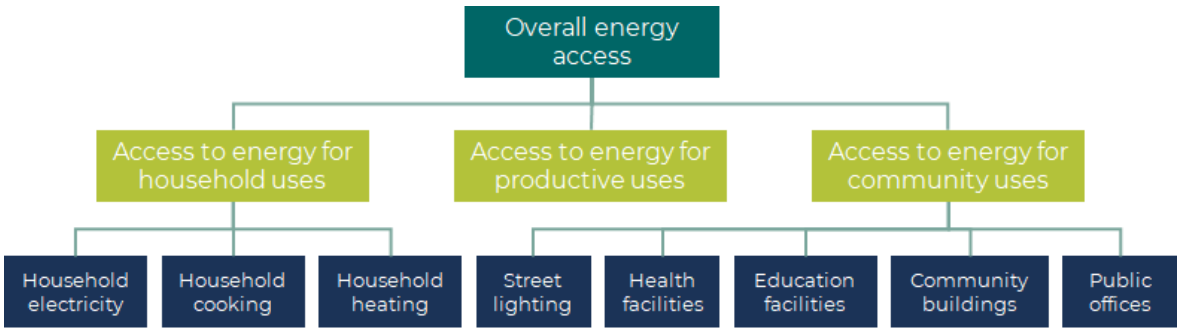

Figure 1.2: Energy access for different energy locales, adapted from Bhatia and Angelou (2014).

While access to energy is crucial for cooking, lighting, heating, clean water, and most income-earning activities, the electricity provided in refugee camps is either non-existent or severely lacking in terms of availability, accessibility, and quality (Lahn and Grafham, 2015). Services related to energy are listed as distribution of stoves, winterization kits, charcoal, and solar lanterns while diesel generators are used for meeting the basic electricity demand of camp (Grafham, 2019). A recent report by Moving Energy Initiative (MEI) shows that 89% of camp populations only have Tier 0 lighting and 77% have Tier 0 cooking access worldwide (Lahn and Grafham, 2015). Overall, 97% of refugee households have limited to no electricity access (UNHCR, 2019a).

The report by MEI shows that 3.5 million tonnes of oil equivalent of energy is used by displaced populations in 2014, supplied mainly by firewood and charcoal (Lahn and Grafham, 2015). It is estimated that 85% of refugee households use firewood for cooking (UNHCR, 2019a). As a result of this use, around 13 million tonnes of CO_2 is emitted for household energy access in refugee camps (Lahn and Grafham, 2015). In addition, firewood creates indoor pollution which results in respiratory diseases among refugee populations, endangers women and girls who are harassed on the way to collect them, and causes problems with host communities when there is a rivalry over limited resources (Lyytinen, 2009). Even though diesel generators might be practical in the early phases of settlement, renewable energy sources such as wind and solar can meet the demand without releasing CO_2 to the atmosphere. With their higher generation capacities, solar mini-grids increase the chances that the energy can be used for productive uses in addition to household and community uses, which is crucial for empowerment and resilience of refugees.

1.2 PROBLEM STATEMENT

Solar energy has been included as an option to provide energy access in refugee camps in the limited number of academic papers published, as presented in Appendix A. The studies focus on energy demand modeling, energy system optimization, food-energy nexus, or market analysis. The literature shows that solar energy seems to be promising but the challenge is that providing energy access in refugee camps requires designing in the complex humanitarian energy sector. Humanitarian energy sector is defined as "institutions, policies, programmes, global initiatives, actions, and activities which use a range of sustainable and fossil fuel energy sources in contexts of displacement, to meet the energy needs of people in camps and urban settings, self-settled refugees, host communities, and internally displaced people" (Rosenberg-Jansen, 2019). From local to international authorities in public, private and voluntary domains are involved in the decision-making, provision, production, financing, coordination, and monitoring activities and the roles and responsibilities of the actors involved are not clearly defined (Rosenberg-Jansen, 2019).

Goldthau (2014) states that governance might be helpful in these non-hierarchical, multi-level complex problems. There are many different definitions of governance in the literature. Cayford and Scholten (2014) define governance as "the intentional but ubiquitous shaping and guiding of collective human behavior by various means within various arrangements". McGinnis (2011) states that "governance is a process by which the repertoire of rules, norms, and strategies that guide behavior within a given realm of policy interactions are formed, applied, interpreted, and reformed". It defines who can do what with whom and with which roles and responsibilities (McGinnis, 2011). In the context of this research, the governance aims towards providing energy access within camps through policies for solar mini-grid implementation.

Three different governance perspectives used in humanitarian aid literature are hierarchy, market, and collective action (Tortia and Valentinov, 2018). As an example of hierarchical governance, humanitarian organizations ask social enterprises to design a system for which these enterprises assess the energy demand by estimating the electricity and lighting used in a camp. The enterprises then get several offers from private sector actors who provide the technical system. The social enterprise might operate and maintain the system in coordination with the humanitarian organizations and local government policies. In another example, the solar energy market can provide different options such as solar home systems or pay-as-you-go for refugees which would leave the governance of the system to the markets. Market-based approaches offer the private sector an entrance to an untapped market and solve the problem for public actors.

Hierarchy and market-based governance perspectives might exclude refugees in the design, operation, and maintenance processes which decreases the lifetime and acceptance of the system (Fuentes et al., 2018; Grafham and Lahn, 2018). Rosenberg-Jansen et al. (2019) state that renewable energy systems should be inclusive so that

the refugees are not beneficiaries but "agents of change" and solutions have a higher success rate. Therefore, community-based energy systems might be promoted where refugees are actively participating in the planning, design, installation, operation, and maintenance activities. The refugee communities, in collaboration with the humanitarian organizations, might assess their energy needs and decide on rules to make sure that over-consumption or lack of maintenance does not result in system failure. To achieve such a system, an analysis of the current governance of humanitarian energy sector is needed on global and camp level to understand to what extent community-based governance can be used for solar mini-grids in refugee camps.

1.3 RESEARCH OBJECTIVE

This research aims to explore to what extent a community-based approach is applicable for solar mini-grids in refugee camps as visualized in Figure 1.3. With the rise of community-based approaches within the humanitarian aid field and community solar mini-grid projects for development, the collective action literature led by Ostrom becomes the anchor for this study. The technological, institutional, economic, and social factors that impact the success of community solar mini-grids in refugee camps are identified through desk research and interviews. A case study is conducted by applying the Institutional Analysis and Design (IAD) framework in the Kigeme refugee camp. Desk research and expert interviews are carried out to understand the interactions between the actors, outcomes of policy decisions, and challenges of using solar mini-grids in camps. The research provides recommendations for humanitarian organizations that wish to promote community involvement in solar mini-grid projects to provide energy access in refugee camps.

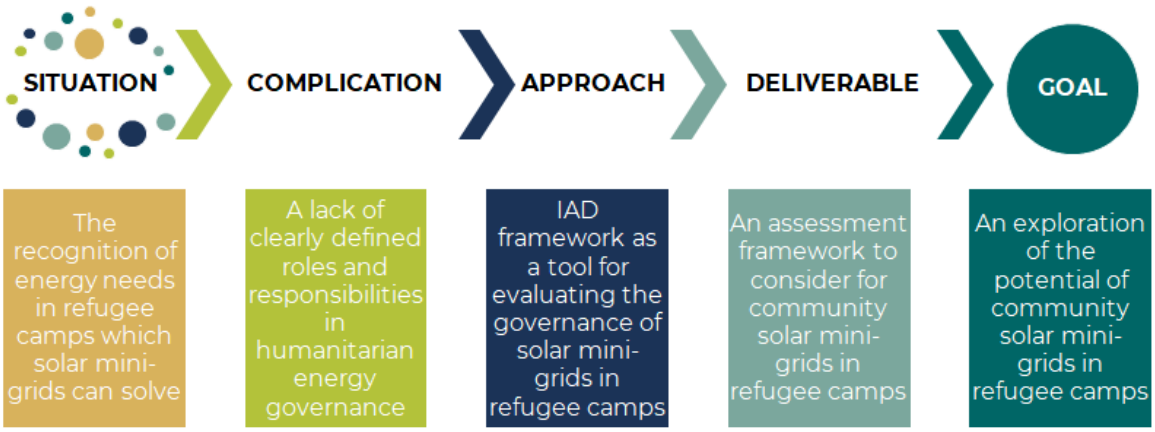

Figure 1.3: The objective of the research.

1.4 RESEARCH SCOPE

The scope of the research is the energy requirements for household, community, and productive uses of refugees and internally displaced persons (IDPs) who live in a camp setting administered by an official institution like UNHCR, government, or other NGOs. The research excludes refugee settlements such as self-settlement and organized camps where governance structures are not clear. The policies and practices for providing energy access in the Kigeme refugee camp in Rwanda are analyzed according to the IAD framework.

1.5 RESEARCH QUESTIONS

In light of the initial literature review conducted, it can be concluded that the potential of community solar mini-grids which takes into account the roles and responsibilities of humanitarian organizations, national and local governments, funding partners, private sector actors, and camp residents and the coordination between them have not been investigated. As a result, the main research question (RQ) and sub research questions are formulated as follows:

Main Research Question

To what extent can community-based governance approaches for solar mini-grids provide energy access in refugee camps?

1. **How can the governance of community solar mini-grids be studied in the context of refugee camps?**

   This question establishes the theoretical framework for the research. The literature review shows that governance of solar mini-grids significantly impacts how the system operates in the long-term. Thus, desk research is conducted to go through literature on governance and institutional analysis. It is found that the IAD framework can help to understand the humanitarian energy governance and the potential that community solar mini-grids hold. The multiple levels of analysis are integrated with the IAD framework in order to understand how rules at higher levels affect the actions at the camp level.

2. **What are the current governance practices for providing energy access in refugee camps?**

   This question investigates humanitarian energy governance at the global level since decisions made in this level impact the situation in the camp level. Through desk research and semi-structured interviews, the actors involved in humanitarian energy governance are identified as humanitarian and development organizations, nation states and local governments, partnerships, funders, private sector, and research organizations. The roles and responsibilities of these actors and the coordination between them are described to get a better understanding

of current decision-making processes. The recent policies, projects, initiatives and their outcomes to improve energy access in displacement settings are listed and discussed based on the goals set through international agreements.

3. **What energy-related problems are experienced in the Kigeme refugee camp and how do the actors respond to these problems?**

   This question explores the humanitarian energy governance in the Kigeme refugee camp in Rwanda. While applying the IAD framework, desk research and semi-structured interviews are conducted to understand how humanitarian and development organizations, nation states and local governments, partnerships, funders, private sector, research organizations, and refugee communities interact with each other. The international and camp-level rules and practices, attributes of community, and physical conditions in camp are analyzed with the help of assessment framework created, which ultimately impact the policy decisions regarding energy access in camp.

4. **What are the drivers and barriers for community solar mini-grids in refugee camps?**

   This question aims to understand the technical, institutional, economic, and social factors that affect the success of community solar mini-grids in refugee camps. The global level analysis is used to identify the community solar mini-grids as an option to provide energy access in camps. Desk research is conducted to create an assessment framework that lists success and failure factors for community solar mini-grids in refugee camps by combining literature on sustainable management of common resources and mini-grids in high and low-income countries. It is argued that understanding advantages and disadvantages of such systems enables humanitarian organizations and local governments to tackle problems that might arise. These findings are discussed with experts through semi-structured interviews to improve the reliability and validity of the research.

The research flow diagram showing the research activity required for answering each research question is shown in Figure 1.4.

1.6 ANALYTICAL FOUNDATION

This exploratory research uses deductive and reflective research approaches to answer the research question. Deductive approach uses existing theories to test a hypothesis while exploratory approach investigates the applicability of community solar mini-grids from identifying patterns of interactions in refugee camps (Creswell, 2009; Van Thiel, 2014). The deductive part of the research applies the IAD framework to policy-making process for energy access in the Kigeme refugee camp. The interviews questions are prepared so that the variables of the theoretical framework are operationalized as suggested by Van Thiel (2014). The elements of the IAD framework are used as guidelines in organizing information regarding the case study of energy

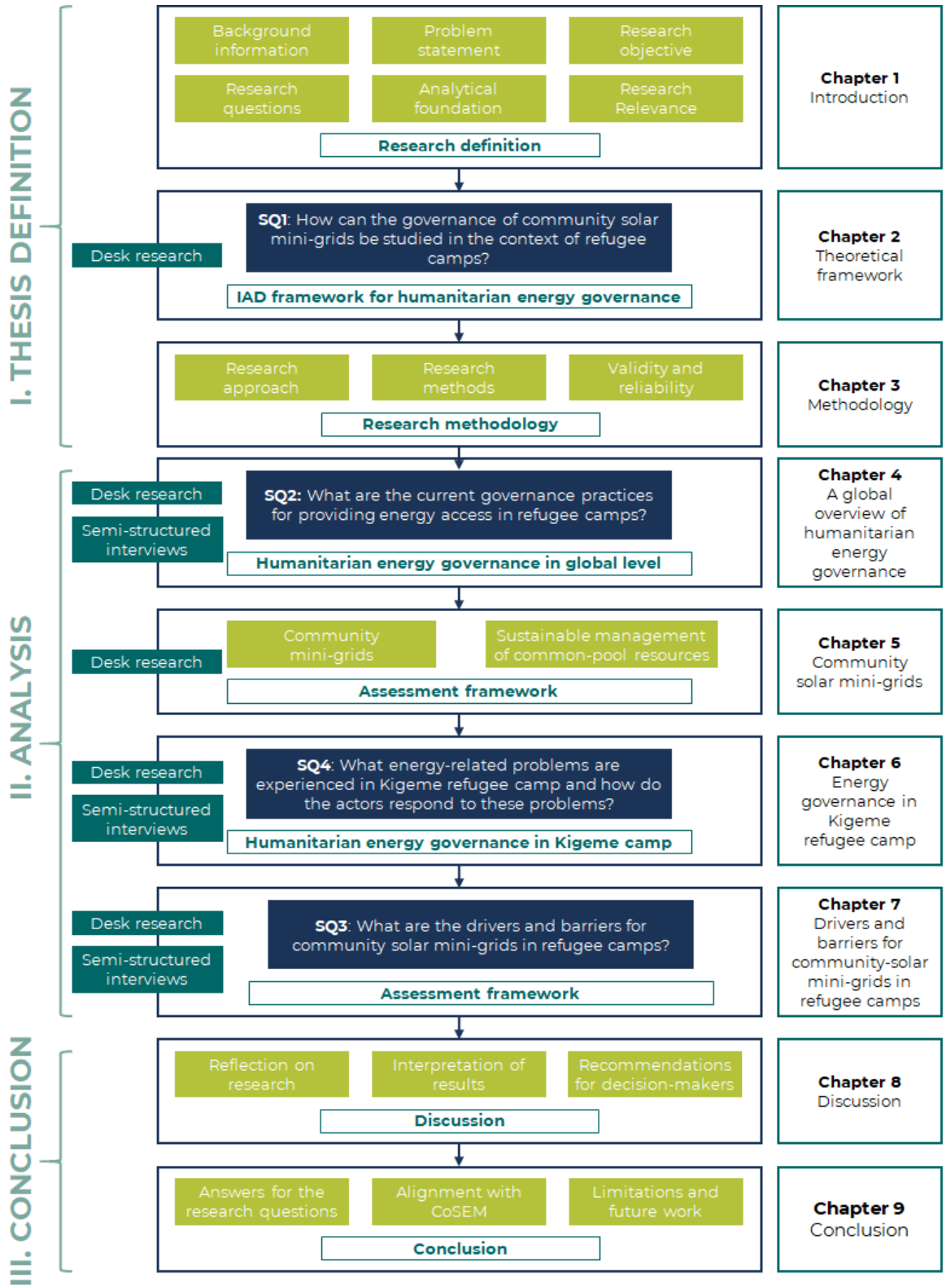

Figure 1.4: The research flow diagram presenting the research activities related to each sub-question and output of each chapter.

governance in the Kigeme refugee camp. In the reflective part of the research, the findings from the case study are used to build on the existing theories that map out

factors that promote or hinder community mini-grid projects in high and low-income countries. An assessment framework is created by merging common-pool resource management and community mini-grids in a refugee camp context. This analytical approach is illustrated in Figure 1.5.

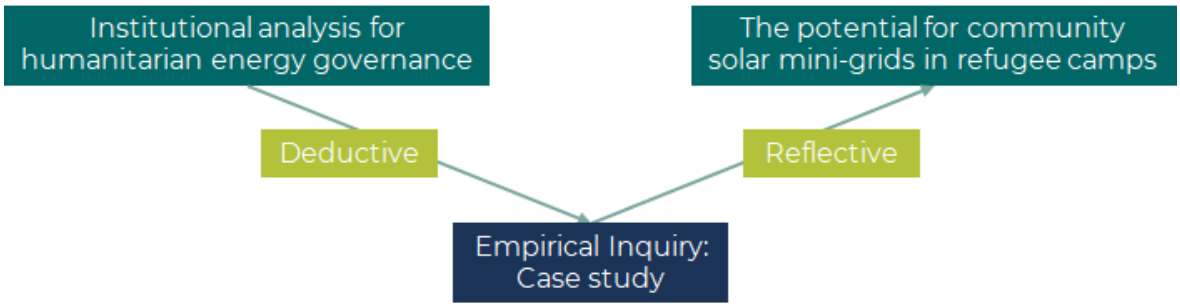

Figure 1.5: The analytical approach taken in the research, inspired by Mittal (2019).

1.7 RELEVANCE

1.7.1 Social relevance

Energy is considered to be one of the key factors in overcoming major challenges and seizing the opportunities that people face today. Among 17 Sustainable Development Goals (SDGs) outlined by the United Nations (UN), SDG 7 refers to "ensuring access to affordable, reliable, sustainable and modern energy for all" (UN, 2015). Energy is seen as an important tool for reaching other SDGs as well. Nerini et al. (2018) show that achieving SDG 7 helps to reach 65% of targets identified for all SDGs such as addressing climate change, reducing deaths from pollution, and ending human rights abuses. As International Renewable Energy Agency (IRENA) reports, this is because access to safe and sustainable energy has an impact on access to clean water and sanitation, job creation, security, climate change, food production, and economic development (IRENA, 2019). Household energy access enables children to do their homework during the evening and decreases health-related problems because of indoor air pollution. Lighting and access to clean cooking are one of the most important factors that increase the resilience of the camp residents. Community use helps to decrease violence against women and children, support operations of humanitarian organizations, and promote the education of camp residents. Street lighting can help women and girls who are harmed by sexual and gender-based violence in the absence of street lighting in the evenings where they use bathrooms or collect firewood (Gunning, 2014). Productive use supports small enterprises like barbers or ice-cream shops within camps which increases the self-reliance of camp residents.

1.7.2 Academic relevance

Access to energy is often seen as a long-term investment that requires infrastructure planning and establishment which does not fit with the emergent disaster relief ef-

forts (Lahn and Grafham, 2015; Lahn et al., 2016b; Turner, 2016). However, since a refugee can spend two decades in a camp, humanitarian agencies and NGOs started to include energy access in their agenda (UNHCR, 2020d). Since energy is a newly developing area in humanitarian response field, there is a lack of organization and coordination between actors which decreases the chances of success for implemented projects. It is argued that governance and institutional analysis literature can help to disentangle the complex layers of the humanitarian energy sector in order to include communities in the systems. This research applies the IAD framework to a socio-technical system that is solar mini-grids in refugee camps. The governance literature generally comprises of analyses and studies that focus on socio-ecological systems with little attention to socio-technical systems (Künneke and Finger, 2009). In addition, most of the studies use the governance of natural resources by long-established communities -which might not always be the case for refugee camps depending on the year of establishment and heterogeneity of backgrounds of people staying in the camp. Thus, academically, this research aims to contribute to the literature on institutional analysis with a focus on socio-technical systems in a displacement setting.

1.8 REPORT STRUCTURE

This research comprises of three parts: thesis definition, analysis, and conclusion with eight chapters. In the first part, a general framework for the thesis is provided. Chapter 1 introduces the problem. Chapter 2 provides the theoretical framework that guides the research. Chapter 3 discusses the research methodology. In the second part, the analysis is done on the humanitarian energy sector through desk research and semi-structured interviews. Chapter 4 describes humanitarian energy governance at the global level. Chapter 5 provides a brief description of mini-grid technology and ways to sustainably manage community mini-grids. Chapter 6 focuses on the Kigeme refugee camp and investigates how energy related problems are handled within the camp by applying the IAD framework. Chapter 7 discusses drivers and barriers for using community mini-grids in refugee camps in terms of technological, institutional, economic, and social aspects. In the third and last part, the research is concluded with discussion and conclusion. Chapter 8 provides a reflection on the research process, a discussion on the interpretation of results, and recommendations for decision makers. Finally, Chapter 9 concludes the report by providing answers to research questions; discussing the alignment of the research with the study program; identifying limitations and recommending ideas for future research.

2 THEORETICAL FRAMEWORK

This chapter answers the first research question "*How can the governance of community solar mini-grids be studied in the context of refugee camps?*" by providing the theoretical framework. Section 2.1 argues that institutional analysis helps to understand the governance of humanitarian energy sector, and especially solar mini-grids. Section 2.2 gives thorough information on the IAD framework and its elements. Section 2.3 provides guidelines for applying the IAD framework and multiple levels of analysis embedded within the framework. The chapter concludes with Section 2.4 that discusses how the IAD framework with multiple levels of analysis is applied to the governance of humanitarian energy sector.

2.1 THE NEED FOR INSTITUTIONAL ANALYSIS OF HUMANITARIAN ENERGY GOVERNANCE

According to Cooper (2015), literature review can serve four purposes: (i) integrating what others said or worked on, (ii) criticizing previous works, (iii) building bridges between related topics, and (iv) identifying central topics in a field. For this research, the aim is to combine previous research and projects and build bridges between institutional analysis of polycentric governance and community solar mini-grids for refugee camps.

2.1.1 Governance of resources: From market vs. hierarchy to community

The successful implementation of energy projects in refugee camps depends on the governance of the system. Fuentes et al. (2018) discuss that the lifetime of the solar energy system installed in Saharawi refugee camp was significantly reduced due to lack of coordination between several organizations operating in the refugee camp, clear definition of maintenance responsibilities, and training on the operation of the system. The authors state that the system tends to be successful in the long-term if the end-users pay or care for the system (Fuentes et al., 2018). The expert interview conducted by Ossenbrink et al. (2018) reveals that the lack of data on energy demand and costs, expertise in solar energy within the humanitarian sector, payment schemes, adaptable solutions for emergency response, and use of complementary technologies limit the use of solar energy. These studies show the importance of the creation and application of rules and strategies, which is defined as governance in the previous chapter, to make sure that renewable energy projects are successful in the long-term.

Different modes of governance

Governance literature mainly distinguishes between two main perspectives: market and hierarchy (Williamson, 1996). Ménard (2012) discusses hybrid markets that lie between two schemes that can be governed by third party coordination. For non-profit organizations, three different modes of governance are identified: *governance by hierarchy* where the humanitarian organization is responsible for the actions related to the design, installation, and management of the system; *governance by market* in which demand and supply are the main incentives; and *governance by collective action* which is a mix of the first two with the inclusion of collective action by communities (Tortia and Valentinov, 2018). Hybrids are seen as a mixture of hierarchy and markets whereas collective action denies both of them. Collective-action is different from hierarchy because of its self-governing and voluntary nature and it cannot be thought of as market since it does not necessarily involve agents buying and selling from each other (Tortia and Valentinov, 2018). Self-governance happens when communities are capable of organizing themselves to participate in governance activities. This research focuses on governance by collective-action because complex systems like humanitarian energy sector need communities and governance of the activities (Provan and Kenis, 2008).

Whether collective-action can be successful and sustainable to govern resources is initially met with skepticism by Hardin (1968) and Olson (2012). Hardin (1968) argues that leaving the management of resources to communities leads to tragedy due to over-consumption. He illustrates this by giving an example of a pasture shared by multiple herdsmen. Here, the positive impact of having one more cattle is observed solely on the herdsman whereas the negative impact of overgrazing is shared by all herdsmen, making the individual herdsman's overall gain positive. It follows that each herdsman would seek to increase their gain by adding one more cattle to their herd, which results in overgrazing of the pasture. The individual profit maximization of each individual leads to a tragedy: the depletion of natural resources (Hardin, 1968). Olson (2012) also argues that beneficial results are highly unlikely in case of a public or common good because of the "free-rider" problem. As a solution to avoid this tragedy, Hardin (1968) proposes privatization of the property or defining allocation rights to public property.

Community governance

In contrast to the pessimistic views of Hardin and Olson, Nobel laureate Elinor Ostrom shows that community governance can produce fruitful results through institutional arrangements. Ostrom's several case studies show the sustainable management of natural resources by local communities such as inshore fisheries, small grazing areas, groundwater basins, irrigation systems, and communal forests (Ostrom, 1990). For example, Ostrom (1990) analyzes how land tenure is managed in a village of 600 people in Törbel, Switzerland. Legal documents written in as early as 1224 define rules for five types of community-owned land: the alpine grazing meadows, the forests, the wastelands, the irrigation systems, and the roads (Ostrom, 1990). Villagers unanimously set up rules stating that the citizens cannot send more cows

than they can feed during winter for grazing (Ostrom, 1990). Accordance with this rule is monitored by counting the number of cows sent by each family and heavy fines are imposed upon those who do not comply with the rule (Ostrom, 1990). It is observed that communal tenure brought people together to make sure that they protected their resources while improving the land by maintenance activities.

This case shows that in time, small communities jointly establish rules to sustainably manage their resources on who can use the resource, how much one actor can use the resource, and how the behaviors of actors are monitored. According to Ostrom (1990), communities can establish rules even in uncertain and complex settings. Seeing what communities can achieve through self-governance, Ostrom (1990) focuses on enhancing the capabilities of those involved to change the rules of the game so that there would be favorable outcomes instead of tragedies. This idea is the inspiration behind this research as the question is how these governance practices can be applied in refugee camps to provide energy access for camp residents.

2.1.2 The need for institutional analysis

Rosenberg-Jansen (2019), in the only resource focused solely on humanitarian energy governance, states that humanitarian energy sector is positioned between two fields: energy access for development and humanitarian aid. Development is established through long-term decentralized sustainable energy projects in developing countries by national and local authorities (Rosenberg-Jansen, 2019). On the other hand, humanitarian response is carried out by global organizations and, as mentioned in the previous chapter, aimed to last for a short period of time. Since the institutional arrangements within these two sectors are highly divergent, the governance of humanitarian energy sector becomes difficult (Rosenberg-Jansen, 2019).

The number of donor agencies, NGOs, government authorities at national and local levels, the conditions of the camp, and the needs of camp residents result in a complex environment to regulate and provide energy access. It can be argued that humanitarian energy sector is a polycentric governance system. Polycentric is defined as "many centers of decision making that are formally independent of each other" (Ostrom et al., 1961, p. 831). It is argued that polycentric governance might be even required for complex institutional arrangements since economics, political science, and sociology are intertwined within these systems. McGinnis (2011) distinguishes four properties of polycentricity:

- *Multi-level*: Local, provincial, national, regional, and global units of governance
- *Multi-type*: From general purposed jurisdictions (traditional federalism) to specialized, cross-jurisdictional political units (special districts)
- *Multi-sectoral*: public, private, voluntary, community-based, and hybrid kinds of organizations
- *Multi-functional*: provision, production, financing, coordination, monitoring, sanctioning, and dispute resolution activities

Polycentricity is clearly observed in humanitarian energy sector. The multi-level nature is detected since from international organizations like UNHCR, IOM, and NRC to national governments and local authorities are involved in the decision-making processes. It is multi-type because refugee camps are special units that are in jurisdiction of both international agreements and national and/or local governments. Humanitarian energy sector is multi-sector since even though humanitarian response is voluntary in nature, public authorities provide the legitimacy for international organizations and private actors started to get involved either as donors or service providers. Energy access in humanitarian response fields is multi-functional as it deals with the provision of energy sources such as firewood or clean cooking stoves, production of energy from mini-grids or main grid, and coordination and financing of these activities. Ostrom et al. (1961) argues that polycentricity does not necessarily bring out chaos. To ensure that, one needs to understand what are the practices for governing humanitarian energy sector and how institutions are operationalized (Rosenberg-Jansen, 2019).

2.2 THE INSTITUTIONAL ANALYSIS AND DEVELOPMENT (IAD) FRAMEWORK

Ostrom originally developed the Institutional Analysis and Development (IAD) framework to study governance of natural resources without the state intervention in the 1980s. Over at least three decades, Ostrom and her colleagues at Indiana University refined the IAD framework for anyone who wants to understand how human interactions and outcomes differ across diverse institutional settings (Ostrom, 2005). The framework provides a set of variables to consider for identifying the factors that influence complex situations in a manageable manner as shown in Figure 2.1. Many scholars use the framework as a coding manual to keep track of the variables for data collection and analysis (Ostrom, 2010). The framework serves a basic vocabulary for scholars to discuss or compare theories (Ostrom, 2010). According to this framework, action situations, affected by external variables, are in patterns of interactions. These interactions create outcomes whose performance is evaluated by some criteria. The outcomes of policy affect external variables and action situation in the end.

2.2.1 Action situation

The core of the IAD framework is action situation which refers to “the social space where participants with diverse preferences interact, exchange goods and services, solve problems, dominate one another, or fight” (Ostrom, 2005, p. 14). The individuals observe the information provided to them, interact with each other, and observe the outcomes of those interactions in the action situation (McGinnis, 2011). In the previous versions of the framework, the action situation, together with actors, was in a box called “action arena”. This distinction between action arena and action situation was discarded as position rules already cover the capabilities of the participants

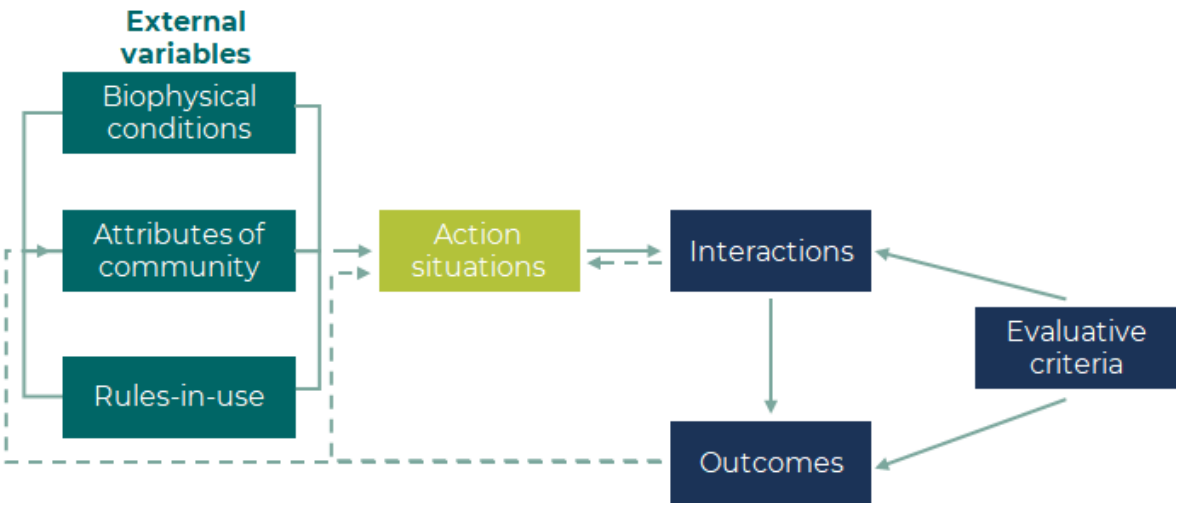

Figure 2.1: The Institutional Analysis and Development framework, adapted from Ostrom (2010).

and there is no need to point out actors separately (Ostrom, 2010).

According to Ostrom (2010), to specify the structure of a game and predict outcomes, the theorist needs the posit:

(i) characteristics of the actors involved

(ii) positions they hold

(iii) set of actions that actors can take at specific nodes in a decision tree

(iv) amount of information available at a decision node

(v) outcomes that actors jointly affect

(vi) set of functions that map actors and actions at a decision node into intermediate or final outcomes

(vii) benefits and costs assigned to the linkage of actions chosen and outcomes obtained

These variables are also identified as the inner workings of an action situation as shown in Figure 2.2.

2.2.2 External variables

External variables, also called exogenous variables or contextual factors, comprise of social, cultural, institutional, and physical environment that set the context for the action situation (McGinnis, 2011). These variables are clustered as biophysical conditions, attributes of community, and rules-in-use that the participants use to interact within the policy sphere. The external variables collectively shape the interactions of participants and the outcomes of these interactions.

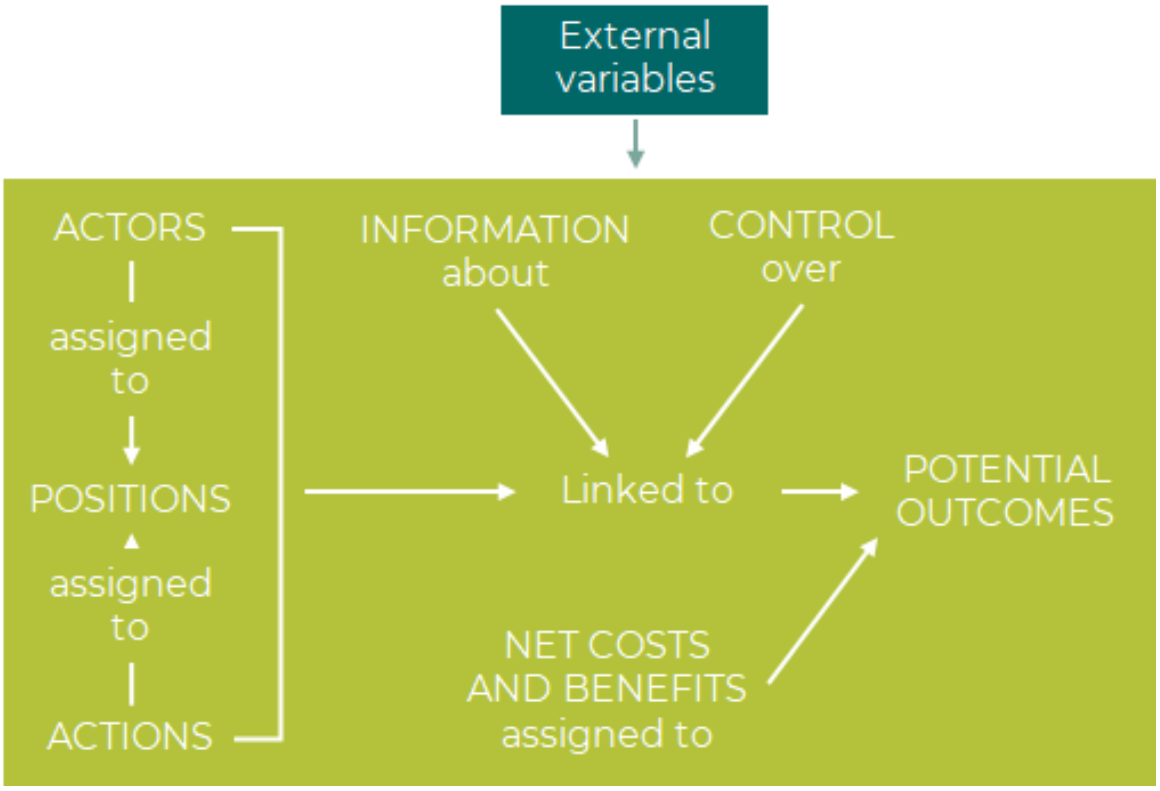

Figure 2.2: The internal structure of an action situation, adapted from Ostrom (2010).

Biophysical conditions

Biophysical conditions refer to the characteristics of the type of good selected. Ostrom (2010) challenges the classification of goods as only public and private and doubles the types of goods depending on the subtractability of use and difficulty of excluding potential beneficiaries as shown in Table 2.1. This adds common-pool resources and toll goods to the categorization of goods. In this categorization, the subtractability of use refers to the situation whether one user's consumption of the good decreases the value or quality of resources available for other users. The difficulty of excluding potential beneficiaries means whether an individual might be excluded from using that resource or how costly for an individual to exclude another.

Table 2.1: The classification of different types of goods, adapted from Ostrom (2010).

		Subtractability of use	
		High	**Low**
Difficulty of excluding potential beneficiaries	**High**	*Common-pool resources*: groundwater basins, lakes, irrigation systems, fisheries, forests, etc.	*Public goods*: peace and security of a community, national defense, knowledge, fire protection, weather forecasts, etc.
	Low	*Private goods*: food, clothing, automobiles, etc.	*Toll goods*: theaters, private clubs, daycare centers, etc.

Attributes of community

Attributes of community stands for prior interactions, heterogeneity or homogeneity of key attributes, and knowledge and social capital of participants (Ostrom, 2010). These can be vaguely understood as culture and shared values. The attributes significantly impact the interactions among participants, especially in small communities that govern their natural resources. McGinnis (2011) specifies five notions that can be used to analyze the community attributes:

- *Trust*: a measure of individuals in a community is convinced that others will help them if needed, keep up with the agreements even though it might not be favorable to them in the short term.
- *Reciprocity*: a standard behavior prompting individuals from a community to collaborate with other individuals whom they worked together before
- *Common understanding*: a measure of how much the community members share the same values or goals
- *Social capital*: resources that a community members can rely on for support if need be or the total assistance potential of a community created through interactions between the members
- *Cultural repertoire*: a collection of of strategies, norms, rules, and practices available to the members of a community to be used in deliberation and implementation

Rules-in-use

Rules-in-use is common understanding between participants regarding who must take action and how sanctions will be enforced to those who do not comply with the rules. Ostrom linked the working parts of an action situation to seven types of rules which affect the elements of an action situation as exogenous variables is shown in Figure 2.3. These rules are:

- *Boundary rules*: how actors enter or leave these positions
- *Position rules*: a set of positions (with resources, preferences, and responsibilities) and how many actors hold each one
- *Choice rules*: which actions are assigned to an actor in a position
- *Information rules*: channels of communication among actors and what information must, may, or must not be shared
- *Scope rules*: the outcomes that could be affected
- *Aggregation rules*: how the decisions of actors at a node were to be mapped to intermediate or final outcomes
- *Payoff rules*: how benefits and costs were to be permitted, distributed, or forbidden to actors in positions

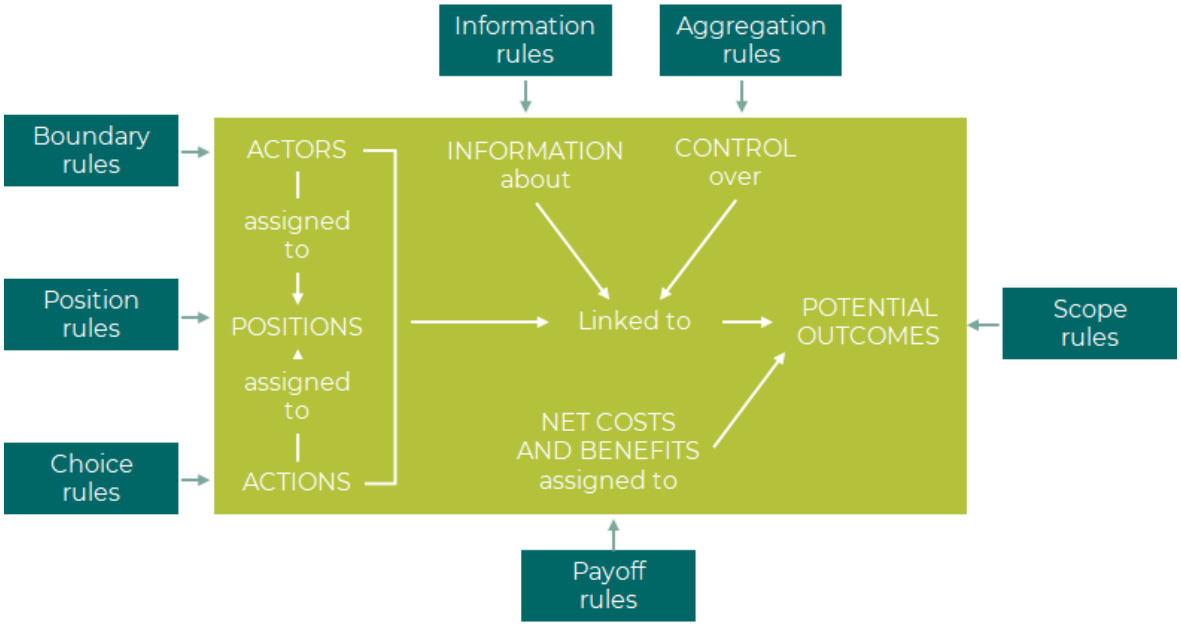

Figure 2.3: The rules as exogenous variables affecting the elements of an action situation, adapted from Ostrom (2010).

2.2.3 Interactions, outcomes and evaluative criteria

The patterns of interactions, outcomes based on these interactions, and evaluative criteria used to assess these outcomes follow the actions within the policy sphere shaped by the limitations of the biophysical conditions, attributes of community, and rules-in-use.

Interactions

Patterns of interactions mean the structures within an action situation and the behaviors of the actors confined in that structure (Polski and Ostrom, 1999). Based on the level of uncertainty and the number of strategies that participants have, the patterns of behavior can be predicted by an analyst. To illustrate, it is expected that the users of a common-pool resource, if there are no boundaries or rules defined for how the resource will be used, might over-harvest the resource (Polski and Ostrom, 1999).

Outcomes

Based on the interactions between the participants within the action situation, several policy outcomes are created. Outcomes are influenced by the external variables and other related action situations (McGinnis, 2011). The evaluation of the performance of a system requires a benchmark or standard set of criteria.

Evaluative criteria

Participants or observers use several criteria to evaluate policy situation. Based on these criteria, they decide whether the policy outcomes are satisfactory or need further improvement. Polski and Ostrom (1999) identifies economic efficiency, redis-

tributional equity, accountability, adaptability, conformance to general morality, and fiscal equivalence as measures to assess the outcomes. Ostrom (2005) discards fiscal equivalence and adds resilience and robustness to the adaptability criterion. McGinnis (2011) provides a more comprehensive set of criteria and includes legitimacy and participation as well. The descriptions of these criteria from Polski and Ostrom (1999) and Ostrom (2005) will be combined with the criteria listed by (McGinnis, 2011) to evaluate policy outcomes. The evaluative criteria provided by McGinnis (2011) are:

- *Efficiency*: can be thought of as economic efficiency and measured as (i) marginal cost of production being equal to the price of the good or service, (ii) the marginal social benefits being equal to the marginal social cost, (iii) maximization of the discounted present value, or (iv) cost effectiveness (Polski and Ostrom, 1999). It should be noted that economic analysis might not work in cases where the prices for inputs and outputs are not easily measured or valued (Polski and Ostrom, 1999).
- *Equity*: also called distributional equity of outcomes, where individuals pay for the cost of goods and services depending on their ability.
- *Legitimacy*: a measure of the extent to which the participants think of the decision process.
- *Participation*: practices such as co-production that contributes to the legitimacy.
- *Accountability*: a measure of (i) the cost of sharing information and transparency with the users of the resource, (ii) to what extent the participants are capable of evaluating the actions of others, and (iii) the extent of how participants access to monitoring and sanctioning systems.
- *Fiscal equivalence*: a measure of how much the beneficiaries contribute to the production of the good based on the benefits they receive from a good or service.
- *Consistency with moral values*: measure of how the decision process and principles are in line with participants' collective values.
- *Adaptability, resilience, robustness, or sustainability*: a measure of how well the system continues to operate after a change or disturbance. It shows whether the participants adapt their interactions based on their experience within an action situation (Ostrom, 2005).

2.3 APPLICATION OF THE IAD FRAMEWORK

2.3.1 Guidelines for the application of the IAD framework

The IAD framework has been applied to economic development issues, common-pool resource management, local and metropolitan public services and governance,

state/regional/provincial public services and governance, federal public services and governance, constitutional design, and international relations (Polski and Ostrom, 1999). Even though the IAD framework aims to reduce complexity and simplify identifying policy activities, it has become complicated over time (McGinnis, 2011). Thus, the guidelines by Polski and Ostrom (1999) for the application of the IAD framework for policy analysis and design will be used in the research while analyzing the governance within the humanitarian energy sector.

1. **Define the policy analysis objective and the analytical approach**

   The authors specify two different purposes for using the framework.

   - *As a diagnostic tool*: In this case, the researcher works backward within the IAD framework by first revising the policy objectives. Then, policy outcomes are evaluated and the patterns of interactions and action situation are observed. The analyst moves on to understanding the contextual factors leading to that outcome. This method is useful for assessing already established policies to check whether they meet the objectives or need reform.
   - *As a policy design tool*: This method involves working forward within the IAD framework for a particular policy activity. The analyst starts with the analysis of external factors that impact a certain policy situation, action situation, and outcomes. This approach is suited for developing new policies or comparing different policies.

   The questions to ask in this step are:

   - What is happening in the policy arena?
   - How do observed outcomes compare to policy objectives?
   - Which outcomes are satisfactory? Which are not?
   - Which outcomes are most important?
   - When are these outcomes occurring?
   - Where are they occurring? Who is involved?
   - How are policy outcomes occurring?

2. **Analyze physical and material conditions**

   The physical and material conditions refer to the physical and human resources and means for the production and provision of goods and services. These conditions are capital, labor, technology, and sources of finance, storage, and distribution channels. The biophysical conditions have a significant impact on the action situations, institutional settings, and community behavior. The economic nature of the goods or services can be determined as one of the four types of goods described depending on their excludability and subtractability. After identifying the economic nature of the policy activity, production and provision activities are analyzed. Production activities change inputs to outputs whereas

provision is related to financing and distribution of goods and services. Analyzing these activities helps an analyst to understand resources, capabilities, and coordination mechanisms required for effective policy implementation. There are multiple ways to organize production and provision activities depending on the attributes of the community who use goods and services.

The questions to ask in this step are:

- Focusing on the good or service produced in the policy situation, what is the economic nature of the activity?
- How is this good or service provided?
- How is this good or service produced?
- What physical and human resources are required to provide and produce this good or service?
- What technologies and processes are required?
- What are storage requirements, and distribution channels?
- What is the scale and scope of provision and production activity?

3. Analyze community attributes

The attributes of the community refer to the population demographics, norms and common understanding about the policy activity, the extent to which the norms, beliefs, and values of the participants are homogeneous among the community. Even though understanding cultural characteristics can be difficult, an analyst should investigate the conditions and cultural context as much as possible.

The questions to ask in this step are:

- What is the size of the community and who is in it?
- How homogeneous is the community? What knowledge and information do participants have about the relationship among policy-oriented strategies, actions, and outcomes?
- What are participants' values and preferences with respect to strategies for achieving outcomes, as well as outcomes themselves?
- What are participants' beliefs about the relationship among policy oriented strategies, actions, and outcomes?
- What are participants' beliefs about other participants' strategy preferences and outcomes?

4. Analyze rules-in-use

As mentioned in the previous section, the rules strictly affect the elements of an action situation. This step also follows the aim of institutional analysis to understand how the behaviors are impacted by formal and informal rules. The important thing is that a policy analyst should consider the working rules rather than the rules that are written but not observed in real-life. The rules considered are boundary, position, choice, information, scope, aggregation, and payoff rules.

5. **Integrate the analysis**

   This step focuses on the action situation which is the policy space where the participants take action related to the policy problem. The analysis is integrated by going through each working element in an action situation.

   The questions to ask in this step are:

   - What are the positions or roles that actors play in this situation?
   - Who are the participants?
   - What actions can participants take, and how are actions linked to outcomes?
   - What is the level of control that each participant has over action in this situation?
   - What outcomes are possible in this situation?
   - What information about the action situation is available to participants?
   - What costs and benefits do participants incur when they take action in this situation?

6. **Analyze patterns of interaction**

   The patterns of interaction follows naturally from biophysical conditions, rules-in-use and attributes of community since they influence the available position, information, and actions available for the participants. These factors might change over time. Thus, the analyst still tries to make predictions about the likely scenarios for interactions.

7. **Analyze outcomes**

   In this final step, the analyst analyzes the performance of the system across several criteria. These criteria are defined as efficiency, equity, legitimacy, participation, accountability, fiscal equivalence, consistency with moral values, and adaptability, resilience, robustness, or sustainability.

2.3.2 Multiple levels of analysis within the IAD framework

Polski and Ostrom (1999) maintain that the majority of policy situations comprise of multiple overlapping action arenas linked sequentially and several levels of rules. It is argued that there are nested rules within other broader set of rules crafting the lower-level rules. Therefore, what lower-level rules can permit is decided at the higher level. Any policy situation is affected by these nested set of rules collectively shaping outcomes. From a narrow to a broader scope, Ostrom (2005) defines four levels of rules: operational, collective-choice, constitutional, and meta-constitutional. These four levels of analysis are illustrated in Figure 2.4.

Operational situations

Operational rules specify the daily decision-making activities for participants such as provision, production, distribution, appropriation, assignment, and consumption.

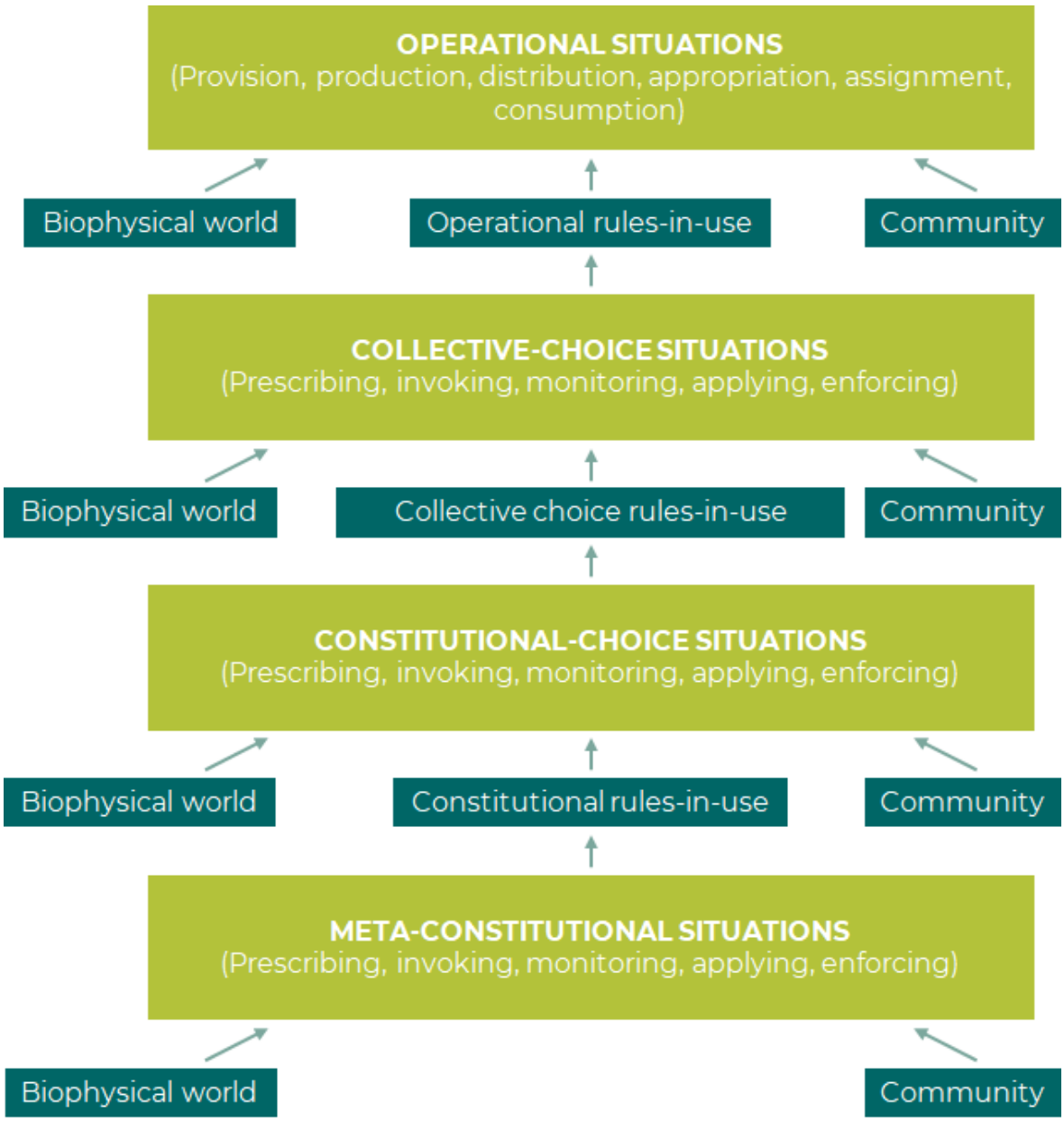

Figure 2.4: The multiple levels of analysis and outcomes, adapted from Ostrom (2005).

These rules can change quite promptly. Ostrom (2005) lists several examples for operational-level situations: families choosing which neighborhood to move based on the shared attributes, workers facing a complex task depending on the required effort and incentives, and people choosing how much, when, and how to harvest a common-pool resource. The individuals are given the right to participate in these activities as a result of collective-choice processes.

Collective-choice situations

Collective-choice rules control who can participate and what are the rules for changing operational rules. Change in collective-choice processes happens slower than the operational processes. Ostrom (2005) gives the following example for collective-choice situations: teams designing systems for the allocation of space stations for

NASA, elected representatives creating policies depending on the popular predisposition, and citizens deciding on their electoral choice. They are processes that construct institutions and policy decisions as a result of constitutional choice processes.

Constitutional-choice situations

Constitutional-choice rules directly affect collective-choice situations as they specify who can participate and what are the rules for changing the collective-choice rules, thus affecting operational rules. These rules change the slowest as they require more formal arenas. Ostrom (2005) provides various examples for constitutional-choice situations: groundwater producers coming together to establish a public district responsible for devising rules and regulations for the water extraction, elected representatives discussing changes in a national constitution, and representatives creating strategies for forming new international unions. These are situations where collective choice procedures such as legitimizing and constituting entities are defined which are affected by the meta-constitutional level.

Meta-constitutional situations

Long-lasting constraints are formed by biophysical world and community attributes which might change over long periods of time. Ostrom (2005) asserts that even though there is a need for infinite layering for formal theory, for the majority of institutional analysis applications three levels of analysis are sufficient. Thus, meta-constitutional analysis will not be evaluated in this research.

2.4 APPLICATION OF THE IAD FRAMEWORK TO HUMANITARIAN ENERGY SECTOR

2.4.1 Integration of multiple levels of analysis to the IAD framework

As mentioned in the previous sections, humanitarian energy is a polycentric governance system which deals with authorities from global to local level, stakeholders with public, private, voluntary, and community-based organizational structures, different functions such as the production, provision, coordination, funding, and monitoring of the energy systems. In order to gain a deeper understanding of the contextual factors and the multiple levels of rules within the humanitarian energy sector, three levels of rules need to be integrated into the IAD framework. This integration can be done in two different ways. In the first approach, the IAD framework can be applied repetitively three times, starting with the constitutional level and ending with the operational level. In the second approach, only the rules-in-use in three different levels are analyzed while applying the framework at the operational level. The second approach allows for an in-depth understanding of the actual camp setting which is affected by rules made by different communities, biophysical conditions, and action situations in higher levels. Therefore, this research integrates the multiple levels

of analysis notion for one action situation and different levels of rules.

Here, the differences between constitutional and collective-choice levels are not very clear because there is not an actor or actor group that is responsible for governing the humanitarian energy field (Rosenberg-Jansen, 2019). Instead, there are several actors from international to local level shaping policies. The constitutional and collective-choice levels are intertwined in humanitarian response because of decisions regarding energy access for displaced populations are made in an international arena. In this merged level, international agreements signed by states specify who participates in decision-making processes and policies are created to ensure displaced populations have access to energy. This level is analyzed through a global overview of the governance of humanitarian energy sector. A discussion on the current international policies, organizations, and initiatives is provided which argues for community solar mini-grids in refugee camps and lays the ground for the deeper level analysis. The investigation continues with a camp- or operational level analysis where the IAD framework is used. These two levels are connected since the constitutional and collective-choice level rules influence the rules-in-use at the operating level. The camps are governed according to the international agreements signed by the countries and implementing organizations that run the camp. The operational rules are examined through a case study of the Kigeme refugee camp the day-to-day activities conducted by the humanitarian organization and local government running the camp, private sector actors, and donor agencies are investigated.

2.4.2 The operationalization of the IAD framework

The IAD framework is generally used for analyzing the governance of common-pool resources by communities. Community is defined as "a group of people that recognizes itself or is recognized by outsiders as sharing common cultural, religious or other social features, backgrounds and interests, and that forms a collective identity with shared goals" (UNHCR, 2008, p. 14). Because of the differences in nationality, religion, language, background and interests, one might have a hard time conceptualizing refugee populations as communities. For example, Hyndman (2000) asserts that camps are not communities established through voluntary action but enforced colonies. Yet, communities are "the inevitable result of the unavoidable sociality of being" (Bulley, 2014, p. 7). It has been shown that communities form in camps as people start to rebuild their lives (Turner, 2016; UNHCR, 2008). Thus, for the sake of this research, it is assumed that there are established communities within the camp environment.

In this research, the guidelines described in the previous section for using the IAD framework is followed rigorously. Thus, the first course of action is to decide on the purpose of using the framework. The goal of this research is to explore the extent to which communities can be included in the decisions regarding the planning, operation, and maintenance of energy systems in refugee camps for better energy access. In addition, there is a lack of established policies since humanitarian energy is a newly developing area. Therefore, the IAD framework is used as a policy design tool

instead of a diagnostic tool and the analysis moves forward rather than backward while using the framework.

After the application of the IAD framework in camp level, an assessment framework is created based on the outcomes of the institutional analysis at the camp level and literature on common-pool resource management and community mini-grids. It is a framework in the sense that it provides a general list of variables that decision-makers should consider if they were to implement community solar mini-grids in refugee camps. The assessment framework lists technological, institutional, economic, and social factors that affect the success of community solar mini-grid projects in refugee camps. The conceptual framework showing the steps of analysis is provided in Figure 2.5:

1. Start by describing the biophysical conditions within the camp, attributes of refugee community, and rules-in-use which are shaped by the global level decisions.

2. Interpret how the combination of these factors affects daily operations regarding energy access in camp within the action situation.

3. Provide a detailed account of interactions between humanitarian and development organizations, nation states and local governments, partnerships, funders, private sector, research organizations and camp residents that result in certain policy outcomes.

4. Evaluate the outcomes by criteria reflecting improvement of energy access in the long-term.

5. Merge the results of the analysis with the literature review on community mini-grids and management of common-pool resources to create an assessment framework which lists technological, institutional, economic, and social factors that needs to be considered for community solar mini-grids in refugee camps.

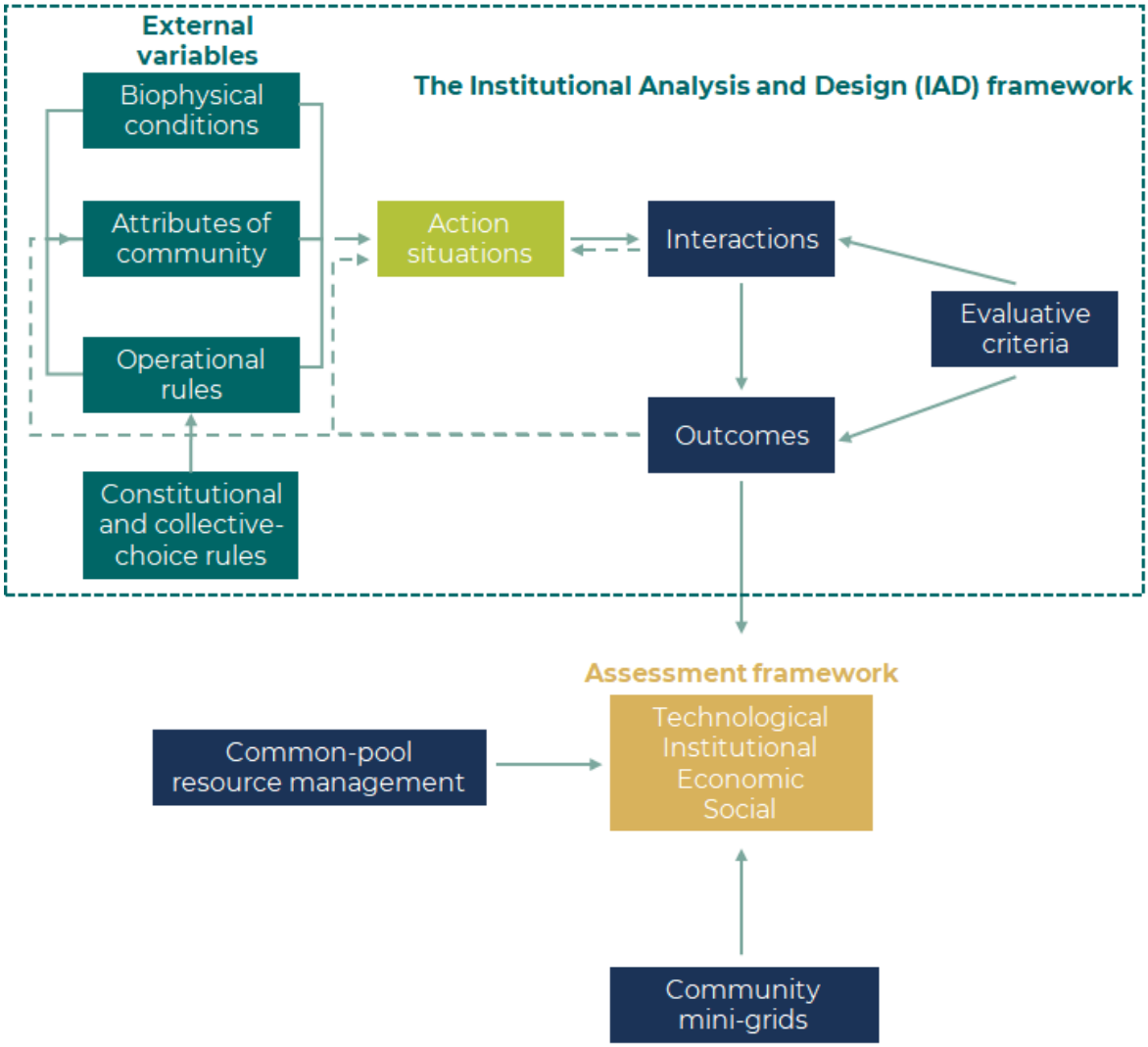

Figure 2.5: The conceptual framework guiding the research, adapted from (Ostrom, 2010).

3 METHODOLOGY

This chapter provides the methodology that is chosen for this research. Section 3.1 starts with a discussion of the research approach taken. Section 3.2 explains the specific research strategy chosen to answer research questions which is case study and the criteria used for selecting the cases. Section Section 3.3 gives information about the data collection methods like desk research and semi-structured interviews, together with obstacles encountered when collecting data and how these obstacles are handled. Section 3.4 discusses how the data is analyzed. Section 3.5 provides a discussion on validity and reliability, and how they are ensured in this research. Section 3.6 concludes the chapter with a discussion of ethical considerations in the research.

3.1 QUALITATIVE RESEARCH APPROACH

This research aims to explore to what extent using community-based approaches is possible for governing the solar mini-grids in refugee camps. The research is exploratory in nature since this topic has not been studied in the literature, which brings out qualitative research as an approach. Qualitative research is "an approach for exploring and understanding the meaning individuals or groups ascribe to a social or human problem" (Creswell, 2009). In order to understand the complex institutional and societal factors that come into play while governing solar energy systems in refugee camps, qualitative research approach was used in this research.

Humanitarian energy sector is a newly developing area of study. Thus, the literature is rather limited as mentioned in Chapter 1. There are high-level reports describing the global status of energy access in refugee camps and roles of humanitarian organizations, the government, or the private-sector. Most of the studies focus on a particular camp and several different technologies or provide general information. There has been a number of quantitative studies aiming to minimize cost or maximize the reliability of renewable energy systems in displacement settings. However, the recent reports show that an understanding of the governance of these systems is missing both in literature and practice. Thus, it is thought that a qualitative research approach will help to gain insights into the factors that improve or hinder the promotion of energy access in displacement settings.

In the previous chapter, it is shown that institutional analysis, and particularly the IAD framework can help to understand the governance of complex systems. The application of the IAD framework requires interviews and observation of the interactions between participants. Qualitative data describing the biophysical conditions, attributes of community, rules-in-use, interactions between participants, outcomes of these interactions, and evaluative criteria to be used to evaluate these outcomes are needed. For understanding biophysical conditions and rules-in-use, secondary data extracted from literature and reports from humanitarian organizations were used. To analyze the attributes of community, interactions, and outcomes, primary data was collected through semi-structured interviews with the participants.

3.2 CASE STUDY AS RESEARCH STRATEGY

Case study was selected as the strategy to conduct qualitative and exploratory research that this thesis is concerned with. Yin (2009) defines case study as "an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident". Case study contributes to the understanding of complex individual, organizational, social, and political phenomena (Yin, 2009). Case study method has been a widely used methodology in policy, psychology, social work, and community planning research (Yin, 2009). Case studies help understanding complex systems of interaction between subjects and answers "how" and "why" questions that are asked in explanatory research (Yin, 2009). They allow researcher to analyze a situation within its context which is missing in experiments. As reasoned in the previous chapter, two levels of analysis are required to get a better understanding of the humanitarian energy governance and community solar mini-grids within a camp. Therefore, following a global-level description, a camp-specific analysis was conducted using the IAD framework.

3.2.1 The critiques of case study

With this section, several disadvantages of using case studies are listed, together with methods used in this research overcome them. The first criticism on case studies concerns the lack of rigor in some studies in which the researcher has not been meticulous, does not follow systemic procedures, or has taken a biased approach when driving conclusions (Yin, 2009). This makes verification difficult as only the researcher collects and processes data to drive conclusions. Therefore, the implicit bias was acknowledged and the information collected through desk research and semi-structured interviews were rigorously checked for consistency. The second argument against case studies is that they provide little basis for generalization, especially single case studies (Yin, 2009). It should also be noted that the aim of using the case study in this research was not to generalize results to populations as in statistical generalization but to theoretical premises as in analytical generalization (Yin, 2009). The third issue is the amount of time case studies take which brings about documents

that are hard to read (Yin, 2009). This issue was handled by selecting an efficient data collection method such as interviews and web search, and documenting the findings in a structured way.

3.2.2 Case selection

In order to administer a case study, a general criterion that needs to be satisfied is having access to data. This access can be in the form of interviews, observations in the field, or documentations. The other criteria used for selecting the cases and a brief reasoning behind them are outlined in Table 3.1.

Table 3.1: The criteria used for case selection.

Case selection criterion	Description of the criterion
Political and managerial stability	The camp should have established institutions with clear roles and responsibilities between actors.
Existence of an ongoing energy access initiative	There should be ongoing or finished projects to improve access to energy within the camp.
Availability of data	The data required for analysis about the energy governance in the camp should be available and easily accessible, preferably in English.

As mentioned in Section 1.5, the scope of this research is camps governed by a humanitarian organization or a government authority. Firstly, It is required that these camps are politically and physically stable, meaning that the government has defined protocols for the management of the camp, which is a necessary condition for the successful implementation of community solar mini-grid projects. Greece was eliminated since it wrestles with a "policy and management crisis" (Lahn et al., 2016a) even though the researcher has already conducted a field study and made observations in the field. Greece has played two roles that complicated policy strategies: being a transit country for people who settle into a third country which entails dealing with legal application processes and meeting short-term needs, and simultaneously being a host country for people who need long-term aid (Lahn et al., 2016b). This resulted in a complicated situation where the Moria refugee camp had to accommodate more than 12,000 people which is four times its original capacity before it got destroyed due to the fire on 8 September 2020.

Secondly, there need to be initiatives for improving energy access within the camp. These initiatives might be in the form of distribution of cookstoves running with alternative fuel, the building of mini-grids, or utilization of renewable energy technologies. Lastly, since there is a general lack of data on energy access in refugee camps, the most important criterion was the availability of information. Here the interviewees' willingness to share information played a crucial role as they might have critical insight or role in the interactions within the policy situation. This, unfortunately, resulted in the elimination of most of the camps as it was challenging to reach a contact person or organization managing the camp. It is found that two camps have several reports and studies on energy access: the Kigeme refugee camp in Rwanda

and the Kakuma refugee camp in Kenya. In addition, the social network of the researcher allowed an easy connection to the people who were part of energy-related projects in those camps. Considering the time limitations of the research, it was decided to focus on one camp where information was more abundant as the Rwandan government has several protocols regarding displaced populations: the Kigeme refugee camp.

3.3 DATA COLLECTION METHODS

Research methods are specific paths chosen for data collection, analysis, interpretation of the results, and validation (Creswell, 2009). Data collection for the selected case study was the main obstacle in this research. Generally selected methods for the application of the IAD framework in the literature are observations and interviews during a field study. Thus, the initial research plan was to visit selected refugee camps and conduct interviews and observations of the daily operations. However, since field studies came to a halt due to the coronavirus pandemic, only desk research and semi-structured interviews were feasible as data collection methods. These methods were chosen so that they help to analyze the policy situation with respect to the elements of the IAD framework. Like any research method, the selected methods have several advantages and disadvantages. The next sections discuss each of them and argue how the critiques were handled within this research.

3.3.1 Desk research

Desk research is using existing data that has been collected and created by someone else (Van Thiel, 2014). Desk research is an efficient and cost-effective method since it allows access to international data without even traveling, which is the main advantage and choice for selection in this research. The initial desk research on the existing energy services in displacement settings was done by looking into the documentation of finished projects and field studies on different refugee camps. This process helped in understanding the current situation and identify certain technical and institutional arrangements that prove useful for increasing the sustainability of the system. The research was done using online databases but grey literature from humanitarian organizations and social enterprises were also included to get a better grip on the situation in the field. The reports and online databases by UNHCR were used to get statistics on camp population and demographics whereas the concept papers by Chatham House, MEI, and IRENA were used to delve into energy access initiatives.

The critiques of desk research

There are several drawbacks of using desk research as a data collection method. The first disadvantage is that since the data source is not specifically created for the purposes of the researcher's topic of investigation, the provided data might not exactly match with the research variables (Van Thiel, 2014). In order to resolve this issue,

an effort was made to access the data that serves the purposes of the research as closely as possible and to adapt the existing information in a way that it matches the set of research variables. The second disadvantage is that gathering, organizing, and utilizing the data takes time and rigor (Van Thiel, 2014). A systemic approach and good planning were used to solve this problem. The third and last concern is about the reliability and validity of data. Data from reliable sources like governments, international organizations, or journal articles were used for this research and it was checked whether the information gathered from these sources is outdated or still holds true.

3.3.2 Semi-structured interviews

Longhurst (2003) defines semi-structured interviews as "a verbal interchange where one person, the interviewer, attempt to elicit information from another person by asking questions". Semi-structured interviews are between structured and unstructured interviews in the sense that there are predetermined questions but the interview follows a more flexible and conversational attitude, and consists of open-ended questions. Semi-structured interviews allow the interviewer to extract information on topics that might not be well studied or documented (Van Thiel, 2014). For this research, semi-structured interviews were held in order to gain insights about humanitarian energy governance in the global level, several elements of the IAD framework which will be used to explore the policies regarding energy access in the Kigeme refugee camp, and drivers and barriers for community solar mini-grids in camps. Thus, the answers for the interview questions helped with the operationalization of the variables in a deductive manner (Van Thiel, 2014). Since interviewees have different backgrounds and roles within the policy situation, the order and the content of the questions were changed to fit the purpose. The guidelines by Jacob and Furgerson (2012) were used to prepare for the interview and an interview protocol was followed as presented in Appendix B.

The critiques of semi-structured interviews

Similar to desk research, semi-structured interviews are criticized on multiple different issues. It is important for a researcher to be aware of these disadvantages and try to overcome them. The first issue is that semi-structured interviews consume plenty of time, require intense labor, and need a sophisticated interviewer for extracting relevant information (Adams, 2015). The process of organizing, conducting, and analyzing interviews might be highly time-consuming. This disadvantage was overcame by planning ahead, limiting the number of interviews and the length of interviews, and matching the interview questions with research variables to help with the coding phase. The second pitfall is, since interviews are time and labor intensive methods, the small number of interviews might not provide highly precise information (Adams, 2015). To overcome this challenge, the information provided by different interviewees was cross-checked with data from other interviews and desk research when possible. The third and final drawback is that interviewees, because of their role in the policy situation or bias, might provide information according to

their agenda. This is why it was important to get information from as many actors as possible and fact checking the information without exhausting the resources.

The selection of interviewees

There are several actor groups with different roles in the system each providing valuable insights for the study. As there are three sub-questions that require insights from actors in the field (RQ3 on governance of the humanitarian energy sector at the global level, RQ3 on community solar mini-grids for refugee camps, and RQ4 on the energy governance in the Kigeme refugee camp), the interviewees were selected so that they would have knowledge on these topics. Humanitarian and development organizations can provide information on how energy is used within the community (which technological equipment is used for how long and where within households, community facilities, or enterprises). The governance structure on the field and how the coordination between different actors are structured can be understood through humanitarian organization and national or local government officials responsible for camp management. People working for business associations, think tanks, or funded partnerships can provide the rules in place for the governance of the already existing systems and check the feasibility and applicability of community solar mini-grids in camps. The funders give insights on the type of projects and initiatives that are supported and the collaboration between private sector and humanitarian organizations. The feedback from private sector actors is used to understand the advantages and disadvantages of certain business models and governance approaches and how they promote involvement of these actors. Humanitarian energy researchers who worked on several projects in camps help to understand the interactions between actors and outcomes of the projects.

Based on these differing roles and knowledge within humanitarian energy sector, the interviewees were selected purposefully to represent various actors in the system. Unfortunately, it was not possible to arrange an interview with all actor groups due to inability to get in touch or scheduling conflicts. This situation was overcame by reaching out to highly influential and knowledgeable experts in the field that are in touch with missing interviewees as shown in Table 3.2. The interviews were conducted online through video or voice calls depending on the quality of the internet connection and preference of the interviewee via Skype or Zoom. The interviews generally lasted one to one and a half hours except for the first interview that lasted thirty minutes due to interviewee's busy schedule. Since the interviews were held towards the end of the research process, it was possible to discuss more details without spending time on general issues within the humanitarian energy sector. The literature review and personal perspective and interpretation of the research topic added a depth to the conversation, which was appreciated by the interviewees as well. The experience of conducting the interviews was very positive since all interviewees were tremendously friendly and helpful and answered each question in a very detailed manner. The interviews showed that the existing initiatives barely scratched the surface of energy access issue in displacement settings but there are a lot of projects and partnerships that will accelerate the movement even further.

Table 3.2: The list of actors interviewed.

Interviewee	Date of the interview	Actor group that interviewee is involved
1. Anonymous	25/09/2020	Humanitarian and development organizations
2. Anonymous	23/09/2020	Think tanks, funded partnerships and policy bodies
3. Jose Carrasco Montejano	15/09/2020	Think tanks, funded partnerships and policy bodies
4. Anonymous	25/09/2020	Humanitarian and development organizations
5. Bertram Peterson	15/09/2020	Private sector actors
6. Philip Sandwell	16/09/2020	Academic and research organizations

3.4 DATA ANALYSIS METHODS

The information elicited through desk research is organized in a way to provide three main insights: the theoretical framework used to analyze the governance of humanitarian energy sector, application of the IAD framework for camp-level analysis, and creation of the assessment framework. Some of the data from desk research also guided the case selection as the availability of information was the most important criterion. Desk research is also used to form interview questions as it was preferable to have knowledge on the topic beforehand and make sure that interviews provide the missing or more detailed information that was not present in desk research. The interview data was stored as an audio recording of the interviews following the consent of the interviewee. Data security and privacy are considered to be of importance while treating the interview data. The security of interview data is ensured by storing the audio data on local hard drive and the anonymity was granted from the beginning of the storage by using the initials of the interviewees while transcribing the data. After the interviews, the qualitative data went through four steps: organization and preparation, a read-through of data, codification of data, and description of data (Creswell, 2009). The questions asked during the interviews were prepared so that they reflect a specific element of the IAD framework or a particular technological, institutional, economic or social factor for community solar mini-grids. This helped to identify common themes and streamlined the codification process. The information gathered from desk research and semi-structured interviews were presented in related elements of the IAD framework. Thus, the chapters and sections in the report follow the same elements for efficient categorization of data and easy readability.

3.5 CRITERIA FOR THE ASSESSMENT OF RESEARCH DESIGN QUALITY

Yin (2009) suggests using four tests relevant to case studies to ground the research design: reliability, construct validity, internal validity, and external validity. Reliability is the repeatability of the research process operations such as data collection and

analysis and achievement of the same results (Yin, 2009). The researcher should develop a case study protocol in the data collection phase to ensure reliability. Construct validity refers to using correct measures for studying the specific concepts (Yin, 2009). Using multiple sources of information and establishing a logical flow of evidence during data collection phase are recommended for warranting construct validity. In addition, verification of the report by experts is suggested in the composition phase. Internal validity tries to show causal relationships and it is required for explanatory or causal studies rather than descriptive or exploratory studies (Yin, 2009). For case studies, the suggested tactics for internal validity are applicable during the data analysis phase: matching patterns, building explanations, addressing contradicting arguments, and using logical models. External validity is concerned with the extent to which the findings are generalizable to other cases (Yin, 2009). To secure external validity in case studies, using theory and replications are suggested during the research design phase. Apart from the specific tactics to ensure research design is of high quality, triangulation is a suggested method to overcome concerns regarding reliability and validity of research findings (Yin, 2009; Van Thiel, 2014). Triangulation indicates using more than one method during the research to double-check the collected data and findings (Van Thiel, 2014). For this research, semi-structured interviews and desk research are combined and multiple sources of information were used when possible to preserve the quality.

3.6 ETHICAL CONSIDERATIONS

The ethical considerations refer to beneficence, veracity, privacy, confidentiality, and informed consent (Van Thiel, 2014). Beneficence refers to a study striving to contribute to the existing knowledge in a field or resolving a problem (Van Thiel, 2014). This study aims to fill the knowledge gap on the institutions and governance mechanisms regarding humanitarian energy with community values in mind to provide energy access in displacement settings. Veracity ensures that the research is not misleading research subjects (Van Thiel, 2014). In this research, veracity is guaranteed by informing the interviewees about the aim of the study. Privacy is respecting the participants' right to disengage or keep information to themselves (Van Thiel, 2014). This is particularly important considering that humanitarian organizations working with people who had to flee their home and they have the right to not share certain details. Confidentiality refers to the agreement between the researcher and participants about how the information is used (Van Thiel, 2014). Confidentiality is guaranteed for interviewees who requested certain avoidance whether it be their name or role within the organization. Informed consent requires the researcher to have authorization from the participants for studying a certain topic and publishing the research results (Van Thiel, 2014). Similar to privacy and confidentiality, informed consent is ensured by providing information to the interviewees and agreeing on how information will be handled in the publishing phase of the thesis.

Part II

ANALYSIS

4 A GLOBAL OVERVIEW OF HUMANITARIAN ENERGY GOVERNANCE

This chapter answers the second research question "*What are the current governance practices for providing energy access in refugee camps?*" by providing an analysis of global humanitarian energy governance. Section 4.1 introduces the policy situation about energy access for forcibly displaced populations. Section 4.2 gives a detailed description of the actors involved in humanitarian energy governance around the world. Section 4.3 provides an overview of developments in the humanitarian energy sector. Section 4.4 discusses the traditional ways of governing energy in refugee camps. Section 4.5 highlights emerging trends that affect both energy access and management in camps. Lastly, Section 4.6 gives a summary of results for humanitarian energy governance at the global level.

4.1 INTRODUCTION TO THE HUMANITARIAN ENERGY SECTOR

The analysis at the global level helps to understand how past practices and emerging trends shape the energy access planning process for refugee camps. Understanding how the institutions come into play in a complex setting is crucial for improving energy access at the camp level where the IAD framework is applied. Since there is not a single governing body responsible for the humanitarian energy sector, a regulatory framework detailing the roles and coordination among actors is missing (Rosenberg-Jansen, 2019). Instead, energy access is promoted through several different international agreements and local initiatives. Thus, the next section gives an overview of the actors in the humanitarian energy sector.

4.2 ACTORS INVOLVED IN GLOBAL HUMANITARIAN ENERGY GOVERNANCE

The actors involved in the decision-making processes regarding improving energy access in refugee camps are humanitarian and development organizations, nation states, and local governments, business associations, think tanks, funded partnerships, funders, private sector actors, and academic and research organizations. This

categorization of actors builds on the list by Rosenberg-Jansen (2019) and describes the roles, responsibilities, and projects of each actor in detail. The list of important actors can be found in Appendix C.

4.2.1 Humanitarian and development organizations

As mentioned in Chapter 1, the primary goal of humanitarian organizations is to provide emergency assistance to people of concern during disasters and conflicts around the world. Long-established humanitarian organizations like UNHCR, IOM, and NRC have energy programs in place but these initiatives are relatively small and low-impact in comparison with their core programs (Rosenberg-Jansen, 2019). The actions of humanitarian organizations are more towards coordinating energy services rather than designing or implementing systems (Rosenberg-Jansen, 2019). This is partly because these organizations lack technical knowledge and expertise to lead these initiatives. Development organizations, on the other hand, work in developing countries to make sure that basic needs such as shelter, water and sanitation, food, health, and energy are met through sustainable solutions. Especially rural electrification projects that use solar or hybrid mini-grids are conducted by development organizations such as Energy4Impact and Practical Action. Since humanitarian energy can be seen as an intersection of humanitarian and development principles, it is expected that these organizations are involved in this sector.

4.2.2 Nation states and local governments

The nation states that are most affected by forced displacement such as Rwanda, Uganda, Kenya, Turkey, the Republic of Korea, Yemen, Nigeria, and Somalia have policies that guarantee the protection of forcibly displaced populations within and outside their borders. These policies cover issues such as security, safety, education, health and in some cases, energy. The energy provision differs for displaced populations who live in an urban or camp settlement. Some of the governments might distribute charcoal for urban settlements otherwise, it is hard to keep track of their energy needs. In camps, the ministries and local government authorities might be responsible for the provision or coordination of energy services (Rosenberg-Jansen, 2019). Still, the energy needs of forcibly displaced people in camp settings are not addressed through policies.

4.2.3 Business associations, think tanks, and funded partnerships

The humanitarian energy sector developed through business associations, partnerships, and think tanks that brought different actors who work on development, emergency response, and rural electrification topics together. Business associations are generally energy companies working on decentralized electrification such as Alliance for Rural Electrification (ARE) and Clean Cooking Alliance. Think tanks are research institutes aiming to conduct research on energy access on data availability, tracking energy needs, and monitoring implemented projects like Chatham House. Funded

partnerships advocate for policy-making in global, national, and camp level to make sure that energy provision for displaced populations is guaranteed such as Global Plan of Action for Sustainable Energy Solutions in Situations of Displacement (GPA), Moving Energy Initiative (MEI), and Renewable Energy for Refugees (RE4R).

4.2.4 Funders

The funders are banks, foundations, or development financial institutions that either provide financial support for projects or initiatives or have investment programs that promote energy access in refugee camps. These institutions aim to support public and private sector development in countries through subsidies or funds such as Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), Federal Foreign Office of Germany, IKEA Foundation, SNV Netherlands Development Organisation (SNV), and World Bank.

4.2.5 Private sector actors

The involvement of private sector actors in humanitarian response activities has been increasing in recent years. These actors have local reach in most cases which helps to provide rapid support to people of concern. The roles of private sector actors can differ as some of them specifically focus on providing safe and sustainable energy solutions for refugee camps such as Bboxx, Inyenyeri, and Little Sun whereas others established energy companies that want to expand to the humanitarian energy market like Energias de Portugal (EDP), Kube Energy, MeshPower, and SCENE.

4.2.6 Academic and research organizations

There has been an increase in academic research done on humanitarian energy in recent years. Some of the organizations are part of international partnerships such as Coventry University and Technical University of Denmark whereas others conduct field studies where energy access is improved in camps such as KTH Royal Institute of Technology and Politecnico di Milano.

4.3 DEVELOPMENTS IN HUMANITARIAN ENERGY SECTOR

In the previous section, it is observed that there are various actors involved in policy, planning, implementation, and monitoring processes of improving energy access in refugee camps. These actors create different partnerships and projects to improve energy access in displacement settings. In one of the first extensive research papers on the policy framework of the humanitarian energy sector, Bellanca (2014) lists several international policies, frameworks, and initiatives that have been put into practice between the years 1995 and 2014. In one of the chapters of the first book on energy access and forced displacement, Rosenberg-Jansen (2019) extends this list by including the initiatives from 2014 to 2018. The initiatives, reports, and partnerships

that have been established from 1995 to present are discussed in the next sections and illustrated in Table 4.1.

Table 4.1: The chronological summary of initiatives and events regarding humanitarian energy, 1995-present, adapted from (Rosenberg-Jansen, 2019).

1995	Boiling Point, Issue 37. 'Household Energy in Emergency Situations', Stove Checklist for Refugee Situations
1995-ongoing	UNHCR, Environment Unit
1996-2005	UNHCR, Environmental Guidelines
1997-2011	Red Cross and Red Crescent, The Sphere Project and Handbook (2004)
1998	UNHCR, Environmental Guidelines: Domestic Energy in Refugee Situations
2001-2009	UNHCR, FRAME Toolkit
2002	UNHCR, Cooking Options in Refugee Situations
2002-2008	NRC, Camp Management Project: Toolkit
2005	UNHCR, Forest Management in Refugee and Returnee Situations
2005	IASC, Cluster creation
2006	WRC, Fuel and Firewood Initiative: Beyond Firewood
2007	IASC (UNHCR, WFP, WRC) SAFE
2007	UNHCR, Handbook for Emergencies
2009	SAFE Matrix, SAFE Decision Tree Diagrams
2009-ongoing	IUCN, IES, FUEL project
2010	Boiling Point, Issue 59, 'Energy in Conflict and Emergency Relief'
2010	PA, IRC, EMMA Emergency Market Mapping and Analysis Toolkit
2010	USAID, Fuel-Efficient Stove Programs in Humanitarian Settings: An Implementers' Toolkit
2011	UNHCR, Light Years Ahead
2011	UNIFII, State of Environment
2012	WFP, Handbook on SAFE
2012	UNEP, Greening the blue helmets
2012	Humanitarian Innovation Project
2013	FAO in Emergencies, Guidance Note
2014	GACC, Strategy for SAFE
2014	UNHCR, Global Strategy for SAFE
2014	UNHCR Energy Lab
2015-ongoing	MEI projects and research papers
2016	SAFE initiative expands commitment to humanitarian settings
2017	Energy for displaced people included in the Global Tracking Framework
2017-ongoing	Renewable Energy for Refugees (RE4R)
2018-ongoing	Global Plan of Action for Sustainable Energy Solutions in Situations of Displacement (GPA)
2019	Clean Energy Challenge

4.3.1 Environment and protection focus

1995 was the year that the first report on household energy was published. The Environmental Unit of UNHCR was established in 1995 with the purpose of reflecting the energy issues as a by-product of the environmental impact of refugee camps (Bellanca, 2014). At the beginning of the 2000s, camp management documents included energy as a cross-cutting issue within water and sanitation, shelter and health, and food areas (Bellanca, 2014). Camp Management Toolkit, a joint publication by IOM, NRC, and UNHCR, mentions firewood as the only energy source (Alford-Daniel et al., 2015). The Sphere Handbook discusses improved cookstoves for livelihood opportunities, boiling water for sanitation, food and nutrition, and reducing smoke. It can be observed from the list that the initial projects focused on environmental impact and household cooking while including a small discussion on agencies' and beneficiaries' needs.

In 2005, 15 years after the initial planning, the Cluster Approach was introduced to improve predictability and strengthen coordination between humanitarian organizations (Humanitarian Response, 2020). The agencies appointed by Inter-Agency Standing Committee (IASC) work on core humanitarian and emergency response activities as shown in Figure 4.1. The clusters focus on different sectors of humanitarian aid: camp coordination and camp management, early recovery, education, emergency telecommunications, food security, health, logistics, nutrition, protection, shelter, water, sanitation and hygiene. Energy is not a cluster on its own even though energy production and provision activities are needed during activities for other clusters like camp coordination and management, nutrition, water, protection, health, and logistics. This results in an institutional void where coordination, funding, knowledge sharing about improving energy access lack defined rules and structures (Rosenberg-Jansen, 2019). The field experts stated that the IASC is not keen on introducing new clusters for several reasons. First, there are also requests to create other clusters such as disability and gender equality (Anonymous 2, personal communication, September 23, 2020). In addition, it is questionable to what extent the cluster system works efficiently (Anonymous 2, personal communication, September 23, 2020). Lastly, conceptualizing energy as a cross-cutting issue is useful for involving all clusters in the field (Anonymous 1, personal communication, September 25, 2020).

4.3.2 Sustainable energy and community focus

After the creation of clusters, IASC established Safe Access to Firewood and Alternative Energy in Humanitarian Settings. Within this initiative, a matrix and decision tree for cross-sectional coordination of activities related to cooking fuel in emergencies and protracted situations were created (Bellanca, 2014). Following this initiative, UNHCR issued the Global Strategy for Safe Access to Fuel and Energy 2014-2018 which discusses sustainable ways to meet the energy needs of displaced populations. In the same year, UNHCR Energy Lab was established with the purpose of using innovative and holistic solutions for energy-related problems that refugees face. In 2014, the Moving Energy Initiative published two reports on sustainable energy provision

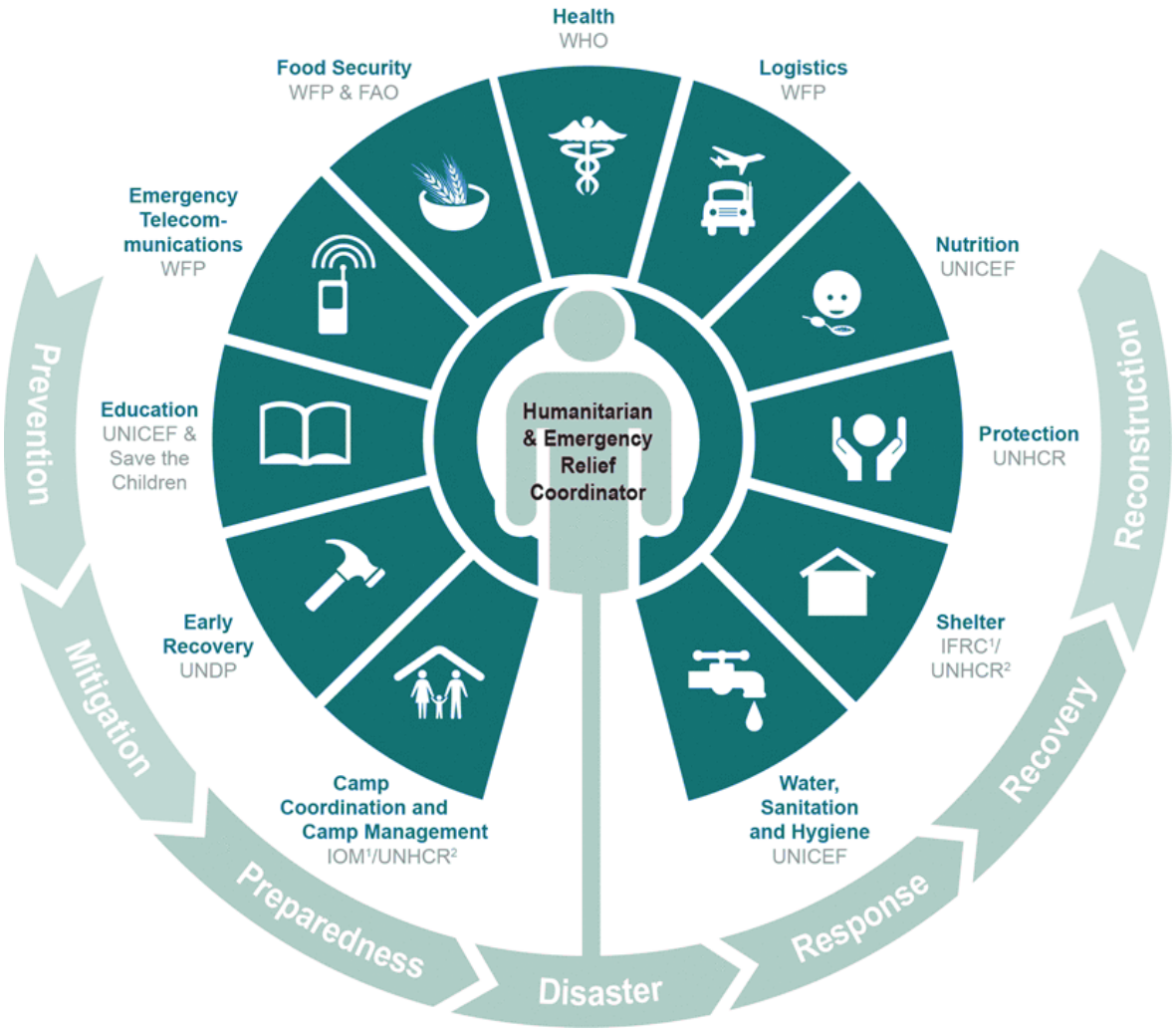

Figure 4.1: The clusters within humanitarian and emergency relief coordination operations (Humanitarian Response, 2020).

for displaced populations: a discussion on the current state by Gunning (2014) and policies by Bellanca (2014) as mentioned before. It is seen that the focus shifted from environment and protection to sustainable access to energy, market-based innovation, and reducing costs in the last five years (Rosenberg-Jansen, 2019).

The latest important development in the humanitarian energy sector is the creation of the Global Plan of Action for Sustainable Energy Solutions in Situations of Displacement (GPA) at the High-level Political Forum on Sustainable Development in 2018 (GPA, 2018). Motivated by the fact that energy is not one of the clusters in the humanitarian energy sector, GPA is a partnership established to reach the GPA Framework goal that is: "Every person affected by conflict or natural disaster has access to affordable, reliable, sustainable and modern energy services by 2030." (GPA, 2018). A more detailed analysis of the roles and responsibilities, coordination, and results of efforts is provided in Appendix D. In addition, Global Refugee Forum in December 2019 resulted in commitment for green energy by 40 states and the adoption of the Clean Energy Challenge by 30 states and multiple stakeholders committed to providing energy access to forcibly displaced populations by 2030 (UNHCR, 2019b).

The recent developments and trends show that the policies are made through partnerships and international collaborations in order to meet the needs of forcibly displaced people. The next chapter provides a more detailed account of traditional ways of governing energy in refugee camps.

4.4 TRADITIONAL ENERGY GOVERNANCE IN REFUGEE CAMPS

In order to understand how energy is traditionally governed in camps, the distinguishing features of camps from other settlements need to be identified. It is seen that the terms camp and settlement are used interchangeably, even by UNHCR when presenting statistical data (Schmidt, 2003). Yet, camps have distinct features like "segregation from the host population, the need to share facilities, plus overcrowding and a limited, restricted area within which the whole compass of daily life is to be conducted" (Stein, 1986). Schmidt (2003) identifies five differences between camps and settlements: freedom of movement, mode of assistance/economics, mode of governance, the designation of temporary locations/shelter, and population size and/or density. It is argued that a camp tends to have less freedom of movement and income-generating activities compared to a refugee settlement. Mode of governance refers to the decision-making procedures within the displaced community. Camps are more controlled spaces as the decisions about the socio-economic and political decisions are generally made by humanitarian agencies. Camps are initially designed as temporary spaces which also affects the freedoms provided to refugee populations. Lastly, the settlements are generally turned into camps or transit centers as they accommodate people beyond capacity.

Camp Management Toolkit states that camps should be seen as a last resort and encourages considering other options before setting up a camp (Alford-Daniel et al., 2015). Currently, 2.6 million refugees live in camps whereas others are dispersed to urban areas or informal settings (UNHCR, 2020d). Some of the world's largest refugee camps are Kutupalong-Balukhali refugee camp in Cox's Bazaar in Bangladesh, Bidi Bidi refugee camp in Uganda, Dadaab and Kakuma refugee camps, Kalobeyei settlement in Kenya, Azraq and Za'atari refugee camps in Jordan, Nyarugusu, Nduta, and Mtendeli refugee camps in Tanzania, and Kebribeyah, Aw-barre, and Sheder refugee camps in Ethiopia. These camps turn into densely populated cities, like Cox's Bazaar where more than 60,000 people share one square kilometer. This situation requires camp managers to find ways to create or implement policies for the improvement of energy provision. Traditionally, humanitarian organizations use a top-down approach for governance as the decisions are made from the higher levels of hierarchy and applied by the lower levels.

Energy provision has been included in humanitarian aid operations in the form of distribution of cookstoves and firewood for household cooking use in these camps. However, this top-down and product-based approach has disadvantages in terms of resilience, environment, health, and economic aspects. Ilcan and Rygiel (2015) men-

tions that dependence on humanitarian organizations for goods and services makes residents passive aid receivers and leads to disempowerment. Firewood is the main fuel source for cooking in most of the camps as shown in Figure 4.2. The use of firewood for cooking or heating results in deforestation near camp settlements, coming close to the burning of 64,700 acres of forest (Lahn and Grafham, 2015). Kerosene lamps or candles that are used for household lighting cause fires in dry climates (Lahn and Grafham, 2015). In addition, displaced populations skip meals when fuel is not available or swap food for fuel within camp (Grafham, 2019). It is stated that while funding for humanitarian assistance operations was increased to $17.0 billion, the funding shortage of $11.0 billion resulted in the fact that only 61% of the requirements were met (Urquhart, 2019). Already limited funds are spent on pollutant diesel generators which cost 5% of humanitarian organizations' budget (Grafham and Lahn, 2018).

Figure 4.2: The sources used for cooking by refugees and IDPs according to Grafham and Lahn (2018).

4.5 EMERGING TRENDS IN ENERGY GOVERNANCE IN REFUGEE CAMPS

While energy provision revolves around carbon-based resources in camps, renewable energy sources have started to gain more attention in recent years. Ossenbrink et al. (2018) show that 70% of the largest refugee camps have a global horizontal solar irradiation of more than 2,000 kWh per square meter per year and are located in countries where the price for electricity from traditional resources is relatively high. It is recognized that high initial investment cost and low operational costs of solar energy are well aligned with initially high but then decreasing funding that humanitarian organizations get as a humanitarian crisis is prolonged (Nielsen and Santos, 2013). Also, the reduction in fuel use and daily cost savings results in a relatively

short amortization time for a renewable energy system (Frack et al., 2015). The distribution of products like solar lanterns instead of providing services might not be preferable since it can cause market disruption because of the re-selling of the products and the creation of a dependency syndrome for refugees (Bellanca, 2014). Therefore, solar mini-grids become a viable option to consider for humanitarian organizations aiming to provide energy access in refugee camps.

Ilcan and Rygiel (2015) maintain that humanitarian organizations also had a shift in the way camps are conceptualized: from "temporary permanence" to permanent places that facilitate community building. The new paradigm for aid delivery is called *resilience humanitarianism* which focuses on the empowerment of people of concern through local institutions instead of them merely receiving aid from humanitarian organizations like UN in *classical humanitarianism* (Hilhorst, 2018). This practice of humanitarian assistance has become particularly important in protracted refugee situations where people want to have more control over their lives (Ilcan and Rygiel, 2015). Through a more community-based approach, UNHCR and NRC aim to promote dignity, self-reliance, sense of achievement, and self-esteem for displaced people (Ilcan and Rygiel, 2015). This results in an environment where refugees can practice meaningful participation and self-governance for the management of the camp (Ilcan and Rygiel, 2015). The Community-based approach report by UNHCR (2008) asserts that when people of concern are involved in decision-making processes, they are better protected, the solutions will be sustained for longer, and the resources will be used more efficiently. A community-based approach promotes using the knowledge and skills of refugees for processes that affect their lives.

4.6 CHAPTER SYNTHESIS

This chapter presents an overview of global humanitarian energy governance shaped by multiple actors with various mandates and objectives. The analysis shows that there are an institutional void and a lack of formally defined roles in terms of the governance of energy in displacement settings. This situation informs the institutional setting in the Kigeme refugee camp and complicates implementing solar mini-grids, let alone community-based approaches for governance. Solar energy technologies can solve many problems faced by promoting collaboration between humanitarian organizations, nation states and local governments, funders, and the private sector. In this way, these institutions move closer to reaching SDGs and abiding by international agreements through sustainable energy provision in camps. Funders and private sector actors benefit from investing in humanitarian response activities that support their social responsibility goals. Most importantly, camp communities benefit from the policies aiming to increase energy access as they have improved cooking for household use, lighting and clean fuels for community use, and electricity for productive use. While camp residents ask for involvement in management and decision-making processes, community solar mini-grids has become an interesting idea for investigation, which is explored in the next chapter.

5 COMMUNITY SOLAR MINI-GRIDS

This chapter provides a brief description of mini-grids and how common-pool resource management literature can be utilized for the governance of community mini-grids. Section 5.1 gives a definition of mini-grids and an introduction to the literature on community mini-grids in high and low-income countries. Section 5.2 provides information on sustainable management of common-pool resources and how can this idea can be applied to solar mini-grids in refugee camps. Finally, Section 5.3 provides a synthesis of findings and argues how these findings are used in the next chapter.

5.1 MINI-GRIDS

5.1.1 Definition of mini-grids

Mini-grids are electricity systems with small-scale generation capacity and a distribution network. Mini-grids can be connected to the national transmission grid but can also operate in isolation. Franz et al. (2014) define mini-grid as a system composed of small-scale electricity generation (from 10 kW to 10 MW) and supply of electricity to a small number of customers through distribution grid that can operate without national electricity transmission networks and supply (ARE, 2020). Mini-grids have five components: power generation, storage, distribution, user or application subsystem, and smart management systems as shown in Figure 5.1 (Franz et al., 2014). Power generation includes generators that convert fuel (diesel) or energy (solar PV, wind, hydro, or biomass) to electricity, power conditioners (voltage converters and AC/DC inverters), and energy management technology (dispatch system) (Franz et al., 2014). Storage is necessary when intermittent renewable energy sources such as solar and wind are used for electricity generation. For storage, batteries or pumped hydropower systems can be used. Distribution is the network responsible for carrying electricity from generation network to consumers. The type of distribution system affects costs and future options to connect to the grid (Franz et al., 2014). User or application subsystem consists of meters, internal wiring, grounding, and electricity-consuming appliances (Franz et al., 2014). Smart management systems such as smart meters are used for monitoring and evaluating the system. These systems are particularly useful for demand-side management and optimal sizing of the system (Franz et al., 2014).

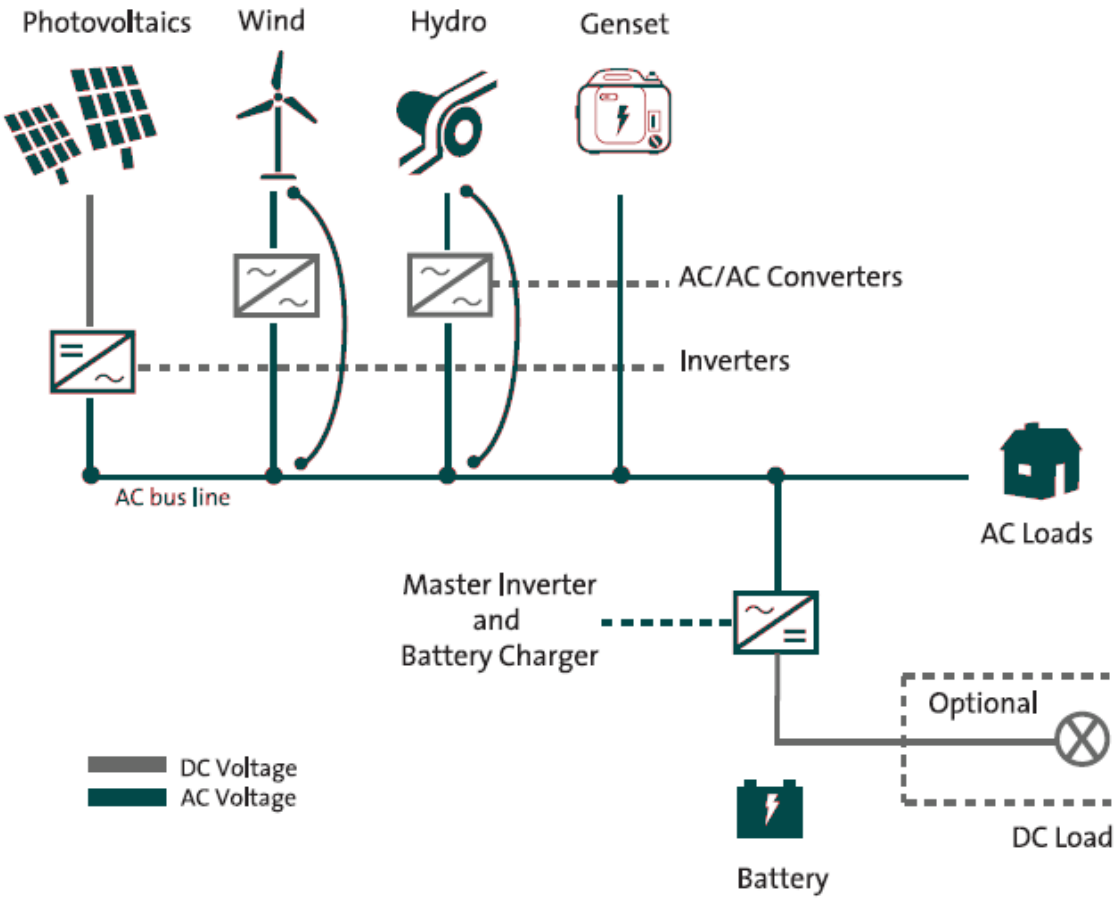

Figure 5.1: The system components of a mini-grid (Franz et al., 2014).

5.1.2 Community mini-grids

Franz et al. (2014) identify four different models for mini-grids: private sector-based, utility-based, community-based, and hybrid. The community-based mini-grid occurs when the private sector or utility is not involved in the system and "the community becomes the owner and operator of the system and provides maintenance, tariff collection, and management services" (Rolland and Glania, 2011, p. 21). A community energy system is defined as "a technical system which subsists upon a high degree of participation from the community which it serves" (Cayford and Scholten, 2014, p. 9). The participation can be in different phases of a project such as initiation, implementation, operations, or expansion (Cayford and Scholten, 2014). It is argued that community-based approaches for governance contribute to the long-term success of any system (Holland et al., 2001).

Community mini-grid projects are implemented with differing purposes in high and low-income countries. In high-income countries, solar PV, hydro, and wind energy systems are used to enhance the capacity of the existing grid which is supported by governments to cut off carbon emissions. Rural locations in low-income countries host 85% of the global refugee population (UNHCR, 2020). Since how energy needs of refugee camps are met depends on the conditions in the host country, it is useful

to look at rural mini-grids in low-income countries. In locations where electrification rates are low, connecting to the national grid is not preferred or possible because the geography makes distribution costly or the low capacity results in frequent black-outs and load shedding programs (Frame et al., 2011). The household, productive, and community energy demands can be met by solar mini-grids backed up by diesel generators and batteries as illustrated in Figure 5.2. Therefore, there are are several projects and literature on solar mini-grids in Sub-Saharan Africa, East Asia, and Latin America that aim to help improve energy access in rural areas (Frame et al., 2011).

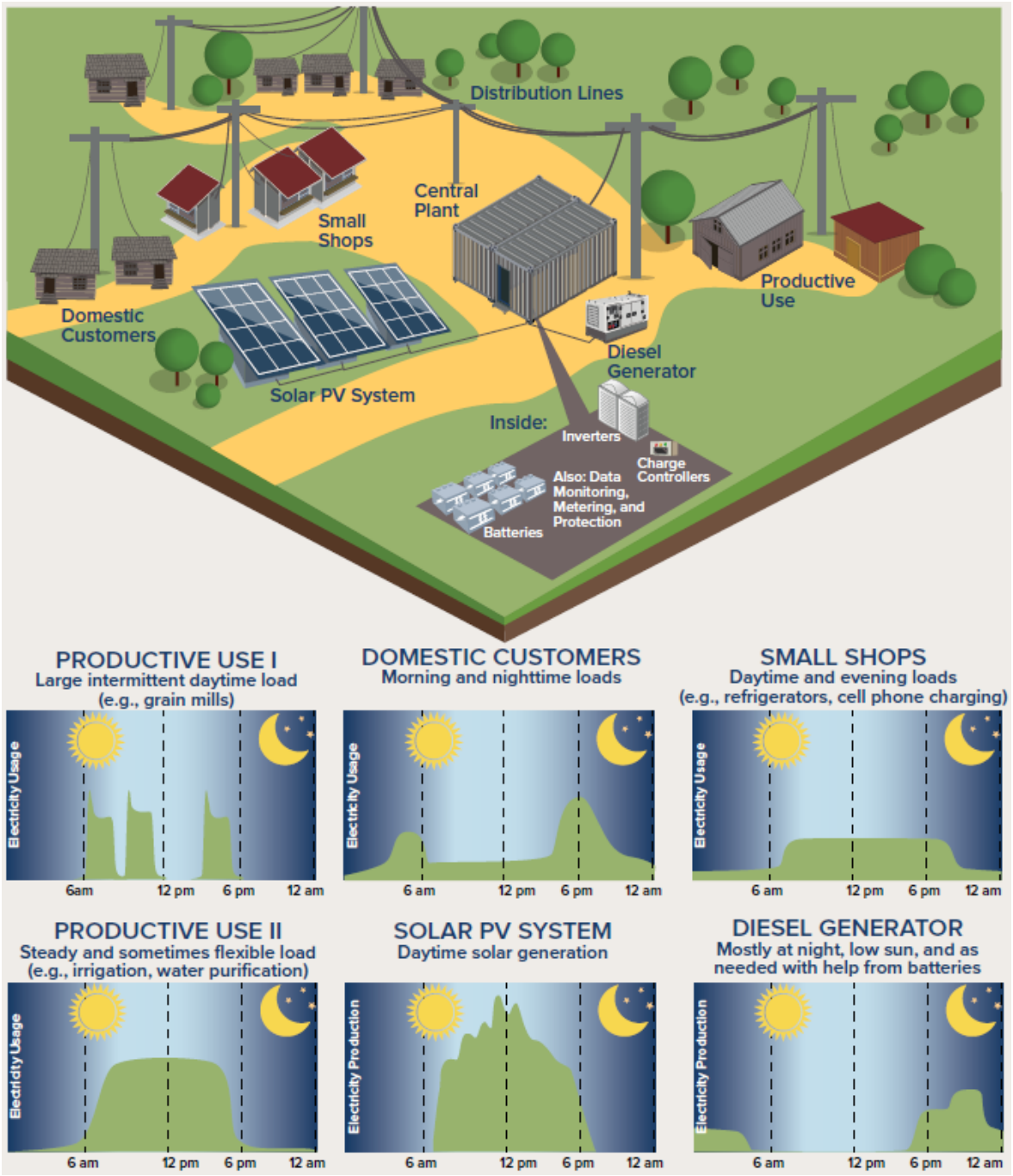

Figure 5.2: An example of how mini-grids can meet the energy needs of communities (Agenbroad et al., 2018).

5.2 SUSTAINABLE MANAGEMENT OF COMMON-POOL RESOURCES

Sustainability of energy systems seems to be an ongoing problem in decentralized rural electrification projects (Lestari et al., 2018). Gollwitzer et al. (2015) define a sustainably managed mini-grid as being financially viable and meeting the needs of all users (including large commercial users, micro and small enterprises and, poor women and men in individual households). Wolsink (2012) studied common-pool resources (CPRs) in the context of future smart-grids in high income countries for social acceptance. Wolsink (2020) argues that electricity should be treated as a "co-produced common good" instead of a private property being delivered via public grid and applies CPR theories to distributed energy systems for social acceptance.

Lestari et al. (2018) combined the IAD framework and indicators for sustainability for off-grid technologies and evaluates ownership, management, extension, generation capacity, and number of users of six projects in Indonesia. The authors conclude that position, authority, aggregation, information, and pay-off rules are of high importance for the success of system (Lestari et al., 2018). It is suggested that focusing on actor characteristics like values and preferences, access to information can explain the reason why grid is preferred over often more reliable and sustainable mini-grids (Lestari et al., 2018).

Gollwitzer et al. (2015) conducted an empirical analysis in mini-grids in Kenya and identifies use rules and shared community ownership as factors for fair allocation of benefits and responsibilities between heterogeneous user groups like households, schools, and private sector actors. In their study, Melville et al. (2017) explored community accountability for consumption patterns, one of eight design principles laid by Ostrom (2010) for sustainable management of CPRs, through a community demand response program in the UK. Even though research results are inconclusive in terms of the applicability and usefulness of a commons approach in urban setting, the authors state that the topic needs further investigation to understand how issues like sense of community, privacy, ownership are handled within communities (Melville et al., 2017).

Frame et al. (2011) applied community-based approach as community ownership and community monitoring of off-grid solar PV systems in developing countries. Acosta et al. (2018) also argued that integrated community energy systems face the risk of free-riding, fair allocation of costs and benefits, and risk of rebound effects endangering energy savings. The authors modify the Social-Ecological System (SES) framework, which is explained in Appendix E, so that it encompasses design and implementation phases of community energy systems projects. For the design phase, norms/social capital (A6), knowledge of SES/mental model (A7), social network structure (GS3), constitutional rules (GS7), productivity (RS5), importance of the resource (A8), equilibrium properties (RS6), predictability of resource dynamics (RS7), operational choice rules (GS5), and collective choice rules (GS6) are selected.

For the implementation phase, investment activities (I5), monitoring activities (I9), and evaluative activities (I10) are chosen as important variables.

Agrawal (2001) came up with critical enabling conditions for the sustainability of CPRs. The author composed a framework for design principles by combining works of Wade (1989), Ostrom (1990), and Baland and Platteau (1996). Based on this synthesis, Gollwitzer (2014) argued which of these conditions are applicable for sustainable management of mini-grids in rural areas for energy access as shown in Figure 5.3. The authors used conditions defined by Agrawal (2001) and Ostrom (2010) such as shared norms, low levels of user demand, well-defined boundaries, simplicity of rules, and locally devised access and management rules as conditions for sustainable management. The enabling conditions are listed as: small group size, appropriate leadership, interdependence among group members, heterogeneity of endowments, homogeneity of identities and interests, low levels of poverty, overlap between user group and resource location, high dependence by users on resource system, fairness in allocation of benefits from CPR, low levels of user demand, gradual change in levels of demand, match restrictions on harvests to regeneration of resources, simple and easy to understand rules, locally devised access and management rules, ease in enforcement rules, graduated sanctions, availability of low-cost adjudication, accountability of monitors and other officials to users (Gollwitzer et al., 2018).

5.3 CHAPTER SYNTHESIS

This chapter presented definitions for mini-grids and community solar mini-grids in particular with a description of their system components. Due to the intermittent nature of solar energy, storage is needed to meet the energy demand for household, community, and productive uses of energy. In addition, smart metering systems help to monitor the system and allows for using demand-side management. Together with storage, these tools can help achieve the optimal sizing of the system capacity and reduce costs in the long-term. The study results in mini-grids in high and low-income countries are evaluated through the lens of common-pool resources. Several criteria for the sustainable management of community solar mini-grids are identified. These criteria are merged with the results from camp level analysis done in the next chapter to create the assessment framework. The next chapter provides further information at a camp level and reveals more insights about the daily operations related to energy access in refugee camps.

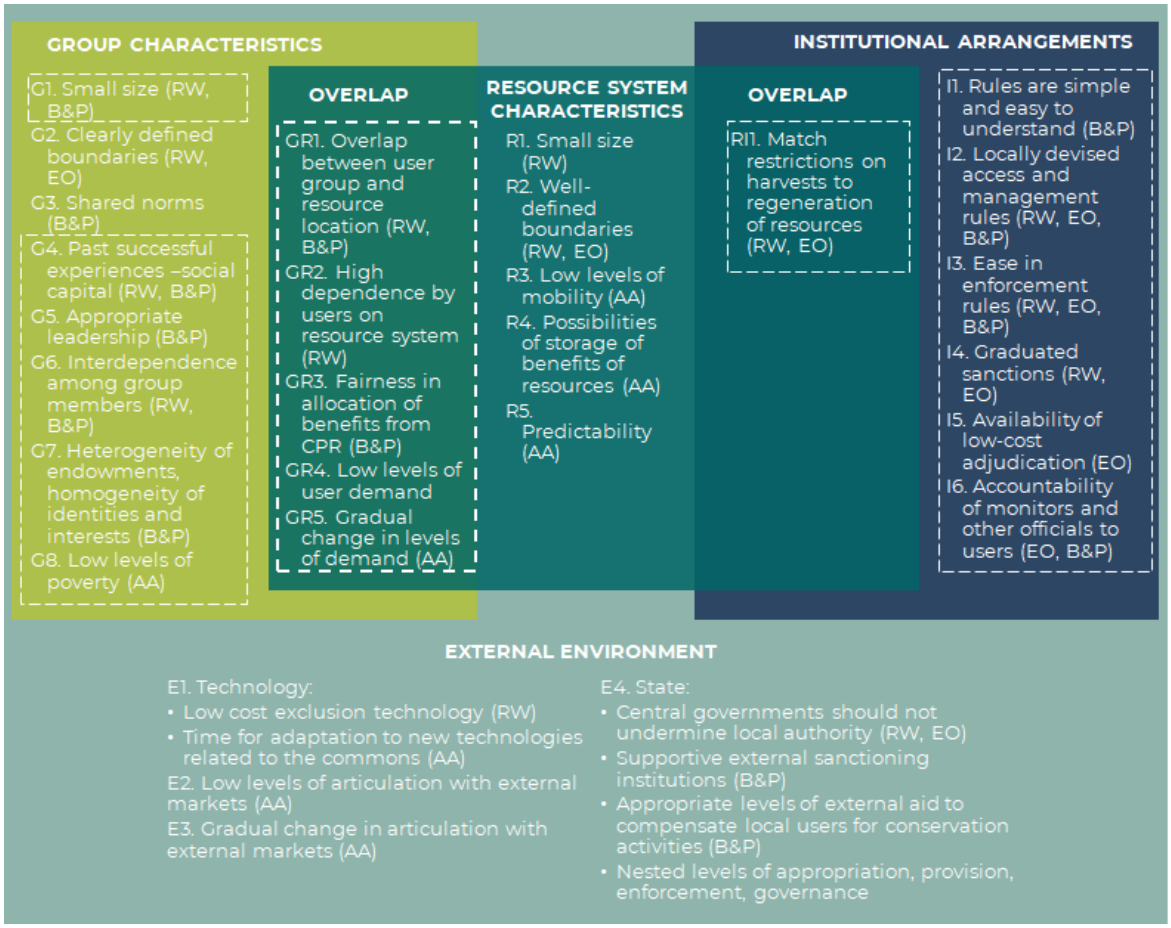

Figure 5.3: The enabling conditions for sustainable management of common-pool resources, adapted from Gollwitzer et al. (2018). Condition first identified by: AA = Agrawal (2001), B&P = Baland and Platteau (1996), EO= Ostrom (1990), RW = Wade (1989).

6 ENERGY GOVERNANCE IN THE KIGEME REFUGEE CAMP

This chapter answers the fourth research question "*What energy-related problems are experienced in the Kigeme refugee camp and how do the actors respond to these problems?*" by presenting an analysis of current energy governance in the Rwandan refugee camp through the IAD framework. Section 6.1 provides an introduction to Rwanda by briefly mentioning the economic and political status and country's response to humanitarian crises. Section 6.2 discusses external variables such as biophysical conditions, community attributes, and constitutional and collective-choice rules-in-use, and operational rules-in-use that affect energy governance within the Kigeme refugee camp. Section 6.3 describes the action situation with its working elements. Section 6.4 analyzes the interactions within the action situation. Section 6.5 provides the outcomes of these interactions that are assessed by evaluative criteria. Lastly, Section 6.6 gives a summary of the findings of the analysis of energy governance on a camp level.

6.1 INTRODUCTION TO THE STUDY AREA

Rwanda, officially the Republic of Rwanda, is a small and landlocked country in central Africa. It is neighbor of the Democratic Republic of Congo (DRC), Tanzania, Uganda, and Burundi. Also known as *the land of a thousand hills*, Rwanda has high hills and deep valleys and is covered with volcanoes, lakes, and rivers. With a total land size of 26,338 km^2 and a population of 12.3 million, it is a densely populated country where there are 445 people per km^2 (Republic of Rwanda, 2020). The capital and the largest city of the country is Kigali. The country has been politically stable since the 1994 Genocide Against the Tutsi and making substantial progress for growth through economic reforms (World Bank, 2020). Rwanda aims to reach the middle-income country level by 2035 and high-income country level by 2050 (World Bank, 2020).

To reach this goal, Rwanda works together with the International Monetary Fund (IMF) and the World Bank on several projects and made substantial reforms for economic growth (World Bank, 2020). These projects focus on providing basic infrastructure, social protection system, acceleration of growth, and electricity to rural households (World Bank, 2020). Rwanda, following an ambitious electrification program, increased its electrification rate for households from 6% in 2008 to 49% in

2019 (Baranda Alonso and Sandwell, 2020). This achievement is partly due to the renewable mini-grids which have become a cost-effective option to provide energy access in rural areas (Baranda Alonso and Sandwell, 2020). The government aims to reach 100% electricity access by 2024 (Baranda Alonso and Sandwell, 2020). It is stated that 48% of this access will be provided through renewable off-grid connections (IRENA, 2018).

While Rwanda has preserved its political stability since 1994, the country has been dealing with humanitarian crises for more than 20 years. The country started hosting refugees in 1996 when people fled DRC. The first refugee camp established to host Congolese refugees is Kiziba camp (Crawford et al., 2019). Another flux of refugees happened in 2015 when people from Burundi take refuge in Rwanda (Crawford et al., 2019). This resulted in the opening of the Mahama camp which currently has the highest number of refugees. As of 31 May 2020, there are 148,938 people of concern in Rwanda in multiple locations as shown in Figure 6.1. Of these, 144,025 are refugees, 367 are asylum-seekers, and 4,546 are categorized as others (UNHCR, 2020a). 50.8% of the people of concern are from DRC, 48.5% are from Burundi, and others are from countries like Eritrea, Somalia, Sudan, Ethiopia, and South Sudan (UNHCR, 2020b). Half of this population is under the age of 18 which necessitates additional measures for ensuring safety and security. The gender distribution is almost equal with 51% of women and 49% of men (UNHCR, 2020b). Nearly 92% of the refugee population resides in camps, which is partly because local integration is challenging in displacement conditions despite governmental efforts (UNHCR, 2020b). The focus of analysis is one of these camps, the Kigeme refugee camp.

6.2 EXTERNAL VARIABLES

The utilization of the IAD framework for analyzing the energy governance in the Kigeme refugee camp starts with a description of external variables affecting the action situation. The external factors such as biophysical conditions, attributes of community, constitutional and collective-choice rules-in-use, and operational rules-in-use are explained in detail in the following sections.

6.2.1 Biophysical conditions

Based on the guidelines for the application of the IAD framework provided in Section 2.3.1, in addition to the description of the material world, the biophysical conditions are conceptualized as resources necessary for production and provision of energy services for displaced populations. First, the physical conditions of the camp are described. Second, the economic nature of the activity is described and eventually identified as one of the four types of goods categorized by Ostrom (2010). Lastly, production and provision activities are discussed.

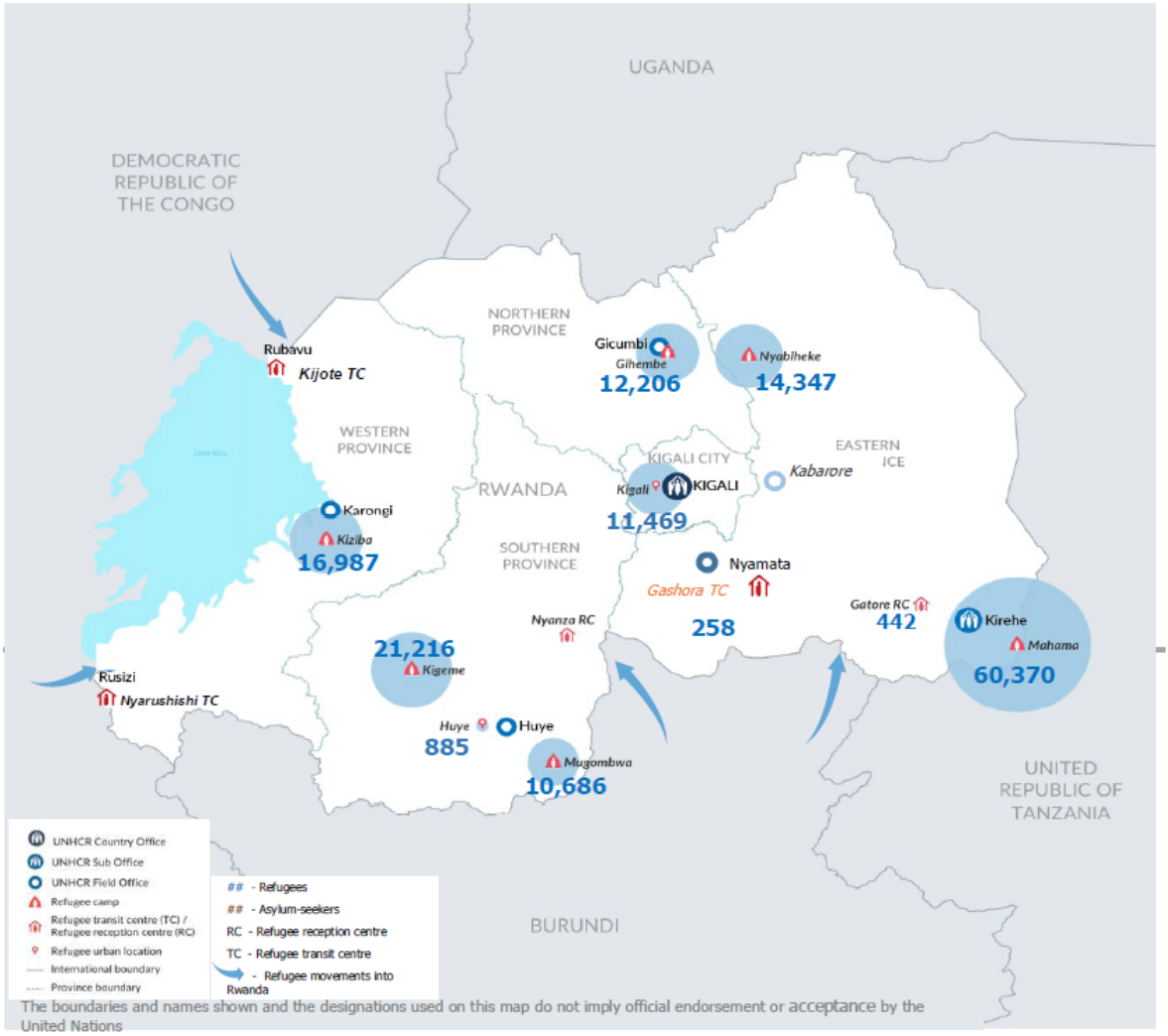

Figure 6.1: The population statistics for Rwanda (UNHCR, 2020a).

Description of the physical world

The Kigeme refugee camp is located in Gakasa Sector, Nyamagabe District in the Southern Province of Rwanda. The report by Ministry in Charge of Emergency Management (MINEMA) explains that the camp was opened in 2012 following an influx of over 35,000 refugees from the DRC as a result of conflicts between government forces and militias (MINEMA, 2019b). The camp has an area of 348,414 meter-squares and is located at an altitude of 2,140 meters (MINEMA, 2019b). The camp has two sectors divided by a busy road (UNDP, 2012). According to the Country Refugee Response Plan for Rwanda by UNHCR (2020), shelter, water, sanitation, and hygiene related assistance are lacking due to funding gaps in the camp. Even though services related to these areas are provided as much as possible, the assistance fails at meeting minimum standards (UNHCR, 2020). The camp residents, similar to the host community, live in dwellings with mudbrick walls and a metal roof (Sandwell et al., 2020). Shelters, especially the ones with female-headed households, are old and need to be transformed as shown in Figure 6.2. With 0.059 person per meter-square, the camp has the highest population density among others in Rwanda (MINEMA, 2019b). The camp is overcrowded which obstructs household access to roads and

fire exit routes (UNHCR, 2020). The secondary and tertiary health facilities require upgrades in the structure, staffing, and logistics (UNHCR, 2020). In addition, the land that the camp is located is prone to landslides due to its topography but proper measures cannot be taken due to limited funding (UNHCR, 2020).

Figure 6.2: The Kigeme refugee camp (UNDP, 2012).

Economic nature of the activity

There have been several studies on whether energy can be treated as a common-pool resource (Gollwitzer, 2014; Gollwitzer et al., 2015, 2018; Maier, 2007; Melville et al., 2017; Wolsink, 2012, 2020). Based on the recent focus on renewable energy projects and especially solar mini-grids in displacement settings, two arguments should be made for electricity produced via such systems: that exclusion is hard and there is rivalry in consumption. The exclusion for access is defined in two ways: one for being connected or not connected to the grid which can be easily monitored and another for measuring the electricity use of the users. Maier (2007) states that it is difficult to identify and restrict access to the resource once users are electrified. If a user exceeds the agreed demand limits, then there might be blackouts and degradation in the whole system. Gollwitzer (2014) states that the rivalry in consumption is high since the demand should be met by the limited capacity for generation. Gollwitzer (2014) frames electricity provided in mini-grids as a common-pool resource by detailing how certain characteristics of electricity is similar to a frequently studied common-pool resource, groundwater, by using "hydraulic analogy". Similar to irrigation systems, the actions of one user significantly impact the system quality and availability for other users. The coordination need is even higher in mini-grids since electricity storage is of high cost. The rivalry of consumption is different than irrigation systems in the sense that smart metering and tariffs may be applied so that the users who use more pay more. Yet, there is still value in treating electricity via mini-grids as common-pool resources since it might be hard to increase the capacity

of the system because of financial considerations.

The economic nature of energy access in refugee camps highly varies from camp to camp, even from project to project within the same camp. For example, the Moria refugee camp in Greece is established within the military base of the Lesvos island. Therefore, the main sectors of the camp which were set up in the first years due to the flux of refugees to the island are connected to the national grid. As the camp population grew over the years, the pressure on the grid resulted in frequent blackouts, especially during winter times where electricity is used for heating. A solar photovoltaic (PV) system is installed by the foundation Energy for Refugees to support the grid. In such a camp setting, it is not possible to exclude refugees from using the system since everyone is free to use electricity without paying for the system. In contrast, the consumption of one user might reduce the electricity available to others in case of blackouts where the total demand exceeds available supply. This classifies energy provided through the grid in the camp a common-pool resource.

The Kigeme refugee camp has limited connection to the main electricity grid and households have no connection at all. Therefore, household cooking and lighting products and services are provided in two ways: donations and sales. Donated cooking fuels like firewood and charcoal and lighting products like solar lanterns are classified as public goods. This is because humanitarian organizations operate by the principle of "Leaving no one behind", thus it is difficult to exclude potential beneficiaries and the subtractability of use is low. Products like solar lanterns and solar home systems are classified as private goods since only camp residents who can afford these services would use them. Lastly, the solar and diesel micro-grids for the community facilities are classified as common-pool resources.

Production and provision activities

Production activities are activities necessary for transforming inputs (firewood, charcoal, diesel fuel, solar irradiation, and wind) to outputs (energy) such as capital, labor, technology, and sources of finance. Provision activities are concerned with making energy accessible to camp residents -which requires the management of production activities through financing and distribution channels. Information on these activities was scarce up until the Humanitarian Engineering and Energy for Displacement (HEED) project took up in the Kigeme refugee camp. In order to alleviate the data scarcity on energy access in Rwandan refugee camps, several quantitative surveys were conducted to evaluate energy needs and available services. A total energy assessment approach that takes household, productive, and community uses of energy (in line with the energy access locales defined in Chapter 1) into account is used for the surveys. In the Kigeme refugee camp, 202 surveys were carried out for household use, 54 for productive use, and 22 for community use (HEED, 2020). In this case, household use refers to lighting, phone charging, fuels used for cooking. Household energy use is divided into lighting or electricity and cooking since the sources used for them are different. The productive use supports businesses and enterprises within the camp such as lighting a shop or using electronic devices necessary

to provide a service. The community use stands for use of energy in camp facilities for powering office buildings, health centers, water pumping, and lighting in schools.

Key findings from these surveys, interventions that will be implemented in the future, and recommendations for evaluating energy needs in displacement settings are presented in a detailed report by Practical Action (Sandwell et al., 2020). For household cooking, firewood, charcoal, briquettes, or pellets are used (Sandwell et al., 2020). For household lighting, electricity, solar home systems, solar lanterns, and non-electric or improvised solutions are used (Sandwell et al., 2020). As mentioned, these products are either distributed to camp residents as donations or sold by energy companies operating within the camp. For productive use, some of the businesses are connected to the micro-grid but the access is not reliable. Since community facilities are of critical importance for the protection and well-being of the camp residents, they are connected to the national grid and have the highest energy access (Sandwell et al., 2020).

According to Sandwell et al. (2020), of 199 households using primary fuel, 64% use firewood, 30% use charcoal, and 7% use briquettes or pellets. Camp residents are forced to rely on a secondary stove and fuel, the main reason being that primary fuel, generally firewood, is unavailable. Of 134 households using secondary fuel, 28% use firewood, 63% use charcoal, and 9% use briquettes or pellets. Lyytinen (2009) mentions that the fuel and firewood distribution in Rwandan camps was lacking because there is not enough wood for meeting the needs of the camp population. In addition, drought prompted transportation of firewood from other districts -which put pressure on already limited funds (Lyytinen, 2009). Solar home systems have the highest generation capacity and provide electricity for lighting, phone charging, and entertainment. These systems consist of a small solar PV module with a capacity of 10 W to 50 W, a battery, LED bulbs, electronic control mechanisms, and additional applications that vary based on the model or service plan selected (Sandwell et al., 2020). The sales agents of the companies such as Bboxx, Ignite, MeshPower, and Zola visited the camps and the residents that can make the initial deposit payment and monthly payments purchased the system (Sandwell et al., 2020). Solar lanterns used for lighting are sold at an affordable price within the camp or distributed as humanitarian aid. It is observed that people encounter more issues when they use the donated lanterns compared to the purchased ones (Sandwell et al., 2020). Other lighting solutions include mobile phones that are easily stolen or lost, torches made from bulbs, candles that incur costs, and firewood that is dangerous. The use of firewood as lighting and heavy reliance on solar lanterns are most common in the Kigeme refugee camp, which might stem from the distribution of free lanterns earlier (Sandwell et al., 2020).

6.2.2 Attributes of community

There are several actors involved in the decision-making processes on energy provision in the Kigeme refugee camp such as camp residents; MINEMA; UNHCR Rwanda; Refugee Executive Committee (REC); Practical Action and other implementing part-

ners; funding partners like WFP and IKEA Foundation; and private sector actors like Inyenyeri, Bboxx, Ignite, MeshPower and Zola. These actors, their positions, and actions are described in detail within the action situation. Since camp community is the focus of the analysis, this section describes the quantitative and qualitative features of the Kigeme camp community that impact decision-making regarding energy access. Since field observation was not feasible for the duration of the research, the variables such as demographics, trust, reciprocity, common understanding, social capital, and cultural repertoire are assessed through reports on the energy projects within the camp and semi-structured interviews conducted with experts. The Kigeme refugee camp has a population of 21,216 which is approximately 14% of the total number of refugees in Rwanda as of 31 May 2020 (UNHCR, 2020b). There are 4,004 households registered and 8 quarters in the camp (Sandwell et al., 2020). Each household has five to seven people, including two to three children on average (Sandwell et al., 2020). Similar to the country-wide statistics, gender is almost equally distributed with 52% females and 48% males (Sandwell et al., 2020). The Congolese refugees constitute the majority of the camp population. Thus, ethnically, the community is rather homogeneous (P. Sandwell, personal communication, September 16, 2020).

Since the camp has been in place for the past eight years and the current situation does not allow people to go back to DRC, the camp population is relatively stable with established social structures (Sandwell et al., 2020). The people in camps generally speak the official language of Rwanda, Kinyarwanda on top of Congolese languages and French (Sandwell et al., 2020). Sharing a common language makes communication and coordination among the camp residents easier, which is often not the case in other camp settings. The camp residents receive unconditional cash transfers from the World Food Programme (WFP) which can be used for food and other basic items (Sandwell et al., 2020). Since refugees have the right to leave the camp and work, most of them are involved in income-generating activities. In Kigeme, 17% of the heads of households have a wage-earning occupation such as phone charging or haircut shops, 49% are unemployed or looking for a job, and the remaining 34% engage in non-wage-earning occupations as homemaker, volunteer, student, retired, or disabled (Sandwell et al., 2020). Some camp residents have the skills to repair broken electronics at a reasonable price for other residents (Sandwell et al., 2020). Through capacity building activities the knowledge and awareness of camp residents on solar energy products increased (Anonymous 3, personal communication, September 25, 2020).

6.2.3 Constitutional and collective-choice rules-in-use

As mentioned in Section 2.3.2, there are three levels of analysis that shape any policy situation. Since humanitarian energy governance through the regulations of nation states is rare and not incorporated into the formal structures of UN organizations, the constitutional and collective-choice level can be consolidated as one level. This decision is backed by the fact that the policies created in global arena are applied in each camp with slight differences depending on the conditions. Thus, the constitutional and collective-choice rules together shape the operational rules that dictate

daily operations in refugee camps. There are three main regulatory frameworks that give rise to humanitarian energy policies: Sustainable Development Goals (SDGs), the New York Declaration for Refugees and Migrants, and Comprehensive Refugee Response Framework (CRRF).

The international development that indirectly put energy in humanitarian organizations' agenda is the adoption of 17 SDGs in 2015. SDG 7, as mentioned in Section 1.6.1, aims to provide energy access across the globe in an affordable, reliable, and sustainable way (UN, 2015). Huber and Mach (2019) highlight the link between this goal with SDGs 10.7 on migration, 8.8 on labor rights for migrants, 10.c on transaction costs for migrant remittances, 16.2 on violence against children, and 17.3 on mobilizing financial resources for developing countries. The SDGs created a connection between humanitarian and development organizations through energy access. In parallel with the efforts to improve policies for sustainable development, the New Way of Working (NWOW) is launched at the World Humanitarian Summit in 2016 (Huber and Mach, 2019). NWOW promotes collaboration between actors, long-term planning, local focus, and innovative financing mechanism (Huber and Mach, 2019). These are exactly what is lagging in the current humanitarian energy policy sphere and can result in tremendous improvements.

Following the adoption of SDGs and NWOW, the New York Declaration for Refugees and Migrants was endorsed by the United Nations General Assembly (UNGA) on 19 September 2016 (UN, 2018). The declaration points out the importance of supporting refugee-hosting countries, promoting inclusive policies for refugees, and bringing national and local authorities, financial institutions, donor agencies, and private sectors together (UN, 2018). The declaration appointed UNHCR for the development of the CRRF which has four goals: supporting host countries, improving resilience of refugees, easing the process of third-country settlements, and working on improving the conditions in countries of origin to prevent displacement in the first place (UN, 2018). In addition, the Global Compact on Refugees (GCR) was established by UNGA as a framework aiming to create equitable sharing of responsibilities through international cooperation on 17 December 2018 (UN, 2018). Later, CRRF and GCR are brought together and share the abovementioned objectives. GCR explicitly identifies the need to tackle issues such as accommodation, energy, and natural resources as a joint issue for refugee and host communities (UN, 2018). GCR links humanitarian and development organizations and promotes the use of renewable energy technologies and partnerships with private sector.

Rwanda is known to promote policies for the well-being of refugees (Crawford et al., 2019; Bilgili and Craig, 2018; UNHCR, 2020a). The country signed 1951 Refugee Convention, the 1967 Protocol, and the 1969 Organization of African Unity Refugee Convention (MINEMA, 2019b). The rights of refugees are defined in Law N°13/2014 of 21/05/2014 called "Law relating to refugees" (MINEMA, 2019b). This law provides refugees with the right to be protected from discrimination; to own immovable, movable, and intellectual property; to work; to access to justice; and residence (MINEMA, 2019b). The country accepted the CRRF in 2018 and following the CRRF,

the Rwandan refugees have the right to work to build self-reliance, use banking services, be covered by the national health system, posses ID cards and travel documents, and get national education (for children) (Crawford et al., 2019). MINEMA, representing the road map defined by the government, created a Strategic Plan for Refugee Inclusion to address these goals (MINEMA, 2019b). The local governments and UN bodies, together with civil society organizations and private sector actors strive to provide sustainable solutions for the displaced populations (Baranda Alonso and Sandwell, 2020).

Energy provision for refugees has been neglected at national level in Rwanda until recently. Following the Global Refugee Forum in December 2019, MINEMA announced pledges concerning five issues: education; jobs and livelihood; energy, infrastructure, and environment; protection and solutions; and health (MINEMA, 2019a). With the pledge on energy, infrastructure, and environment, the Government of Rwanda aims to protect and rehabilitate the environment in and around the refugee camps, establish resilient settlements that use land consciously and minimizes adversities on environment, and promote renewable energy solutions in refugee and host community households to decrease the use of firewood. These commitments show that the government's priority is protecting the land from soil erosion and degradation, putting an end to deforestation, repairing the damage on ravines, managing water more sustainably. The pledge is in line with the Energy Sector Strategic Plan (ESSP) 2018/19 - 2023/24 published by the Ministry of Infrastructure (MININFRA) (MININFRA, 2018). ESSP highlights the importance of harnessing renewable energy sources for sustainable development (MININFRA, 2018). MINEMA expects to work with other stakeholders to switch to alternative fuels, promote environmental awareness among refugee and host communities, and help initiative renewable energy projects in camps.

6.2.4 Operational rules-in-use

Following rules-in-use in constitutional and collective-choice level, operational rules-in-use describe daily activities concerning provision, production, distribution, assignment, and consumption. There are seven different categories of rules: boundary, position, choice, information, scope, aggregation, and payoff. Each of these rules affects a specific element in the action situation and these elements are explained within their corresponding part in the next section. Since the potential outcomes are discussed within outcomes section, the corresponding scope rules that shape the potential outcomes are not discussed in this section. The desk research and semi-structured interviews revealed that not all rules-in-use in the camp are written down as some of the definition of rules and responsibilities "develop organically within the camp" (Anonymous 3, personal communication, September 25, 2020). This situation made it challenging to identify some of the rules-in-use that affect action situation.

Boundary rules

Boundary rules define conditions for joining the decision-making processes for energy governance within the camp (Ostrom, 2010). MINEMA is the official manager of the camp with government officials appointed as camp managers (MINEMA, 2020). UNHCR is in close coordination with MINEMA for managing the camp because of its mandate to protect refugees (UNHCR, 2020c). Thus, MINEMA and UNHCR decide which actors can join the energy provision activities (Anonymous 3, personal communication, September 25, 2020). There are several implementing organizations responsible for water, sanitation, and hygiene, education, and infrastructure that are managed by UNHCR. In contrast, Practical Action is not under the mandate of UNHCR but designated as energy implementing organization (UNHCR, 2020). The funding partner IKEA Foundation has a contract with both Practical Action and UNHCR to support provision of energy services and shelter (Sandwell et al., 2020; UNHCR, 2020). Refugee Executive Committee is selected according to the guidelines by UNHCR and camp management (UNHCR, 2003). The guidelines specify that the elected candidates have to leave their positions after their serving time is up (UNHCR, 2003).

Position rules

Position rules determine how a set of positions are assigned to the actors (Ostrom, 2010). MINEMA and UNHCR act as co-managers of the energy provision activities based on their mandate to protect refugees (MINEMA, 2020; UNHCR, 2020c). Through their evaluation processes and contracts with funding partners and private sector actors, they determine the positions that these actors can take (Anonymous 3, personal communication, September 25, 2020). Implementing organizations' and Practical Action's roles within the decision-making processes for energy provision are determined by bilateral contracts with UNHCR signed in 2019 (UNHCR, 2020). In addition, UNHCR and MINEMA decide on the electoral list for Refugee Executive Committee (UNHCR, 2003).

Choice rules

Choice rules specify which actions are available to an actor in a particular position (Ostrom, 2010). Similar to boundary and position rules, the actions that actors involved in the energy provision decision-making are determined by the managing partners MINEMA and UNHCR. The Refugee Response Plan states that all "camp-based refugee households will have access to sustainable energy in 2020 and 2021" (UNHCR, 2020). Thus, the actions of the actors are guided by this strategy. The managing partners decide whether a private organization like MeshPower can implement a micro-grid project are how Inyenyeri and Bboxx can sell their clean cooking solutions and solar home systems (Anonymous 3, personal communication, September 25, 2020). Refugees can choose whether or not to buy an energy solution legally but their decision is often guided by their economic status (Sandwell et al., 2020). However, there is also a lack of defined rules on which organization is trying to build a mini-grid in the camp (Anonymous 3, personal communication, September 25, 2020).

Information rules

Information rules dictate how and which information can be shared among actors (Ostrom, 2010). There is not an official structure for sharing information and the basis for sharing information is organically developed (Anonymous 3, personal communication, September 25, 2020). Regular meetings between MINEMA, UNHCR, REC, Practical Action and other implementing organizations ensure that available knowledge was shared (Anonymous 3, personal communication, September 25, 2020). These meetings are held every second month to update all stakeholders and work together to find solutions for problems (UNHCR, 2020).

Aggregation rules

Aggregation rules shape the level of control each actor has over its actions (Ostrom, 2010). MINEMA has the highest control of their actions as the main manager. UNHCR has to obey the rules set by the government and practices enforced by the ministry (Anonymous 2, personal communication, September 23, 2020). Practical Action, even though it is not mandated by UNHCR, has to obey the rules set by the camp management. Other implementing organizations and private sector companies operate in coordination with UNHCR as defined in their contract (UNHCR, 2020). Refugees can elect who can represent them but the fact that election candidates are selected by camp management shows that they have limited control over representation (UNHCR, 2003).

Payoff rules

Payoff rules determine the distribution of costs and benefits among actors based on their assigned positions (Ostrom, 2010). The pricing mechanisms for energy services are decided by UNHCR (Anonymous 3, personal communication, September 25, 2020). UNHCR spends its budget on making sure that refugees have access to shelter, water, food, and cooking fuel. WFP's mandate to provide food for refugees give them an option to distribute food or cash. WFP started cash-based assistance program in the Kigeme refugee camp which provides %80 of refugee income (UNHCR, 2020). IKEA Foundation provides monetary assistance to UNHCR and Practical Action so that these organizations would provide sustainable and renewable energy solutions to people in displacement settings (Anonymous 2, personal communication, September 23, 2020). The contract between Practical Action and IKEA Foundation is valid until February 2022 (Anonymous 2, personal communication, September 23, 2020). The private sector companies like Inyenyeri and Bboxx have a regular purchasing contract with refugees who wants to buy their products (Anonymous 2, personal communication, September 23, 2020). Only MeshPower is not getting paid for the implementation or operation cost of the micro-grid (Anonymous 2, personal communication, September 23, 2020).

6.3 ACTION SITUATION

The action situation is the decision-making process for improving energy access within the Kigeme refugee camp. This is a social space where actors, based on their assigned positions, process the information available to them, interact with each other, and note the outcomes of these interactions. The working elements of action situation, together with external operational rules-in-use that affect them, are described in the following sections.

6.3.1 Actors

There are several different actors operating in the Kigeme refugee camp to ensure that the refugee population is protected. How these actors enter and leave their positions is determined by the boundary rules.

MINEMA

Ministry in Charge of Emergency Management (MINEMA), formerly Ministry of Disaster Management and Refugee Affairs (MIDIMAR), is the representative of the Government of Rwanda in executing the humanitarian response to refugee situation. MINEMA has four units: Single Project Implementation Unit (SPIU), Prevention & Mitigation Unit, Response & Recovery Unit, and Finance & Administration Unit as shown in Figure 6.3. MINEMA has two core working areas: disaster management and refugees management. Disaster management revolves around prevention, preparedness, response, and mitigation activities for disasters like volcanic activity, floods, earthquakes, deforestation, and drought (MINEMA, 2020). Refugees management is concerned with establishing proactive governance mechanisms for dealing with refugees according to the national law and international treaties (MINEMA, 2020). This division is clear from the vision, mission, and core activities of the ministry as well. MINEMA strives for building a nation resilient to disasters and ensuring effective management of refugee-related issues (MINEMA, 2020).

UNHCR Rwanda

UNHCR is the body acting under the authority of the General Assembly providing international protection for refugees through long-term solutions (UNHCR, 2020c). UNHCR Rwanda is responsible for the registration and protection of refugees, multisectoral assistance such as shelter, water, health, and education, and offering sustainable solutions for refugees (Sandwell et al., 2020). The agency tackles the Congolese and Burundian refugee situations, transfer of refugees and asylum seekers from Libya to Rwanda under Emergency Transit Mechanism, assist voluntary repatriation to DRC and manage Rwandan returnees (UNHCR, 2020).

Refugee Executive Committee

REC represents the interests of camp communities in decisions concerning the refugee population and works in coordination with UNHCR and MINEMA (Sandwell et al.,

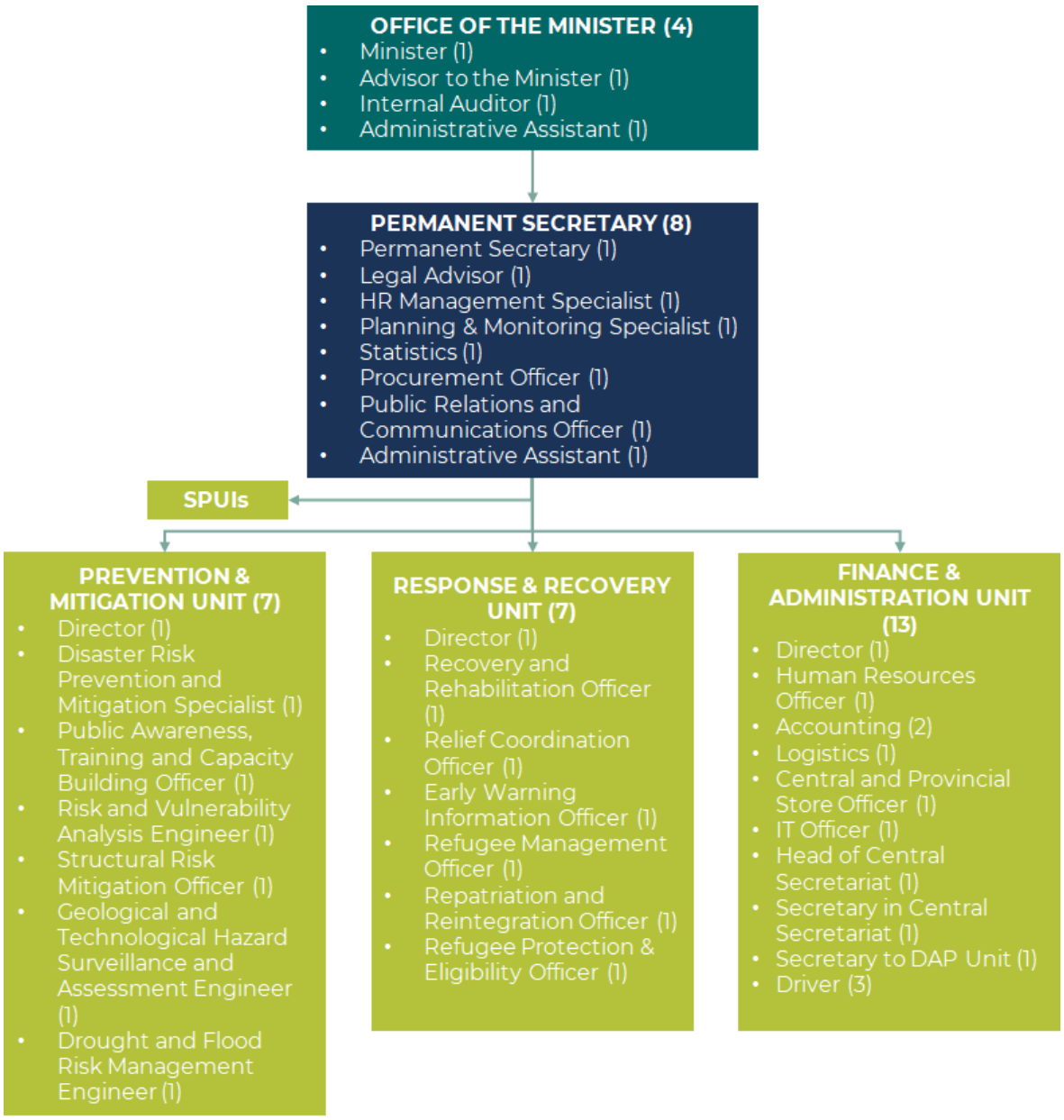

Figure 6.3: The governance structure of the MINEMA, adapted from (MINEMA, 2020).

2020). The committee members are elected by and among the camp residents and take action as an administrative decision-making body on community-level (Sandwell et al., 2020). The committee consists of a president or chief, a vice president or vice chief, secretary, and other members in charge of specific issues such as gender, youth, and security (Sandwell et al., 2020). There are other committees operating at the village and *quartier* level. Villages consist of tens or hundreds of households whereas *quartiers* are groups of several villages (Sandwell et al., 2020). These committees work on distribution of cooking fuels, assist vulnerable households in reaching products, and guiding community in energy use (Sandwell et al., 2020).

Practical Action

Practical Action is an international development organization focusing on improving access to sustainable energy for the refugees. The organization works for the provision of financing, training, and technical expertise in order to supply the electricity needs of households, community facilities like health centers and schools, and businesses in the camp (Practical Action, 2020).

Funding partners

Other than donor agencies that support UNHCR and government budgets set for MINEMA, WFP and IKEA Foundation are two actors working with UNHCR to fund the activities related to energy provision in the camp. WFP is responsible for supplying monthly food assistance to the camp residents and host communities living around the camp and providing additional supplements to vulnerable groups (World Food Program, 2020). Vulnerable people are young children, pregnant and nursing women, and people living with tuberculosis or HIV/AIDS. IKEA Foundation, through its partnership with UNHCR and Practical Action, supports assistance operations and energy projects in the camp.

Private sector actors

There are several private companies providing products for household cooking and electricity demand. Household cooking products are clean cookstoves to replace traditional cookstoves that use wood or biomass. Inyenyeri, before suspending their operations in April 2020, offered free lease on clean cookstoves as long as the customers agree to purchase wood pellet fuel that is compatible with the cookstove (IRENA, 2019). For household electricity, technologies such as solar lanterns and solar home systems. Three companies are selected for providing solar home systems: Bboxx, Ignite, MeshPower, and Zola (Sandwell et al., 2020). These companies provide pay-as-you-go (PAYG) and leasing options for consumers (Rosenberg-Jansen, 2018).

6.3.2 Positions

In different projects, actors can assume different roles based on how the roles and responsibilities are shared and which business model is selected, determined by position rules. The main actors are MINEMA, UNHCR Rwanda, Refugee Executive Committee, Practical Action, WFP, IKEA Foundation, and private sector companies such as Inyenyeri, Bboxx, Ignite, MeshPower, and Zola. There are other partner organizations that are not included in the analysis of energy provision activities that provide specific assistance within the camps: Alight, formerly American Refugee Committee, for shelter and infrastructure, Africa Humanitarian Action for health, and World Vision for water (UNHCR, 2020). The camp is managed by two actors: UNHCR and MINEMA. MINEMA is the governmental body responsible for the management of the camp. UNHCR is the UN agency responsible for managing and coordinating the humanitarian response activities. Refugee Executive Committee serves as an advisory

board in coordinating the needs of the refugee populations with managers. Practical Action is project developer as they initiate research and projects on energy access. IKEA Foundation and WFP are donors as they finance renewable energy projects and cash for energy projects, respectively. Private sector actors like Bboxx and Mobisol are implementers. Camp residents and volunteers from UNHCR and other organizations are the consumers.

6.3.3 Actions

The actions are a set of options for actors to decide, collaborate, and organize in their positions, specified by choice rules. The actions of the actors involved in energy provision in the Kigeme refugee camp are shaped by international policies and national laws and regulations. Based on the law pertaining to refugees, MINEMA has four action points: establishing national policies to improve the efficiency and effectiveness of disaster awareness, preparedness, and management activities and refugee affairs; facilitating coordination between technical ministries and other institutions for disaster awareness, preparedness, and refugee-related issues; monitoring and evaluating all operations; developing institutional and training capacities for disaster management; and mobilizing funds for resources used for disaster management (MINEMA, 2020). UNHCR Rwanda works within the Refugee Coordination Model (RCM) which is a general framework for operating in refugee situations. RCM normally divides humanitarian assistance activities into seven sectors but the recent Refugee Response Plan by UNHCR included energy and environment as illustrated in Figure 6.4. The eight sectors that UNHCR works on are protection; education; food security; health and nutrition; energy and environment; shelter and non-food items (NFIs); water, sanitation and hygiene (WASH); and livelihoods and resilience (UNHCR, 2020c). UNHCR and MINEMA provide support in operations, capacity development, and technical advice (UNHCR, 2020). MINEMA and UNHCR published a joint strategy aiming for the inclusion of refugees in economic activities by 2020 (UNHCR, 2020). The strategy aims to increase the self-reliance of refugees by creating livelihood opportunities for them.

The HEED project aims to provide innovative solutions for meeting the energy of people in three refugee camps Nyabiheke, Gihembe, and Kigeme in Rwanda and IDPs in Nepal following the 2015 earthquake. The project brings together researchers at Coventry University and renewable energy experts at Practical Action and SCENE and is funded by the EPSRC Global Challenges Research Fund (Grant N°EP/P029531/1) (HEED, 2020). An off-grid PV system is installed by MeshPower to supply electricity to two nurseries and a playground (HEED, 2020). The system is connected to lighting and sockets for entertainment, phone charging, and educational devices. The micro-grid is composed of solar panels of 2.55 kW power and 21.1 kWh GEL battery storage as shown in Figure 6.5. A distribution and metering system with GSM connection was included in order to measure the electricity production and consumption. The purposes of installing a monitoring system were to collect evidence on the benefits of using community micro-grids in camps, to evaluate optimal design features that gave negotiation options over energy use by camp residents, and understand

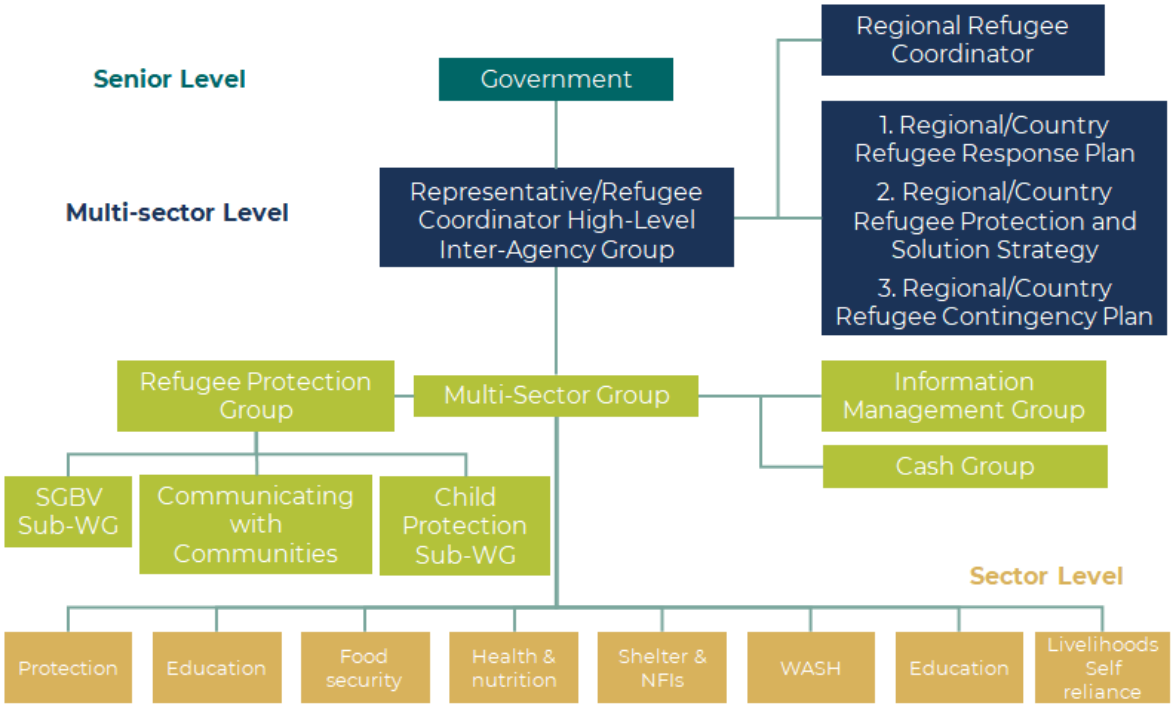

Figure 6.4: The Refugee Coordination Model in action, adapted from (UNHCR, 2020c).

how community priorities grow with energy provision (Nixon and Gaura, 2019).

Practical Action, together with UNHCR, initiated the Renewable Energy for Refugees project to improve access to renewable energy in Rwandan refugee camps so that camp residents can be more resilient and less reliant on aid provided by humanitarian organizations (Practical Action, 2020). The Renewable Energy for Refugees (RE4R) project is a supported by the IKEA Foundation, and in partnership with Chatham House, Energy4Impact, and the Norwegian Refugee Council (Sandwell et al., 2020). The RE4R project is different from previous initiatives that aim to improve energy access for displaced communities in many ways: (i) use of renewable energy sources, (ii) empowerment of refugees so that they would be able to support themselves economically, and (iii) inclusion of refugees and host communities in projects. The project focuses on providing renewable energy for refugees and host communities in Kigeme, Nyabiheke, and Gihembe refugee camps in Rwanda and urban refugees in Irbid in Jordan (Sandwell et al., 2020). As displacement settings are often located in rural or isolated areas in Rwanda, projects by RE4R focus on off-grid renewable technologies (Sandwell et al., 2020). IKEA Foundation sponsors UNHCR Rwanda and RE4R project for food, water and sanitation, shelter, and energy needs in the camp. WFP, in a joint strategy with UNHCR, initiated a cash-based assistance program for the Kigeme refugee camp. Camp residents receive a base monthly allowance of RWF 7,600 (USD 8.84) and can earn up to RWF 24,000 (USD 27.91) through cash-for-work programs within the camp (Sandwell et al., 2020). This allowance is used by camp residents to purchase solar lanterns and solar home systems supplied by private companies operating in the camp.

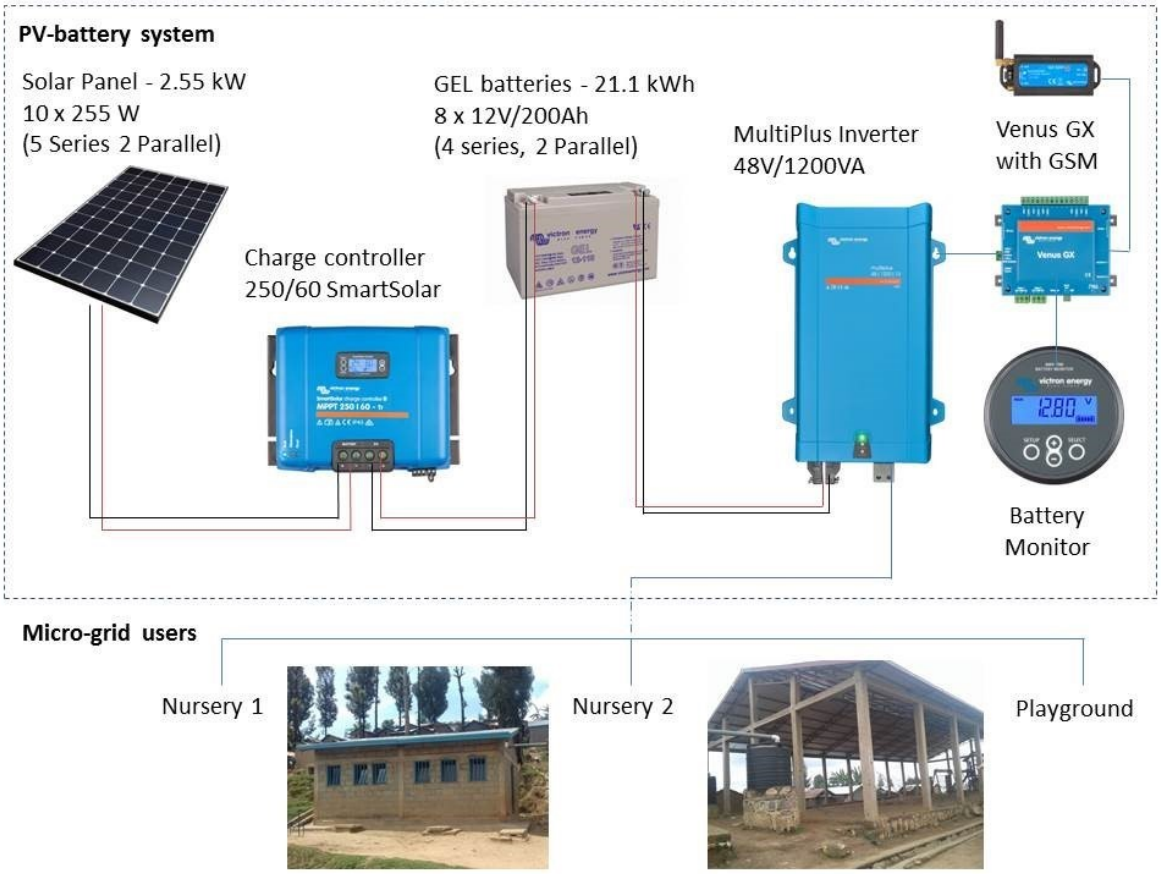

Figure 6.5: The micro-grid system components in the Kigeme refugee camp (HEED, 2020).

6.3.4 Information

Information is the knowledge that is available to the actors in positions on policies, technology, and cost and benefits pertaining to energy access in the camp, dictated by information rules. Information on energy provision in camps is severely lacking but this has been gaining attention and with projects like HEED and RE4R, a database on electricity consumption of households, community facilities, and businesses was created. As partners in managing the camp, UNHCR and MINEMA share information on daily operations and strategic capacity building (Anonymous 3, personal communication, September 25, 2020). Traditionally, these organizations use top-down communication methods. However, with projects like HEED and RE4R in the camp, information sharing between camp residents and camp management has increased. Within the HEED project, several community engagement workshops were arranged to understand community needs and willingness to pay for energy services (HEED, 2020). The decision to install a micro-grid to two nurseries and a playground was made in consultation with the refugee community (HEED, 2020). Throughout the project, the grid was communicated as a shared resource, and representatives from REC were trained about the micro-grid and control systems (HEED, 2020). The database created by the HEED project is available on their website upon request for access and can be used by researchers and other humanitarian organizations to inform their decision making. The website provides hourly consumption and produc-

tion data collected through the GSM connection in the solar micro-grid system. In addition, the participants in the HEED surveys were asked for consent after being informed about the purpose of the study (HEED, 2020). The survey numerators selected from UNHCR workers and camp residents were trained on how to collect data while respecting the privacy of camp residents (Sandwell et al., 2020). It is seen that the actors in the system create and share information collectively in order to achieve the goal of providing refugee communities with clean and sustainable energy.

6.3.5 Control

Control is the control over actions meaning how actors can take actions: whether it is an individual initiative, collective action, or co-creation, influenced by aggregation rules. UNHCR has to obey laws and regulations of the country of operation while protecting people. For energy provision in the camp, UNHCR makes decisions in coordination with camp manager officers from MINEMA. The national law banning use of firewood in 2019 challenged UNHCR to shift towards clean cooking solutions (UNHCR, 2020). Within a year, 48.5% of the population started using liquid petroleum gas (LPG) whereas others received cash-based assistance so that they purchased biomass (in pellets or briquettes) which were made from sawdust (UNHCR, 2020). There were two main problems with this change. The first was the limited number of clean cooking solutions providers and resistance from camp community to switch to a new cooking fuel (UNHCR, 2020). Second, UNHCR had to quickly adapt to this policy change and find ad-hoc solutions (P. Sandwell, personal communication, September 16, 2020). Since the national policy bans the use of firewood, the goal for 2020-2021 is to ensure rolling out of alternative cooking solutions in all camps (UNHCR, 2020). Private sector actors have to obey the national and regional law as well, in addition to prioritizing the safety of people in camps before profits. Funding partners like IKEA Foundation and WFP can choose how much money they will grant to UNHCR and camp residents, respectively. REC, as representing body of refugees, have information and say in the decisions regarding energy provision. The committees can guide UNHCR on identification of vulnerable people within the camp so that their energy needs are prioritized. Practical Action recommends action points and solutions based on the research conducted in the camp. It is observed that the actors with most control over their actions are MINEMA and UNHCR, which is expected considering their managing position.

6.3.6 Net costs and benefits

Net costs an benefits and how these costs and benefits are shared within the actor group are determined by payoff rules. These costs and benefits are system component costs, installation costs, operation and maintenance costs, payback time. WFP and IKEA Foundation, and other donor agencies indirectly and directly bear the costs. For example, UNHCR received a €30.8 million grant from IKEA Foundation, the agency's largest private sector partner to improve lighting (Rosenberg-Jansen, 2018). Refugees pay for services through the cash allowance provided by WFP and UNHCR

Rwanda. Practical Action and private companies assess energy needs and initiate projects through the IKEA Foundation's support. Which actors benefit from the improvement of energy services in the Kigeme refugee camp depends on which energy locales are considered in the provision activities. The already limited budgets for humanitarian response activities could be transferred from energy to other sectors with the deployment of diesel generators. MINEMA and UNHCR would reach their goals of promoting economic inclusion and self-reliance of refugees. Households would directly benefit if their cooking, lighting, and phone charging needs are met. The indirect benefit would be through powering community facilities like health centers and schools which UNHCR operates. The business enterprises would benefit from energy access during the day, in accordance with their operating hours.

6.4 INTERACTIONS

The analysis of the action situation highlights the patterns of interactions shaped by the structures within the action situation and actions taken by actors in the policy sphere. The interactions between the actors involved in the decision-making processes for energy provision in the Kigeme refugee camp are illustrated in Figure 6.6.

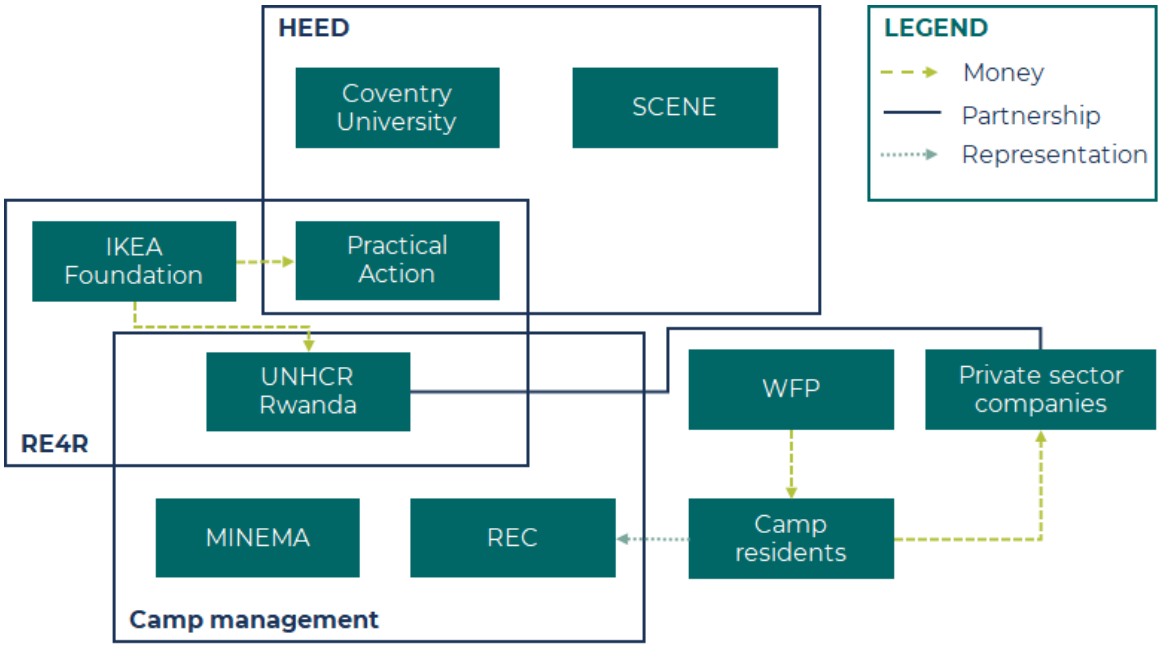

Figure 6.6: The interactions between the actors involved in energy provision activities in the Kigeme refugee camp.

As the figure shows, UNHCR is the most connected actor to others and it is observed that UNHCR is dominating the action situation. The agency decides how a project is implemented and defines structures for governance. This situation might negatively impact energy initiatives as "there is a severe lack of expertise within the energy officers in UNHCR Rwanda" (Anonymous 2, personal communication, September 23, 2020). One of the interviewees mentioned that the problem was not the lack of funding but rather the lack of a clear plan on how to spend the money (Anonymous 2,

personal communication, September 23, 2020). "UNHCR didn't have a plan on how to spend the money. They didn't have people with engineering and technical background at the time and instead of hiring experts with long-term contracts, they hired people with 2-6 months contracts, which is a very short period of time for any energy project" (Anonymous 2, personal communication, September 23, 2020). In addition, "the funding from IKEA Foundation could be used to connect all households to the main grid and the refugees could pay the electricity bill. They are already paying disproportionate amount of money for candles and kerosene in comparison to the service they get in turn. But it was a political no-go because this could have mean that camp community had a better quality of life than Rwandan citizens even though that's certainly can't be the case" (Anonymous 2, personal communication, September 23, 2020). This situation challenged the regular pattern of funding for refugee protection activities. Donor countries and organizations like IKEA Foundation started directly investing in organizations with technical expertise in electrification such as Practical Action (Anonymous 2, personal communication, September 23, 2020).

Another pattern of interaction observed is the lack of defined ownership for the energy systems operated in the camp. For example the diesel generator used as back-up to power UNHCR offices is owned by UNHCR and procured by their procurement office (Anonymous 3, personal communication, September 25, 2020). However, the informal obligation to operate and maintain the system is given to Alight without any official contract (Anonymous 3, personal communication, September 25, 2020). In addition, there is no clear way that maps out how a refugee can connect to the system if they want to (Anonymous 3, personal communication, September 25, 2020). In terms of ownership, it is observed that there is a conflict between rules-in-use. Refugees can own and operate immovable assets as defined in the CRRF and Strategic Plan for Refugee Inclusion (MINEMA, 2019b). However, whether or not they can own an asset like a micro- or mini-grid is determined by UNHCR as gatekeeper organization (Anonymous 2, personal communication, September 23, 2020). Here, there were two different reasons why the ownership of the micro-grid is not handed over to refugees yet. One of the experts mentioned that even though the community was keen on the implementation of the idea it got pushed back from UNHCR. UNHCR preferred a community cooperative to own the system but the community refused this idea because they argued that the "people who own the system would have too much physical and political power" (Anonymous 2, personal communication, September 23, 2020). In addition, UNHCR argued that the whole camp cannot be owners of the system that's why the ownership of the system stayed with the MeshPower (Anonymous 2, personal communication, September 23, 2020). However, there were meetings to decide on how to hand the system over was halted because the camp has been in lockdown for the last three months due to COVID-19 (Anonymous 3, personal communication, September 25, 2020).

6.5 OUTCOMES

The outcomes of the decision-making process regarding energy provision in the Kigeme refugee camp are evaluated using eight criteria: efficiency, equity, legitimacy, participation, accountability, fiscal equivalence, consistency with moral values, and resilience and sustainability. In a camp setting, efficiency is measured by the cost-effectiveness of energy solutions.

6.5.1 Efficiency and equity

Efficiency of the outcomes of energy provision activities is measured by their cost-effectiveness. It has been shown that providing diesel generators by shipping or air travel in a country with high solar irradiation increases the costs without providing reliable and sustainable electricity. Even though the up-front costs of large-scale renewable energy solutions are too high for under-funded UNHCR, private sector engagement shows to be promising. The equity of energy access is an important topic to discuss since not all households can bear the costs of electricity services, especially if they do not have employment or allowance from their relatives abroad (Sandwell et al., 2020). However, the limited access to solar home system suppliers and their high costs make them not easily accessible and affordable for most households (Sandwell et al., 2020). The data shows that almost 75% of the target is reached for rolling-out the solar home systems (NORCAP and BCG, 2020). Innovative funding is needed otherwise mini-grids pose high risk for both humanitarian organizations and private sector in the short term (P. Sandwell, personal communication, September 16, 2020).

6.5.2 Legitimacy and participation

Legitimacy and participation are measures of the extent to which actors think of the decision-making processes in terms of co-creation. However, the inclusion of communities in decision-making and planning activities ensures that their energy needs are understood by the humanitarian organizations (Rosenberg-Jansen, 2018). It is argued that refugees have the most accurate knowledge about themselves so engaging communities and private sector who might meet their needs is required to deliver the best solution. The Kigeme refugee camp, through the HEED and RE4R projects, sets an example for collecting data on energy provision in refugee camps. The camp residents were involved in the projects from start to finish as they collected the data and participated in decisions regarding the choice of facilities to connect to the micro-grid. The common values and homogeneity in the camp population positively impacted the co-design sessions and workshops. The fact that the information is readily shared with interested parties is a positive action since more knowledge sharing is needed within the humanitarian energy sector (P. Sandwell, personal communication, September 16, 2020).

6.5.3 Accountability and fiscal equivalence

Accountability is a measure of the cost of sharing information with the users of the resource, the level of actors' capability to evaluate each other's actions, and the extent of how actors access monitoring and sanctioning systems. In the Kigeme refugee camp, the data on electricity consumption patterns is collected by using monitoring systems and training refugees in using these monitoring systems. The monitoring sensors increase the cost of the overall system yet they are crucial in observing how the consumption changes over time. This way, the community can negotiate and share the electricity provided via solar PV system as a common-pool resource (Nixon and Gaura, 2019). Fiscal equivalence is a measure of the contribution of beneficiaries on the production of the good or service in comparison to the benefits they receive. For market-based solutions, the camp residents pay the full cost of the production of electricity services. However, the service quality they get in return can be labeled as barely sufficient, or insufficient when the limited utilization options of these services are considered. In the case of solar micro-grids, the residents do not pay for the system but monitor and adapt their consumption based on the data (Anonymous 3, personal communication, September 25, 2020).

6.5.4 Consistency with moral values, resilience and sustainability

Consistency with moral values is a measure of how the decision process is in line with the participating organizations' core values. The current levels of energy provision in the camp fall short in respecting these values of protection, resilience, and self-reliance. As the coordination between MINEMA, UNHCR, funding partners, and private companies increases, it is expected that the goals such as self-reliance and security will be reached (Sandwell et al., 2020). Energy is an enabler for education, income-generating activities, and safety for women and children. The sustainability of any energy project depends on how much the camp residents are involved in the decision-making processes.

6.6 CHAPTER SYNTHESIS

This chapter presents an analysis of energy governance in the Kigeme refugee camp through the application of IAD framework with multiple levels of rules-in-use. The use of institutional analysis helped to identify external factors that affect energy provision. The physical conditions in the camp, how energy is produced and provided by UNHCR Rwanda and private sector companies, community attributes, and rules-in-use in international, national and camp levels shape the decision-making processes. The energy needs in camps and participatory approaches for camp management are included in national policies and UNHCR agenda in recent years. This is evident in two extensive projects implemented in the camp. Even though the current situation does not comply with the values of managing partners, the collaboration between actors seems promising. The common theme observed is the importance of community

involvement for successful implementation of solar micro-grid projects in the Kigeme refugee camp. The next chapter explores the drivers and barriers for incorporating community-based approaches for solar mini-grids in refugee camps.

7 DRIVERS AND BARRIERS FOR COMMUNITY SOLAR MINI-GRIDS IN REFUGEE CAMPS

This chapter answers the third research question "*What are the drivers and barriers for community solar mini-grids in refugee camps?*" by providing a discussion on the factors that affect the implementation of such projects. Section 7.1 identifies technological drivers and barriers as sizing of the system,technical expertise, and monitoring. Section 7.2 describes institutional factors as regulatory framework, ownership, and knowledge sharing. Section 7.3 categorizes economic drivers and barriers as funding and private sector involvement. Section 7.4 examines social factors as community involvement and social capital. Lastly, Section 7.5 concludes the chapter with a synthesis of findings.

Since energy for displacement settings as a field has just started to gain movement, reports on recent projects are used together with findings from the case study in the Kigeme refugee camp. There are some studies on success and failure factors for community mini-grid projects in high-income countries (Haggett et al., 2013; Walker, 2008; Warbroek et al., 2019) and in rural areas of low-income countries (Lestari et al., 2018; Frame et al., 2011). In addition, there are studies on the enabling factors that improve the sustainability of common-pool resources. The literature from studies in both domains is evaluated on the basis of whether they are relevant in a displacement setting and merged with the findings from the previous two chapters.

7.1 TECHNOLOGICAL DRIVERS AND BARRIERS

Solar mini-grids poses several advantages since they are considered to have low cost, be environmentally sustainable, and provide better service than unreliable grids (Frame et al., 2011). The solar mini-grids can replace or decrease the need for diesel generators that supply the needs of community facilities and humanitarian organizations' offices. The fact that solar mini-grids are portable energy infrastructures that can be repurposed if the system is not needed anymore makes them compatible with diesel generators (Van Landeghem, 2016). However, there are several technological barriers for using community solar mini-grids in refugee camps: lack of data on energy use, intermittent supply, need for storage, modularity for sizing of the system; operation and maintenance for technical expertise; and balancing supply and demand for monitoring (Baranda Alonso and Sandwell, 2020; Koirala et al., 2016).

7.1.1 Sizing of the system

Frame et al. (2011) argue that the assessment of peak load, average daily load, and solar irradiation is necessary for the design of technical specifications of the system. This information is used to determine the number and arrangement of PV arrays, battery technology, charge control, and inverter components (Frame et al., 2011; IRENA, 2016). However, the data scarcity on energy use can result in over- or under-sizing of the system. In order to overcome this issue, energy demand that is already supplied by diesel generators can be measured over a certain period of time. Initially, a modular system with solar PV modules and batteries can be installed to handle the intermittency of supply which can be scaled up based on the demand over time. Due to the high costs of batteries, a hybrid system might be preferred which supports solar PV with diesel, biomass, or hydropower energy. Another option is to reduce the need for expensive batteries by limiting the electricity use to day time through the establishment of demand response programs.

7.1.2 Technical expertise

Caniato et al. (2017) state that energy technologies used in displacement settings should be easy to be introduced, operated, maintained, and managed at the community level. Solar mini-grids are easier to manage than other renewable energy systems such as wind or hydropower. However, the lack of expertise within humanitarian organizations on energy systems hinders the implementation of solar mini-grid projects in refugee camp settings (Sandwell et al., 2020). This lack of expertise also shows itself during the operation and maintenance of the system. The maintenance of the system, done monthly, can prevent blackouts or safety hazards (B. Peterson, personal communication, September 15, 2020). In addition, for long-term reliability, it is advised that the system components should be readily accessible only for the people responsible for the system (B. Peterson, personal communication, September 15, 2020). Considering the limited number of people with technical expertise on solar mini-grids, the operation and maintenance activities might be of insufficient quality, which reduces the system's long-term reliability.

7.1.3 Monitoring

The distribution and consumption need monitoring as most of the mini-grid projects experience blackouts, brownouts, equipment failure resulting from substandard equipment use, and collective over-consumption (Greacen, 2004). Greacen (2004) states that over-consumption happens because of a mismatch between tariffs and technical characteristics of the system. Similarly, Maier (2007) also maintains that over-consumption leads to equipment degradation and failure. Technologies like smart meters and remote metering can help to ensure the supply meets the energy demand patterns and to avoid technical failures. The experiences with solar mini-grid in camps show that monitoring not only helps in managing the system efficiently

but also informs communities for negotiating their consumption patterns (Nixon and Gaura, 2019).

7.2 INSTITUTIONAL DRIVERS AND BARRIERS

Institutional organization of the mini-grid is highly relevant for the success of these systems, especially in refugee camp settings. Apart from the technological challenges, mini-grids are also more complicated in institutional aspects because of their complex operation, management maintenance operations, and necessary regulatory framework in comparison to solar home systems available in refugee camp settings. The institutional issues identified can be categorized as lack of regulatory framework, definition of ownership, and knowledge sharing (Acosta et al., 2018; Haggett et al., 2013; Koirala et al., 2016; Sandwell et al., 2020; Van Landeghem, 2016).

7.2.1 Regulatory framework

One of the most important institutional problems in community mini-grids is the lack of regulatory framework on energy access in refugee camps. This uncertainty in terms of regulations and the status of refugees also poses a high risk for private actors and funders (Baranda Alonso and Sandwell, 2020). It is seen that even low-income countries with strong electrification programs like Rwanda do not have a governmental body responsible for energy provision in displacement settings. However, with initiatives like Clean Energy Challenge and GPA energy in camps is included in international policies. As the support by private sector actors, funders, NGOs for the humanitarian energy sector, the national regulations might start putting energy as another essential need to be met in displacement settings like shelter, food, and water.

7.2.2 Ownership

The ownership can be defined in a number of different ways in community solar mini-grids. Walker (2008) distinguishes different models of community ownership and use as cooperatives, community charities, development trusts, and shares owned by a local community organization (Walker, 2008). It is argued that investment through shared ownership might benefit members with required economic status whereas all members can benefit from a community charity (Walker, 2008). Defining refugee communities as owners of the system does not seem feasible considering that even humanitarian organizations lack the funding and operation structure to claim ownership of mini-grids (P. Sandwell, personal communication, September 16, 2020). Leasing agreements are preferred in which a private sector company or a foundation is the owner of the system but rents the mini-grid to humanitarian organizations at a lower cost or free (J. Montejano, personal communication, September 15, 2020). In addition, the gap in the identification of available business models is filled with the increasing collaboration and coordination between humanitarian organizations, think

tanks, and private sector partners. In a recent report by MEI and Kube Energy (2018), four business models for humanitarian organizations are offered: purchase, lease to own, limited power purchase agreement (PPA), or full PPA as shown in Figure 7.1. A recent report is published by Fouquet et al. (2020) which identifies standard clauses of PPA and leasing agreements for the humanitarian energy sector.

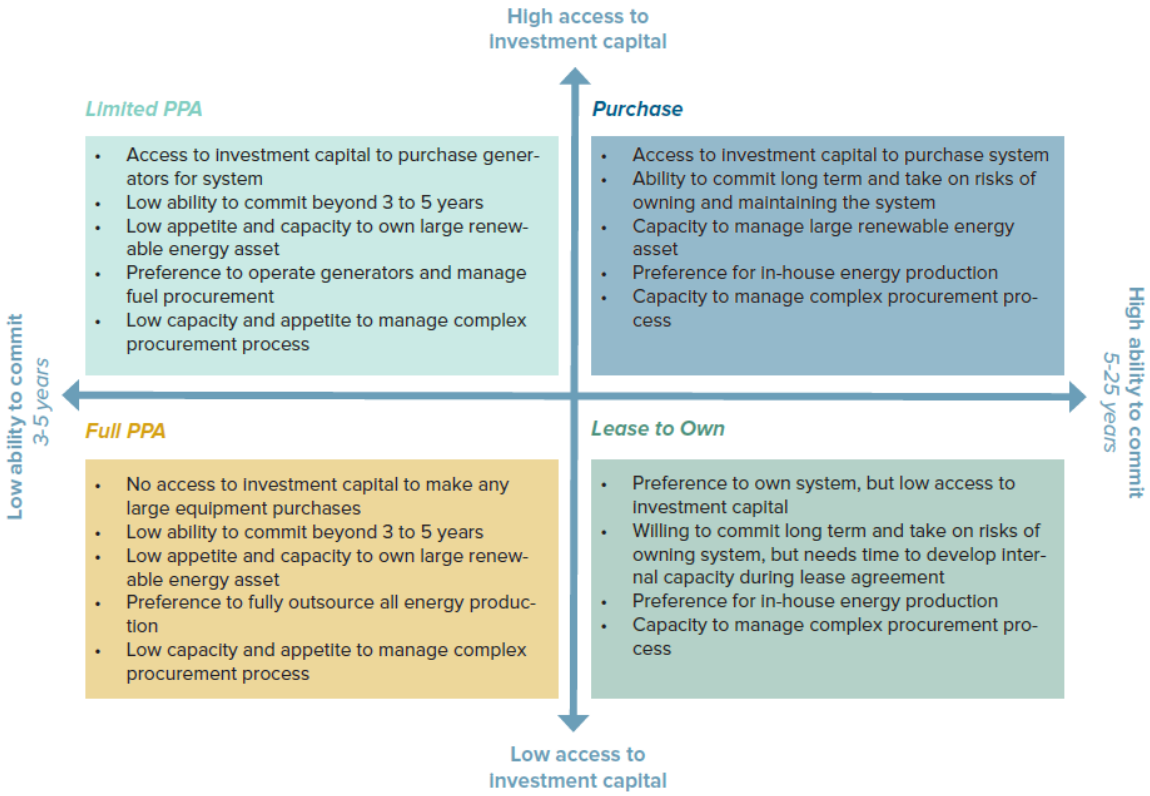

Figure 7.1: Four business models for mini-grids in refugee camps (MEI and Kube Energy, 2018).

7.2.3 Knowledge sharing

In addition to the issues with the institutional design of the system, the sheer number and type of actors involved in the humanitarian energy sector make the decision-making process and coordination more complicated. The priorities between humanitarian organizations and private companies that have little experience in humanitarian or development settings might be different. Rosenberg-Jansen (2018) argues that this complex situation might lead to informed debates and knowledge sharing. In recent years, private sector companies with experience in rural electrification started to work with humanitarian organizations in partnerships (MEI and Kube Energy, 2018; Sandwell et al., 2020). Sharing knowledge is crucial in accelerating the implementation of solar mini-grids in displacement settings. Through communicating study findings or the effectiveness of projects, actors with different expertise and capabilities come together and learn from each other's successes and failures -which is needed for progress (P. Sandwell, personal communication, September 16, 2020).

7.3 ECONOMIC DRIVERS AND BARRIERS

Caniato et al. (2017) indicate that the procurement and operation & maintenance costs of the energy systems should be affordable for their widespread use in refugee camp settings. However, Van Landeghem (2016) states that procurement of energy as a service (solar mini-grids) rather than a product (solar lanterns or solar home systems) requires high up-front costs. Therefore, the economic aspects affecting solar mini-grids are identified as funding, private sector involvement, and financing.

7.3.1 Funding

The report by Shell International (2020) shows that every $1 spent on energy yearly results in a $1.4-1.7 in benefits incurred to host community, displaced community, and global society. Although this clearly indicates the significance of the energy investments, the humanitarian organizations have short-term funding cycles which make long-term planning and investments risky for private companies and funders (Rosenberg-Jansen, 2019). Also, the high investment costs and payback periods of solar mini-grids hinder the prioritization of energy in short-term funded humanitarian assistance operations (Baranda Alonso and Sandwell, 2020). This is mainly because energy is not included in the budgets of humanitarian organizations (Bellanca, 2014). However, when the budgets spared for unreliable diesel generators is taken into account, solar mini-grids become a cheaper option in the long-term (B. Peterson, personal communication, September 15, 2020). Baranda Alonso and Sandwell (2020) calculate the payback period of renewable energy systems as one to six years while including the cost savings from a decrease in diesel fuel use.

7.3.2 Private sector involvement

Camps are insecure, unstable, and remote locations -all of which are factors that damage private sector involvement in mini-grid projects (Shell International, 2020). However, through partnerships with humanitarian agencies, early entrants can benefit from finding innovative business models (Shell International, 2020). The mini-grid development companies benefit from getting involved in the installation of large-scale systems that can be used to meet energy demands of community facilities (Baranda Alonso and Sandwell, 2020). “Displaced people often represent a marginal, low-income and disadvantaged market segment with little visibility of, or capability to plan for, their economic future.” (Cohen et al., 2019). Recently, with increase in private sector involvement, there have been studies to evaluate the willingness to pay for energy services (Corbyn and Vianello, 2018). Partnerships with private sector actors who might provide affordable business models such as power purchase agreements or pay-as-you-go services can serve as another driver for the solar mini-grid implementations in refugee camp settings.

7.4 SOCIAL DRIVERS AND BARRIERS

Institutional organization of the mini-grid and social norms are highly relevant for the success of mini-grids, especially in refugee camp settings. The social aspects of the solar PV mini-grids concern engagement, participation, and accountability of the users (Frame et al., 2011; Nixon and Gaura, 2019). Walker (2008) argues that local income generation, public acceptance, affordability, and environmental impacts incentivize communities while pointing out that funding support and existing rules and regulations can be challenges for taking up energy projects.

Warbroek et al. (2019) contribute to the literature by analyzing social and institutional factors for the success of projects in the Netherlands such as access to funds, community involvement, alignment with local values, and supportive governance arrangement. Kirubi (2009), by contesting the idea that resource users should be homogeneous, states that the heterogeneity of resource users can positively influence success rates of mini-grids. The author instead states that identities and interests of members should be similar for long-term success (Kirubi, 2009). This is a favorable outcome since refugee camps have household, community, and productive energy uses of a relatively homogeneous group.

7.4.1 Community involvement

Community involvement refers to community education on benefits of using new technologies, working with community leaders, training camp community, creating a sense of ownership, and integration with the host community. Jenny et al. (2007) explore the psychological factors for rule compliance in solar community energy system in Cuba and finds that the participation in decision-making and management processes, sanction and probability of being detected are of high importance. Frame et al. (2011) argues that even though the community might not legally own the system, creating a sense of ownership prompts the users to acknowledge system as an enabler for their lives. This increases the chances that the system is well maintained in the long-term (Lestari et al., 2018).

Working with relevant stakeholders from the beginning of the feasibility studies help a relationship with communities and government authorities. For any solar mini-grid project, the need comes from the customer (B. Peterson, personal communication, September 15, 2020). This situation holds for displacement settings as well since humanitarian organizations running the camp initiate the projects. Long-term planning is needed for investing in social capital so that displaced populations would become resilient members of society. Education of refugees and community members for basic maintenance operations are needed (Van Landeghem, 2016).

Haggett et al. (2013) list the social features that affect the success for community energy projects in Scotland in conception, feasibility, planning, and operation phases. The success factors identified are: sharing of common identity within community,

existing social capital, cooperation with a community group, members with technical expertise in community, financial support before and after planning phases, learning from other projects (Haggett et al., 2013). All of these are important factors that need to be considered by humanitarian organizations initiating capacity building activities.

7.4.2 Social capital

Solar mini-grids pose a great opportunity for building social capital within camp communities. Women and girls, who are severely affected by lack of reliable access electricity, can receive training on solar PV installation, management, and maintenance and engage in income-generating activities. UNDP Yemen, with its program to provide solar energy training to women received Ashden Awards in Humanitarian Energy category this year (UNDP, 2020). The project is aimed at elevating two issues: providing access to affordable and sustainable energy and creating opportunities for income generation for women and youth (UNDP, 2020). Integration with host communities can be facilitated through income-generating activities and environmental protection policies. Caniato et al. (2017) state that the use of natural resources and emission levels should be low for any energy technology used in refugee camps. The reduction of carbon-based fuel use can improve air quality and decreases respiratory diseases.

7.5 CHAPTER SYNTHESIS

This chapter presented an assessment of the potential that community solar mini-grids hold for refugee camps. Based on the findings of the institutional analysis conducted for the energy governance in the Kigeme refugee camp, this chapter provides a framework listing technical, institutional, economic, and social factors that need to be addressed to implement community solar mini-grid projects in refugee camps as shown in Table 7.1. The most prominent barriers are identified as lack of data, funding, regulatory framework, and technical expertise. However, there are also drivers for community-based approaches for governing solar-mini grids in refugee camps as well: coordination and collaboration between actors, private sector involvement, and community participation. The next chapter provides reflections on theory and method used in the research, interpretation of research findings, and recommendations for decision-makers.

Table 7.1: The factors that impact the implementation community solar mini-grids in refugee camps.

	Factors	Authors
Technological	Sizing of the system • Energy use data • Intermittent supply • Storage need • Modularity	Baranda et al. (2020), Caniato et al. (2017), IRENA (2016), Koirala et al. (2016), Van Landeghem (2016)
	Technical expertise • Project implementation • Operation and maintenance	Baranda et al. (2020), Caniato et al. (2017), Haggett et al. (2013), Koirala et al. (2016), IRENA (2016), Sandwell et al. (2020)
	Monitoring • Balancing supply and demand • Consumption patterns	Acosta et al. (2018), IRENA (2016), Koirala et al. (2016), Nixon et al. (2019), Van Landeghem (2016)
Institutional	Regulatory framework • International policies • National laws and regulations	Acosta et al. (2018), Baranda et al. (2020), IRENA (2016), Koirala et al. (2016), Walker (2008), Warbroek et al. (2019)
	Ownership • Business models	Koirala et al. (2016), Lestari et al. (2018), Frame et al. (2011)
	Knowledge sharing • Findings • Effectiveness	Haggett et al. (2013), Sandwell et al. (2020)
Economic	Funding • Budget • Investment costs	Bellanca (2014), Caniato et al. (2017), IRENA (2016), Koirala et al. (2016), Rosenberg-Jansen (2019), Warbroek et al. (2019)
	Private sector involvement • Investment risk • Allocation of costs and benefits • Ability/willingness to pay	Baranda et al. (2020), IRENA (2016), Koirala et al. (2016), Shell (2020), Walker (2008)
Social	Community involvement • Community education • Consultations with community leaders • Sense of ownership • Integration with the host community	Acosta (2018), Caniato (2017), Frame (2011), Haggett et al. (2013), Holland (2011), IRENA (2016), Jenny (2007), Koirala et al. (2016), Melville et al. (2017), Van Landeghem (2016), Walker (2008), Warbroek et al. (2019)
	Social capital • Training for camp community • Income-generating activities • Environmental protection	Caniato et al. (2017), Haggett et. al (2013), IRENA (2016), Koirala et al. (2016), Nixon et al. (2019), Walker (2008)

Part III

CONCLUSION

8 DISCUSSION

This chapter provides a discussion on the research findings. Section 8.1 reflects on the research by evaluating the theory and methods used. Section 8.2 makes inferences on the results of the research on global overview of humanitarian energy sector, energy governance in the Kigeme refugee camp, and community solar mini-grids for refugee camps. The chapter concludes with Section 8.3 that gives recommendations to decision makers who aim to provide energy access in refugee camps.

8.1 REFLECTION ON RESEARCH

8.1.1 Reflection on theory

The IAD framework is used for analyzing management of common-pool resources as a deductive approach. This research contributes to academic research in two ways; application of the IAD framework for analyzing polycentric energy governance in a refugee camp and creating an assessment framework for the sustainability of solar mini-grids in displacement settings. First, this research investigates how the IAD framework can be applied to a complex socio-technical system. Traditionally, the IAD framework is applied to socio-ecological systems in which natural resources such as irrigation systems, forests and fishery areas are governed by a small group of community with shared values. The conceptualization of electricity provided by mini-grids as common-pool resources by Acosta et al. (2018); Agrawal (2001); Frame et al. (2011); Gollwitzer et al. (2015, 2018); Lestari et al. (2018); Wolsink (2012, 2020) opened up the commons literature to energy infrastructures that were treated as socio-technical systems (Scholten and Künneke, 2016). This study builds on the previous works by applying the IAD framework to a mini-grid in a displacement setting, which has quite different characteristics than a community energy systems implemented in high- and low-income countries. The case study of the Kigeme refugee camp showed that authorities from global to local level, stakeholders with public, private, voluntary, and community-based organizational structures, different functions such as the production, provision, coordination, funding, and monitoring of the energy systems are intertwined. The institutional analysis for a socio-technical system in a refugee camp setting helped to dismantle overlapping roles and responsibilities and identify options to provide energy access for refugees.

The literature suggests integrating multiple levels of analysis into the framework to get a better understanding of how constitutional, collective-choice, and operational

rules affect action situation, the multiple levels of analysis is integrated into the IAD framework (Ostrom, 2005). This integration could be done by using two different approaches. In the first and traditional way, the IAD framework could be applied to three action situations separately for constitutional (global), collective-choice (national), and operational (camp) level. A second approach analyzes one action situation with three different levels of rules (Polski and Ostrom, 1999). Since the focus of this research was understanding in detail how energy is governed in a camp setting, the second approach was taken. The integration of multiple levels of analysis with the IAD framework needed some adaptation so that it would fit with the way the humanitarian energy sector operates in real life. The fact that there is not an actor responsible for energy governance in the national level blurs the lines between constitutional and collective-choice rules-in-use. Therefore, these two levels are merged as one in which international agreements signed by states specify who participates in decision-making processes and policies are created to ensure displaced populations have access to energy. An additional modification was made in the operationalization of the IAD framework. The potential outcomes was regarded as a repetition of the outcomes and therefore discarded from the analysis, so as scope rules that define them.

The reflective phase of this research builds on the findings from the case study in the Kigeme refugee camp and creates an assessment framework. The framework details technological, institutional, economic, and social factors that affect successful implementation of solar mini-grid projects in the long-term. The framework is inspired by the works of Lestari et al. (2018), Agrawal (2001), and Gollwitzer et al. (2018). Lestari et al. (2018) combine the IAD framework with sustainability indicators for off-grid energy technologies. Agrawal (2001) evaluates the works of Wade (1989), Ostrom (1990), and Baland and Platteau (1996) to come up with a list of enabling conditions that would ensure sustainability of common-pool resources. By building on this work, Gollwitzer et al. (2018) argues which of these conditions are applicable to mini-grids in rural areas. This research contributes to the use of IAD framework and common-pool resource literature by taking the efforts of Gollwitzer (2014) to a next step by examining the conditions from the perspective of community-based approaches in refugee camps. The information from the Kigeme refugee camp that provide the context of governance of energy systems is merged with drivers and barriers to community mini-grids and enabling conditions for sustainable management of mini-grids.

8.1.2 Reflection on methods

This research used a qualitative research approach in order to understand the institutional arrangements for governing community solar mini-grids in refugee camps. The available studies on humanitarian energy sector are twofold: (i) scientific articles that uses quantitative methods to minimize costs or maximize the reliability of renewable energy systems without taking into account the institutional and social aspects and (ii) concept papers that use a mix of quantitative and qualitative methods to describe current practices for energy provision in displacement settings. The

literature on the governance of the humanitarian energy sector is limited. Therefore, qualitative research approach was chosen to understand factors that promote or hinder energy provision for displaced populations.

Desk research and semi-structured interviews were selected as main data collection methods. These methods used to collect data on humanitarian energy governance, decision-making process regarding energy provision in te Kigeme refugee camp, and identifying barriers and drivers to community solar mini-grids in refugee camps. Desk research involved going through academic literature and reports by actors within the humanitarian energy sector. The humanitarian energy sector is a rapidly developing field (the first publication was dated in 2014) and gained significant momentum in the last years. This advancement in the field is also observed in the sheer number of articles and reports published by researchers and humanitarian and development organizations. The speed of information required constant fact checking and was challenging from time to time. Semi-structured interviews were held where experts from the field shared their insights on topics related to the energy governance in global and camp level. It is acknowledged that data from field experts might be biased based on their roles and responsibilities within the sector. Therefore, desk research findings were compared with interview data and different actors were asked questions for fact checking.

8.2 INTERPRETATION OF RESULTS

Energy is recognized as a basic human right but it has been neglected in humanitarian settings until the last decade. Projects and research aiming to provide safe and clean energy access in displacement situations have gained more importance. Actors involved in the humanitarian energy sector range from international level decision-making bodies to local or small-scale initiatives that might not be well documented. Lack of existing regulations in the global level results hinders monitoring and evaluation. Energy is a need that is deeply connected to the culture and daily routines of people. How easily a cooking pot is cleaned after using charcoal or firewood can be a determining factor for the fuel choice for household use. Ethical considerations and “do no harm” principles need to be respected in any project to protect vulnerable populations in order not to cause further discrimination and disparities among camp residents.

Humanitarian energy is a complex issue in many ways. Distribution of products is not enough to meet basic energy needs in a reliable and affordable way for most camp settings. Even though a solar mini-grid itself is a simple technology, implementing it in a displacement setting is quite challenging. The limited funding and technical knowledge inherent in humanitarian response field makes it difficult for organizations to plan, design, own, implement, and operate the system themselves. Normally, private-sector gets involved in providing assistance such as shelter, food and water but since energy projects require long payback periods and high initial costs, it is too

risky for companies to invest in such projects. Innovative funding ideas and business schemes should be considered to promote ways to include private-sector actors. Community involvement in energy projects, but especially mini-grid projects is necessary for the success in the long-term.

The analysis shows that pure solar mini-grids might not be feasible because of their high costs and initial sizing problems. Instead, a hybrid mini-grid with solar PV and diesel can be used as an introduction. In time, the solar PV system can be scaled up and diesel can be phased out. For the systems with installed solar energy solutions, diesel generators can still be used as back-up options especially for critical loads such as healthcare facilities and when there is not regular sunshine. Solar energy solutions and metering measures can help boost the humanitarian energy market and improve energy options for people in camps.

Among different governance methods for renewable mini-grids, this research looked in to the possibility of community management. The case study and interviews with field experts show that defining refugee community as legal owners of the system might not be possible. However, the camp residents can play an active roll in planning, design, implementation, operation, and maintenance activities for the system. It is shown that the sense of ownership and shared responsibilities increases the chances of success in the long-term. Humanitarian organizations and national governments can use this as an opportunity for improving the resilience, self-reliance, and skill set of vulnerable populations. Such an approach is especially useful when local integration is bounded by lack of technical knowledge for income-generating activities. Refugee communities can use their experience of being involved in solar mini-grid projects to reduce their dependency on aid and build social capital.

8.3 RECOMMENDATIONS FOR DECISION-MAKERS

This section provides a list of recommendations for decision-makers based on theoretical and empirical findings of this research.

- Humanitarian system is hard to change because of long-established structures, limited funds, and challenging working conditions (Grafham, 2019). Yet, the newly developing humanitarian energy sector can see these challenges as propellers for improving the existing governance structures for providing energy in displacement settings. The fact that energy is not a cluster within humanitarian response system can be used as an advantage by conceptualizing it as a cross-cutting issue that affect all clusters.

- Long-term planning and funding play an important role to realize change. These can be ensured by strengthened relationships with funding partners and private sector actors. To improve the sustainability of energy services, more coordination will be needed between refugees, local governments, humanitarian organizations, and private sector actors -which opens up the possibility for public-

private partnerships. Coordination and collaboration between different actors can be facilitated by humanitarian organizations for knowledge sharing.

- The lack of data on global and camp levels requires more research to better understand energy needs and opportunities in displacement settings. Following HEED project's steps, inclusive and participatory data collection activities should be carried out so that the sizing of the system would fit the energy consumption patterns of refugee communities.
- Investing in capacity building is extremely necessary because the lack of expertise within humanitarian organizations results in ineffective management of energy projects and limited funds.
- The technical system should enable safe and reliable energy provision to the displaced communities in a financially viable way. Instead of pure solar mini-grids that have high investment cost and risk, hybrid mini-grids with solar PV and diesel can be used to increase energy production capacity. In time, the solar PV system can be scaled up and eventually the diesel generators can be phased out from humanitarian operations.
- The national and local laws and regulations should be evaluated to realize change within a given regulatory framework. When possible, humanitarian and development organizations should operate in line with governments' rural electrification strategies. The solar mini-grids can be implemented in host communities near refugee camps which helps governments to achieve their electrification targets and contributes to the integration of refugees with local community. Eventually, the energy system should help to facilitate the sustainable development of displaced communities.

9 CONCLUSION

This chapter provides conclusions derived from the overall research process. Section 9.1 presents answers to the research questions. Section 9.2 shows how the research is aligned with CoSEM study program. Section 9.3 concludes the report with a discussion of limitations of the research and recommendations for future work.

9.1 ANSWERS FOR THE RESEARCH QUESTIONS

This research aimed to explore to what extent community-based approaches can be used for governing solar mini-grids in refugee camps. In this section, each sub-question identified that help reach this goal are answered. These answers lead to providing ideas for the main research question.

How can the governance of community solar mini-grids be studied in the context of refugee camps?

With the rise of the number and duration of humanitarian crises, refugee camps have been established with the purpose of providing aid to forcibly displaced populations. The humanitarian response activities in these camps are concerned with shelter, water and sanitation, food, healthcare, and legal rights. While these services are necessary in the immediate aftermath of a crisis, it is expected that the needs of refugee populations increase as camps become permanent settlements. Here, energy access becomes an important missing link as it is used for cooking, lighting, heating, drinking water, and income-generating activities. In this research energy access has been measured by a multi-tier framework which categorizes household, productive, and community uses. Energy access has been a neglected area in humanitarian response field until the issue drew attention in the humanitarian response field. Among several technologies to provide renewable and sustainable energy access in refugee camps, mini-grids is thought to be a cost-effective, scalable, modular, easy to install, and environmentally friendly option. The emphasis on community-based approaches for camp management to improve resilience of camp communities suggests that there is a value in exploring governance of community solar mini-grids in refugee camps.

The conceptualizing of solar mini-grids as common-pool resources guided the research to the literature on governance of common-pool resources and community mini-grids. It is found that institutional analysis can help to conceptualize and study

community solar mini-grids in refugee camps. IAD framework by Ostrom is chosen as the tool for analyzing different institutional settings. The IAD framework helps to understand how external variables such as biophysical conditions, attributes of community, and rules-in-use affect a particular action situation where actors interact with each other and create policy outcomes. There are not national regulatory frameworks that organize energy provision activities in refugee camps. Therefore, to examine the effects of international to camp-level situations on providing energy access in the Kigeme refugee camp, the framework is integrated with constitutional and collective-choice, and operational rules-in-use. The findings from the case study is merged with literature on common-pool resource management and community mini-grids to create an assessment framework for governing community solar mini-grids in refugee camps.

What are the current governance practices for providing energy access in refugee camps?

Humanitarian energy is a cross-cutting issue between humanitarian aid and energy access for development with no single organization responsible for coordinating the efforts within the field. The actors involved in the humanitarian energy sector are categorized as humanitarian and development organizations, nation states and local governments, partnerships, funders, private sector, and research organizations. The analysis shows that there is an institutional void in the humanitarian energy sector which results in the lack and overlapping roles and responsibilities among actors. Traditionally, energy provision has been included in humanitarian response in the form of distributing cookstoves and firewood for household cooking. However, this top-down and product-based approach damage the efforts to build resilient communities, results in environmental degradation of lands near the camp, and create problems for the well-being of the refugees.

A number of initiatives and projects are created to address this issue. These initiatives focus on energy provision for displaced populations such as SAFE, MEI, GPA, HEED and RE4R projects, and UNHCR Clean Energy Challenge in recent years. The aim of these initiatives is to move away from distribution of energy products like solar lanterns to finding sustainable solutions that have higher capacity that can replace diesel generators used for community facilities and small business enterprises within the camp and even provide electricity to refugee households. These initiatives highlight the importance of using renewable energy sources and participatory approaches that include displaced people and host communities in the decision-making processes.

This global level of analysis helped guide the application of the IAD framework at camp level by introducing the complex network of actors, decisions, regulations, practices, and newly emerging trends in the humanitarian energy sector. That is partly because the decision-making at the camp level is directly influenced by the decisions made within the global initiatives. Therefore, the institutional void and overlapping roles and responsibilities was also expected in the Kigeme refugee camp which was in

fact the case. Understanding how actors from public to private domain with different agendas are intertwined informed the analysis at camp level.

What energy-related problems are experienced in the Kigeme refugee camp and how do the actors respond to these problems?

The energy governance in the Kigeme refugee camp is analyzed by applying the IAD framework with multiple-levels of analysis that is tailored to represent global and camp-level rules-in-use. The main actors involved in energy provision activities in the camp are MINEMA, UNHCR Rwanda, Refugee Executive Committee, Practical Action, funding partners WFP and IKEA Foundation, and private companies that provide solar energy product like Bboxx, Ignite, Zola, and mini-grid implementing organization MeshPower. It is observed that the level of energy access differs among households, community facilities, and enterprises. For households, electricity access is very limited since the households cannot be connected to the national grid or the mini-grid in the camp. Instead, the refugees buy solar lanterns and solar home systems from companies that are allowed to set up business in the camp. The community facilities are connected to the national grid and this access is granted to some of the small business of refugees as well. However, there is a lack of regulatory framework detailing how a particular energy use can be supplied with available options of national grid, diesel mini-grid, and solar micro-grid. In addition, the lack of technical expertise and dominance of UNHCR in decision-making processes about energy provision activities results in ineffective use of funds. With recent projects like HEED and RE4R, the technical expertise is used to promote community involvement, market-based financing mechanisms, and improved policy making. All actors involved highlight the importance of including the refugee community in planning, decision-making, and implementation phases of the project. Even though the target to provide electricity to all refugee households, the ongoing initiatives seems promising to reach this goal.

What are the drivers and barriers for community solar mini-grids in refugee camps?

The factors that affect the success of community solar mini-grids are compiled by evaluating the findings from the study of the Kigeme refugee camp, and literature review on common-pool resource management and community mini-grids. An assessment framework is created that describes these factors as technological, institutional, economic, and social factors.

Technological factors that needs to be considered by decision-makers are identified as sizing of the system, technical expertise, and monitoring activities. Sizing is one of the most critical phases of solar mini-grid projects because of the intermittent energy supply. Energy demand should be matched with energy supply for reliability of system. This could be done by using already existing diesel generators as backup or using batteries to completely replace diesel generators. The lack of technical expertise within humanitarian organizations severely impact how energy access is improved for households, businesses, and community facilities. The limited understanding of

concepts related to energy systems and costs associated with different business models can halt projects before implementation. Capacity building is needed to ensure solar mini-grids are operated and maintained successfully. Monitoring of the system decreases the chances of experiencing blackouts, brownouts, and equipment failures due to low-quality equipment use and collective over-consumption. Smart meters and remote metering helps to balance supply and demand without technical failures and informs communities on their energy consumption patterns. The information on consumption data can be used to negotiate arrangement such as the hours of electricity use in households, enterprises, and community facilities.

Institutional factors identified are the lack of regulatory framework, definition of ownership, and knowledge sharing. The lack of clearly defined roles and responsibilities for actors involved is one of the biggest barriers for offering sustainable energy solutions to displaced populations. This situation is elevated by multi-sector partnerships that push for creation of international policies and improve capacity building for technical expertise within humanitarian and development organizations. Ownership can be defined in a number of ways for community solar mini-grids such as cooperatives, community charities, development trusts, and share owning by local community organization. These ownership models are evaluated to be infeasible considering the economic status of refugee communities and the lack of not only rules but also application of these rules as seen in the Kigeme refugee camp. Knowledge sharing between humanitarian organizations experienced in aid delivery and development organizations and private sector actors on electrification projects lead to informed decision-making.

Economic aspects that impact community solar mini-grids are funding, private sector involvement, and financing. Funding, more importantly how effectively the funds are spent, significantly impact the success and the level of community involvement in mini-grid projects. The short-term funding cycles of humanitarian organizations hinder investments in solar mini-grids with high capital costs and relatively long payback periods. This problem can be solved by implementing long-term partnerships with donor countries and funding partners or by developing innovative financing models to attract private sector. The payback period of one to six years is relatively short for private sector whose involvement is crucial for scaling-up energy projects in refugee camps. Considering the fact that refugees already pay disproportionate amounts for energy services, there is a business case for private sector companies who wants to expand their customer base to refugee communities by providing affordable solutions and high tiers of energy access.

Social factors that needs to be taken into account are community involvement and social capital. Community involvement represents community education on benefits of using new technologies, working with community leaders, training camp community on monitoring and operating the system, creating a sense of ownership, and integration with the host community. The success of any energy project is dependent on whether community needs are addressed in a transparent manner and to what extent the community perceives the system as an enabler that helps them build re-

silience. Solar mini-grids also build social capital within the camp by reducing the time women and girls have to spend to find firewood and the risk of sexual gender based violence. Instead, community members and especially vulnerable groups can be empowered by training on energy systems. Solar mini-grids also pave the way for integration with host community through income generating activities and protection of environment. The decrease in use of carbon-based energy sources like firewood reduces impact on land, improves air quality in households, and reduces the risk of respiratory diseases.

Main Research Question

To what extent can community-based governance approaches for solar mini-grids provide energy access in refugee camps?

The research shows that there are several drivers as well as barriers to using community-based governance approaches for solar mini-grids in refugee camps. The lack of regulatory framework on defining ownership of the system through different business models challenges successful implementation of community solar mini-grid projects. It is seen that giving the ownership of the system to refugee communities or a cooperative of camp residents is an ambitious goal due to political and institutional reasons. However, a sense of ownership can be created by using participatory activities during planning, design, implementation, and operation and maintenance of the system. Such an approach would both increase the resilience of refugees and improve the sustainability of system.

9.2 ALIGNMENT WITH COSEM

This thesis project was carried out for the completion of the master's program Complex Systems Engineering and Management (CoSEM). The study program is about finding innovative solutions for large-scale complex socio-technical problems. In addition to the technological challenges, the program puts an emphasis on institutional issues such as existing regulatory framework, economic issues such as financing of projects, and social issues such as needs and interests of stakeholders in any system. This research fits well with CoSEM as it explores the extent to which community solar mini-grids (technological/engineering component) would be successful in refugee camps (complex socio-technical system).

Humanitarian energy sector is a multi-level, multi-type, multi-sectoral, and multi-functional complex issue that tremendously affects the lives of vulnerable populations. The field is governed by actors from international organization to national and local government level. The refugee camps are special settings that are protected based on the international agreements but also are in the jurisdiction of nation states. The efforts to provide energy access in refugee camps bring together public, private, and voluntary domains -especially in the last six years when the issue has gained more recognition. There are various ways of organizing functional activities such as procurement, distribution, and financing of electricity and cooking products and ser-

vices. Solar mini-grid is explored as a technology to improve the current situation in camps. The technical requirements of the system is informed by institutional, social, and economic challenges that are prevalent in displacement settings.

This thesis heavily relies on theories and tools introduced in the CoSEM program. A systematic literature review is conducted to understand current situation and trends in the humanitarian energy sector. The network of actors involved in the sector are analyzed and categorized to better understand their motivation and values. The IAD framework for management of common-pool resources that is taught in the course SEN1131 Institutional Economics for Designing in Socio-Technical Systems is used as the theoretical framework guiding the institutional analysis of energy governance in a refugee camp. The domain knowledge provided in Energy track, especially through the course SEN1541 Sociotechnology of Future Energy Systems, was tremendously useful when analyzing the traditional and emerging energy sources used in camps and discussing the technological, institutional, economic, and social aspects of community solar mini-grids. Different phases for systems engineering such as preparation, design, implementation, operation & maintenance, and decommissioning phases introduced in the course SEN1121 Complex Systems Engineering are considered when analyzing the potential for community solar mini-grids in refugee camps. Last but not least, SEN1311 CoSEM Research Ethics course was useful for treating the data on vulnerable populations obtained through desk research and semi-structured interviews responsibly.

9.3 LIMITATIONS AND RECOMMENDATIONS FOR FUTURE WORK

9.3.1 Multi-country analysis

Each refugee camp has different governance practices depending on the country of displacement, the type of settlement (organized or self-settlement), humanitarian organization running the camp, and available technologies and conditions for energy production and provision. Due to time limitations and travel restrictions due to COVID-19, it was not possible to compare energy provision in different camps. To get a better understanding of the potential of community solar mini-grids, a multi-country study can help identify differences and similarities for energy in refugee camps (Rosenberg-Jansen, 2018). In addition to the Kigeme refugee camp, energy governance in other camps can be analyzed through the lens of the IAD framework. Especially Kakuma refugee camp in Kenya is a good candidate for future research as there are already a number of energy-related initiatives taken place (Corbyn and Vianello, 2018; Patel et al., 2019). With a multiple case study the aim would be to reach an analytical generalization on how the energy is governed, not to make statistical generalizations (Yin, 2009). Thus, future research can focus on the local context of different refugee camps to explore drivers and barriers for successful implementation of solar mini-grids and update the assessment framework accordingly. The

findings of the research and projects can be used to create regulatory frameworks and guidelines to be applied in refugee camps around the world.

9.3.2 Field study

This research started with a plan to conduct multiple-case study that analyzes energy provision in different countries. However, because of current COVID-19 crisis around the world, the initial plan to visit three refugee camps (Kigeme in Rwanda, Kakuma in Kenya, and Moria in Greece) and observe the situation in real-life was halted. It has been proven again and again that no matter how sustainable, affordable or reliable a solution is, the projects are not successful if they are not planned and executed according to users' needs. Especially for implementing participatory design principles, it is crucial to understand the needs, habits and wants of camp residents. The change in the research plan also limited the number of interviews that can be conducted. Camp residents, who are the focus of this research, could not be interviewed. Instead, the extensive survey results from the HEED and RE4R projects were used to understand what refugee community values, needs, and wants in terms of energy access. Future research can be based on field work in camps to better understand the energy use of camp residents and evaluate the applicability of solar mini-grids with community participation. Considering the pandemic, it is uncertain when such a field study would be feasible. Alternatively, a close coordination with humanitarian organizations on the ground can be a solution to this problem.

9.3.3 Design of mini-grids

After the analysis of current governance practices in global and camp levels and exploring the potential of off-grid renewable technologies with the involvement of camp residents, the next step for improving energy access in refugee camps is the design of community mini-grids. The Community-based approach report by UNHCR (2008) can be combined with comprehensive energy infrastructure design framework by Scholten and Künneke (2016) and applied step by step during the design phase. The design can start with an analysis on energy needs of community and energy generation options that meet those needs followed by participatory design workshops which gives camp residents a chance to be involved in the decision-making process. Then, decisions are made on which available business models will be used and how the operational roles and responsibilities will be distributed. Next, discussions on how community can actively participate in design, operation, and maintenance activities can take place. Based on their technical skills and background, camp residents can be assigned to teams. The working group decide on a design which meets the performance criteria while making sure that techno-operational and economic-institutional design components are aligned with community needs and capabilities. Working groups and meetings with community members to evaluate how solar-mini grid works after installation. Future research and projects can make use of these steps to provide energy access in refugee camps.

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Appendices

A HUMANITARIAN ENERGY LITERATURE

A literature search is conducted by using Google Scholar and SCOPUS with keywords like “refugee”, “humanitarian”, “displacement” and “energy”. After an initial scan of abstracts, an assessment of full-text, and snowballing process, 33 resources are selected for the analysis. These 33 studies comprise of 13 articles, 4 theses, 1 recently published book, and 15 concept papers. Of 17 academic studies, a total of 16 studies are selected excluding one article on a field study. The selected studies are presented in a thematic order based on their approach, resources used to provide energy access, energy locale that is included, and location of the camp as shown in Table A.1.

A.1 ENERGY DEMAND MODELING AND ECONOMIC STUDY

There is no single database to track energy demand and supply which results in the lack of reliable data that could be useful for humanitarian organizations that want to initiate an energy project. Instead, the energy demand data is generally estimated by an end-use electricity consumption model which multiplies one household’s energy use patterns with refugee camp populations worldwide to achieve data on global level. A recent report by Moving Energy Initiative (MEI) stated that out of 70.8 million, only 7 million displaced people have access to electricity and even this access is for less than 4 hours a day by using this model (Lehne et al., 2016). The assessment by Cerrada and Thomson (2017) show that solar mini-grids backed with diesel generators ensures financial viability and attracts private sector actors by providing both household and community energy access. Among several solar energy options, off-grid solar with participatory design approaches is preferred for emergency relief and development aid in refugee camps (Franceschi et al., 2014). It is important to design with mutual values of the designer and end users, and participatory nature of the off-grid solar PV systems for refugee camps (Franceschi et al., 2014). With its decreasing costs and scalability, solar energy poses a great opportunity for humanitarian organizations who wish to decrease use of costly diesel (Frack et al., 2015; Lehne et al., 2016). Ossenbrink et al. (2018) compare grid, diesel generators, stand-alone solar PV system, and solar PV system with batteries to meet community energy needs in terms of their costs and find that solar PV is a good alternative to conventional water pumping resources. The authors provide drivers and barriers to benefit from the low costs of solar PV for refugee camps and host communities. Sacino et al. (2017) compare a hybrid, only solar and only diesel generator systems and concludes that the hybrid solution has the lowest net present cost.

Stjernquist Desatnik (2019) provides a multi-criteria analysis for different energy systems in the context of environment, social stability, and economy to provide household cooking and electricity access in refugee camps. The research concludes that solar home systems can be used for household electricity as they have short implementation time and low investment cost. Solar hybrid mini-grids are preferred for existing households because of their high reliability and low levelized cost of electricity. A similar research is done by Trinh and Wieselblad (2018) that provides an overview of energy related problems in refugee camps and evaluate fuel generators, solar power, biogas, wind power and fuel cell options by their availability, scalability, adoptability, environmental impact and cost. The research provides a summary table which might help humanitarian organizations that want to implement a solution or researcher who want to test the results with a case study. IRENA (2019), in collaboration with UNHCR, analyzes four refugee settlements in Iraq and Ethiopia for picking the best renewable energy solutions. Solar PV arrays and stand-alone solar systems can work in Iraq where the camp is connected to grid but facing voltage fluctuations and blackouts whereas solar mini-grids can power refugee camps in Ethiopia where only 7% of the population has 4 hours of electricity access, replacing diesel generators.

A.2 ENERGY SYSTEM OPTIMIZATION

Chowdhury et al. (2020) develop a stand-alone hybrid energy system for Rohingya refugee camp with a generator, solar PV, wind, converters and battery with the help of HOMER software for Rohingya refugee community in Bangladesh. In the optimal case, 87% of the energy need is met by renewable energy sources with less than 30% dependence on diesel generators. Malekpoor et al. (2019) provide an optimization model of an off-grid electricity system which minimizes the total cost and prioritizes the favorable generation systems by using VIKOR (a multiple-criteria decision-making technique) and bi-objective integer linear programming for a hypothetical camp setting. Among the options of fuel generators, wind turbines, PV system, and a hybrid energy system, wind turbines are not used in any optimal Pareto solutions because of their high installation cost, noise factor, vast space requirement, and transport logistics for parts. Solar PV perform better than other options because of low maintenance cost and ease of transportation and installation. Salehin et al. (2011) design an energy system for a refugee camp in Chad-Sudan border with a population of 20,000 people which uses solar PV panels, wind turbines, biogas production system and generator, and batteries to meet community energy needs. The authors use HOMER software to optimize the system and conduct a techno-economic analysis of the system and discuss topics like backup operation, net present costs, location flexibility, system operation and logistics.

A.3 FOOD–ENERGY NEXUS

Barbieri et al. (2018) provide a methodology on how to realize energy service provision for households and community facilities while including the food security, planning technology development and inclusive decision making in the design within Sustainable Energy Technologies for food security (SET4food) project which promotes sustainable energy technologies for food utilization in displacement settings. Barbieri (2019) approaches the problem from a food-energy nexus perspective and proposes a comprehensive energy solutions planning framework supported by the SET4food project. Caniato et al. (2017) evaluate energy technologies for food security in camps based on five different domains: economic, environmental, technical, socio-cultural and cross-cutting. The authors argue that there is limited research on food-energy nexus in humanitarian settings and especially energy requirements for food preservation (Caniato et al., 2017). Thus, it is stated that future research is needed on standardization of methods from assessment to implementation phases of energy projects in displacement settings.

A.4 MARKET ANALYSIS

Munoz (2016) creates a framework for linking relief rehabilitation and development and energy access. The research shows that long-term planning for energy infrastructure creates a market if productive use of energy is encouraged, improves living conditions and increases resilience of refugee communities. Nielsen and Santos (2013) state that a humanitarian market is created between humanitarian actors and suppliers who provide items to meet their needs. However, inefficiencies occur in these market because of the conflicting goals of two main stakeholders: humanitarian organizations aim is to save life and protect whereas private sector actors are interested in profit and market share (Nielsen and Santos, 2013).

Table A.1: The literature on humanitarian energy categorized by the approach, system components, energy locales, and location of the camp.

Approach	Author (Year)	Energy sources	Energy locale(s)	Location
Energy demand modeling and economic study	Cerrada and Thomson (2017)	Solar PV + Diesel generator	Household + Community	Hypothetical
	Frack et al. (2015)	Solar PV + Wind	Household + Community	Juba
	Franceschi et al. (2014)	Solar PV	Household + Community + Productive	Global level
	Lehne et al. (2016)	Firewood + Charcoal + LPG + Solar + Diesel generator	Household	Global level
	Ossenbrink et al. (2018)	Grid / Diesel generators / Stand-alone solar PV systems / Solar PV + battery systems	Community	Mafraq Za'atari, Harran-Kokenli, Dadaab
	Sacino et al. (2017)	Solar PV + Diesel generator	Household + Community	Azraq
	Stjernquist Desatnik (2019)	Diesel generators / Solar home systems / Mini-grids / Grid extension	Household + Community	Kakuma
	Trinh and Wieselblad (2018)	Diesel generator / Solar PV / Biogas / Wind power / Fuel cell	Household	Hypothetical
Energy system optimization	Chowdhury et al. (2020)	Generator + Solar PV + Wind + Converters + Battery	Community	Kutupalong
	Malekpoor et al. (2019)	Wind turbine + Solar PV + Fuel generator	Community	Hypothetical
	Salehin et al. (2011)	Wind turbine + Solar PV + Biogas + Batteries	Community	Chad-Sudan border
Food-energy nexus	Barbieri et al. (2018)	Wind and solar + Firewood + Battery	Household + Community	Lebanon
	Barbieri (2019)	Solar PV / Biogas / Wind / Batteries	Household + Community + Productive	Hypothetical
	Caniato et al. (2016)	Solar PV / Diesel generator / Biomass	Household	Hypothetical
Market analysis	Munoz (2016)	Solar lamps / Solar PV / Batteries	Household + Community + Productive	Dadaab, Shimelba, Dollo Ado, Za'atari, Kakuma
	Nielsen and Santos (2013)	Solar PV	Household	Global level

B SEMI-STRUCTURED INTERVIEWS

B.1 INTERVIEW PROTOCOL

Interview protocol consists of three main sections: introductory explanation before the interview begins which includes collection of informed consent for the use of interview data and audio recording (if the interview was recorded), a general list of interview questions, and concluding remarks.

Introduction

My name is Elif Gül Demir. I am a master's student at Delft University of Technology, the Netherlands. I am currently doing research on humanitarian energy sector for my thesis. My thesis is about exploring how community solar mini-grids can be governed to improve energy access in refugee camps. As stated in the invitation letter, this interview is carried out solely for academic purposes and the information will be treated while respecting confidentiality. I will be recording the audio for the interview and sending you the transcript for your approval. If you approve of these, we can start the interview.

Questions

A different set of questions is asked to each interviewee depending on their role within their organization and expertise. Below is a general list of questions used as a guideline. The questions and their orders were changed in some of the interviews, sometimes on the spot, according to the flow of conversation and interviewee's experience. A summary of each interview is provided in the next section.

Introductory questions

- What is the organization's role in promoting energy access for displaced communities?
- What is your role within the organization? How many years have you been at this organization? What are your main tasks?
- How are the decisions to implement an energy project in a camp made? Who are other responsible parties?

Questions on energy governance in Kigeme refugee camp

- Biophysical conditions

  - Can you describe the physical conditions in the camp?
  - How is energy provided in the camp?
  - Do refugees pay for energy products or services?

- Attributes of community
  - How homogeneous is the camp community?
  - Do community members trust each other?
  - Do community members work together for a common goal?
  - What are the opportunities available for community members to improve their capabilities?
  - What kind of knowledge does the community have on energy policies and initiatives within the camp?
  - What do the community members value most about energy access?

- Rules-in-use
  - What are the current laws or regulations that are used in managing energy systems in camps?
  - Are there camp-specific rules on providing energy?

- Action situation
  - Which actors are involved in decisions regarding energy access in the camp?
  - What are the roles/positions these actors have e.g. developer, operator, implementer, funder?
  - What actions can these actors take to improve energy access in camps?
  - How are the decisions made? Does one actor decides or are the decisions made unilaterally?
  - What information is available to participants? Is knowledge shared between all parties openly?
  - What outcomes are possible in this situation?
  - What are the costs and benefits incurred? How are they distributed between actors?

- Interactions
  - How do the actors involved share the roles and responsibilities concerning energy provision? Are there overlaps between organizations?
  - Are there any binding agreements or documents on the operation, management and maintenance of the system?
  - How is the system monitored?
  - How is MINEMA involved in the development of mini-grids?

- Outcomes
  - What is the overall energy access within the camp?
  - Which outcomes are satisfactory? Which are not?
  - Do policy outcomes match with targets?

Questions on drivers and barriers for community solar mini-grids in refugee camps

- Technological aspects
  - How is the preparation phase for the projects organized?
  - How do you decide on which technology to use? How do you design the system? Do you include household lighting, community facilities, or businesses when sizing the system?
  - What do you think are advantages of using solar mini-grids in refugee camps?
  - How would you define performance indicators for mini-grids?
  - How is the system monitored?
  - What should be the ideal frequency of maintenance for sustainability?
- Institutional aspects
  - What are the biggest challenges for realizing a solar mini-grid project in refugee camps?
  - How do you communicate and coordinate with national and local government?
- Economic aspects
  - How are the mini-grid projects funded?
  - What are financial issues that hinder the implementation of solar mini-grids?
  - Do users pay for the system? If yes, is it through pre-paid subscription or meter-based?
- Social aspects
  - What do you think needs to happen so that camp residents are more involved with the governance of energy systems?
  - How do communities benefit from mini-grids?
  - Do you provide basic training for communities on how to use or maintain the system?
  - Who is the owner of the system? How is this defined?

Conclusion

This concludes the list of questions I prepared for this interview. Would you like to add something that I should know about the topic? Do you have any questions for me? Thank you for dedicating this time and providing such valuable information. Would it be okay if I get back to you during the data analysis process for more questions? Thank you once again. I hope you have a great day.

B.2 INTERVIEW SUMMARIES

Interview 1

Name of the interviewee: Anonymous 1
Position: -
Location: -
Date: 25/09/2020

The role of UNITAR in GPA
There are many actors in humanitarian settings, and there is also a lot of competition between the various actors. When I started being engaged in this topic, I had planned to do pilot projects, one in Djibouti, and one in Tanzania. I was able to raise some funding from the German government to do these pilots and to work on replacing diesel generators in general. It took me six months to negotiate this idea with UNHCR. Back then energy was not on their radar and at the end it was more on for administrative reasons. It was not possible to be hosted via UNHCR in this time duration that I had in mind. I was also working with UNITAR at this moment in time and the guy who then became our boss said well if UNHCR cannot make it available then we can host you. Idea was originally I am physically hosted at UNITAR but it was a joint project with UNHCR. It was really for more administrative reasons but then over the time we developed this GPA. It became a bigger movement. At this moment in time, we have asked IOM, UNHCR, other humanitarian partners if we change this, should it be hosted somewhere else. All of them said no, please leave it at UNITAR. For the simple reason, if it is based in one organization then there is a likelihood that you are swallowed by this organization and you don't have this freedom anymore to be a neutral platform for the whole sector to provide certain service solutions. and you need to know as a part of the UN family, UNITAR is the training research institute and it is basically capacity development we are talking about here. This is the big part of the gap we have in this sector, so it actually does fit in the mandate of UNITAR and back in 2018 everybody said let's leave it at UNITAR and let's see how it develops. We don't call ourselves a cluster, I would say we do work as a cluster. But again, for political and acceptance reasons, there is no appetite in the humanitarian system to change the cluster system so there is no appetite to introduce any new structure, a new cluster. Also we think it is useful to be seen as a cross cutting topic across most of the clusters, and that's why we work as a quasi-cluster, but we are not an official

cluster.

Mini-grid projects in displacement settings
Starting with South Sudan, this is really the first example where we see the new form of energy interventions which we would like to see in the future as the standard. It is a public private partnership, so a lot of the money is coming in from the private sector. There was also an upfront payment by IOM. So that is something they have done right because we need more projects like this if we really want to achieve large scale improvement. Just with the grant money, just with the normal humanitarian funding structure it won't be enough. One of the key points here is there is actually a case for the private sector to get in. It is not only on replacing the diesel generators, it is also on the household level. We have enough evidence that actually people are paying already for household electricity or cooking and they are willing to pay more for better services. What would have been maybe they could improve in the future: first of all it took them between 2 and 3 years. That is something we are all working on to make this more streamline process, to roll a project out like this. The second bit, one of the issues here is who is actually owning or how do you structure the ownership of the asset and so who would be the owner of this asset at the end. In this case, it will be transferred to IOM most likely after a certain period of time. I am not sure if that s the best way to go, because first of all it is more expensive, and second, many of the organizations and in your case, maybe communities well it depends, community of course want to own the asset I guess, while many of the NGOs don't want to own the asset. So that is something we need to improve in the future. Also it was the first pilot they have ever done in this space, so it probably was more expensive than it should be in the future, so that's something we all need to improve but in general it's a good example on a way forward. In Djibouti, I would say what we have done right is we had a very clear goal. Our goal was to replace the existing diesel powered infrastructure in the 3 camps of UNHCR and to make Djibouti operations the first in the world where actually everything is solarized. We will achieve this with some caveats, so there will be still one camp where they operate diesel generators, for various reasons we cannot replace them, because they power households as well, and we were only focusing on the infrastructure and that provides services for the households. We have also proven the point that again there is a business case, because we see return periods of less than 3 years, and in Djibouti and even in grid connected stage because electricity is super expensive in Djibouti. One part of the project is installing solar systems in a compound of UNHCR in the middle of the country and since the electricity is so expensive in the country, they can actually reduce or have this amount paid back in 3 years. Also initially we had the idea of using this as a model to bring in the private sector and that something we have not done. Mainly for unfortunately administrative reasons, because we needed to spend the money. This short term funding cycle is a real issue. In the future we'd like to change this, and we will also in the future. On Burundi, on WFP, that's totally a different topic. It is a very first pilot, I think the numbers are quite promising. We need to go away from fossil based cooking solutions and especially when we see this energy topic from a holistic perspective, it is gonna be clear that we need to come up with electric cooking solutions. Then a mini-grid makes sense because then you

have the critical loads. People are paying already for charcoal, they can use what they have for charcoal and pay for electricity, I mean that's the theory.

Funding the energy projects
You know there is a chicken egg thing here because the humanitarian partners are blaming the donor countries for not giving multi year funding, but donor countries say but we already give you multi year funding, which is true. At the same time, countries normally only have one or two year budget cycles within their countries. So within their own operation, within their own budget. It's pretty difficult for them to commit to funding in 5 years when they don't have the national regulation to do so. It is really a chicken and egg thing, very tricky. However it is doable, it is the question of willingness from the various partners, and on the other hand, it is a question for us, developing alternative funding mechanisms, and financing mechanisms.

Business models and financing of energy projects
Well the South Sudan was the first project which uses I think technically speaking it is a leasing, or lease to rent or lease to own document. That is exactly the question we have been working on since a year, to develop a leasing or a PPA contract system, which is in line with all UN financial and procurement rules, and we have done this with the recent BBH report. The second one is the guarantee mechanism which we publish this week. We have these two relevant components in place now. I think there is no reason why we cannot change or replace all diesel gen sets in the next five years. because usually the argument is we don't have the money, and we can prove or we proved it already with a PPA or leasing model, you actually don't need this upfront investment, you just need to sign a contract, and then someone else will take care of the CAPEX and will get the money and then this guys will just deliver electricity to you. Originally the idea was we bring in private companies, they would replace the diesel generators with their own money with their own CAPEX, and then these companies have the interest to sell the electricity and they will find solutions to sell the electricity to at least to the shops in the camps. For households it is gonna be hugely expensive, I mean in grid connection scheme, usually we talk about a couple of hundred USD per household per connection so it will take ages to repay this with this level of income these people have. Of course you have to see the full picture, is it possible to include electric cooking into this, if so, are actually people paying now for charcoal or firewood or briquettes or whatever they use, how much do they pay for charging their phones, how much do they pay for batteries, for the torches, do they pay something for the candles etc. If you see the whole package, then there might be an economic case where you can actually install a mini-grid in camp settings. However, I would assume the more likely option is solar home systems. The interesting question is about the concept of replacing diesel generators. When you have a company that would get money from a bank to invest in the solar system, and they have a contract with UNHCR to sell electricity. What if this contract is not with the company but with the community next to the camp? Then you have a solar system in the village next to the camp which is operated by the locals, and they make their money through selling electricity to UNHCR, and at the same time, if you oversize the system, you can for relatively little money also access or provide certain

access services to the people from the host community.

Community solar mini-grids
The question about these community based approaches is a legal question. Who is actually your partner? You can't sign a contract to 200 people. You have to build a community, you have to build a cooperative. This has to have a legal status. Then, you also come into regulatory issues here. In some countries it is just forbidden to produce your own electricity, while it is okay to offer leasing services. It is like Djibouti, leasing is possible, PPA is not. You are not allowed to produce and sell your own electricity. Of course that is the same for a company, too. However, what I understood for the community based approaches, it is much more difficult from the legal perspective and you would need to train these people as well. It is not easy but from a sustainability point of view and from a development point of view, it might be the perfect solution. What they have done in Jordan is similar to training and capacity building. They elected these energy ambassadors, so each of the blocks in the Za'atari refugee camp have an energy officer. Trained from the refugee community, and they feel the ownership. They also get paid for that, and there are a bunch of people now working on the grid and improving the grid and maintaining it.

Actions needed
I would say the easiest could be the capacity stuff, training stuff. Because that is something very concrete, something very quick. You can train people, and especially if for a private sector model, then these guys have people who actually know what they are doing already. So that could be an easy fix. On the data side, it depends on what you actually want to achieve. For example measuring loads is nowadays also super easy, and not too complicated, not too expensive anymore. On the finance side, in a way it is also an easy fix, or there is an easy fix for this because there is plenty of capital out there, if there is a return for this capital. It does not have to be high, but there are so many impact investors who are interested in working with us, who would basically give money for receiver interest. Especially if they see that we do something good with this money, that could be an easy win as well. Policy side, honestly, with money also comes policy. If you can provide some good examples on how to improve the energy transition for the people for the locals as well, then there is a way to make this happen. In terms of prioritization in the organizations, we already see some good movement. UNHCR has the energy strategy. They implemented, they opened the Clean Energy Challenge. ICRC has an energy strategy in place. IOM is working on it. I think there is a lot of awareness now in comparison to recent years.

Interview 2

Name of the interviewee: Anonymous 2
Position: -
Location: -
Date: 23/09/2020

Energy as a cluster within the cluster system of UNHCR
We submitted a proposal to Inter-Agency Standing Committee (IASC) to create an energy cluster. But the response we got from the IASC was that the cluster system does not work efficiency and creating more clusters will only complicate things. It is nice to see that they reflect upon the system like that but then they need to reform historically inherited clusters that need fixing. With the Global Plan of Action for Sustainable Energy Solutions in Situations of Displacement (GPA), we work as an informal cluster since 2018. We were four people that started and now there are 300 professionals involved in the humanitarian energy sector. There were discussions on who should "host" the GPA like UNHCR or IOM. The coordinator for energy access activities had to encompass all displaced populations. However, UNHCR's mandate is for refugees and IOM's mandate is for migrants, therefore they could not host the GPA. Here, an unlikely party has taken up the role: UNITAR. With three or four people in high levels of leadership, they agreed to coordinate capacity building across different humanitarian and development organizations to improve energy access for displaced populations.

Renewable Energy for Refugees (RE4R) project in the Kigeme refugee camp
There are no formal rules within the humanitarian energy sector which can be messy sometimes. The project in Kigeme started years ago when Renewable Energy for Refugees (RE4R) sent a funding proposal to the IKEA Foundation. The foundation accepted the proposal and has been supporting the project financially by giving $8 million to Practical Action and $2 million to UNHCR. The country officials of UNHCR Rwanda in Kigali were highly interested in topic, which helped setting up the project. The camps Kigeme, Nyabiheke and Gihembe were selected based on several criteria. These settlements are actual refugee camps hosting Congolese refugees, not transit centers that have a flux of displaced populations. These camps are long-term settlements and the refugee communities share similar characteristics. The project started in April 2017 and will continue until February 2022.

Energy access in the Kigeme refugee camp
UNHCR Rwanda was distributing firewood to refugees in the camp. However, with the national ban on firewood in Rwanda, they had three options. Funding clean and more sustainable cooking solutions, continuing to distribute firewood under the radar, or obey the rules and fail to protect camp residents. The problem was that the government warned them before many times but they did not do a good job of finding alternatives for firewood and it was a huge problem at the time. The UNHCR office in the camp is grid-connected, which was unknown to one of the people responsible for the camp. The camps could be connected to the grid easily, especially because the refugee already spend a ton of money to candles. The amount they pay is very disproportionate to the service they get so they would be willing to pay for a grid connection. However, it was argued that connecting the camp to the grid would mean that they would have a better quality of life than Rwandan citizens so this was a political no-go even though the situation in camps couldn't possibly be better.

Actors involved
Imperial College and Practical Action Rwanda did the on-ground assessment in Kigeme. Inyenyeri had already started providing clean cooking solutions and had information on energy assessment within the camp. The survey data collected for the HEED project was used for the RE4R project. BBOXX was selling solar home systems and hired refugees in business as well.

HEED community micro-grid
The HEED project is very community-based in its design and implementation. We had surveys, focus groups, and engagement events with refugee communities even before deciding on which technologies that we can utilize. The micro-grid was implemented by MeshPower and the idea was to hand the system over to a community cooperative within the camp. This idea couldn't realized because there were questions raised by the UNHCR as to how the cooperative would operate. The UNHCR officials said that it was not possible to make all refugees the owners of the system as they couldn't have a direct access to an asset within the camp. While the community was very keen on the idea, they said the ownership should be given to all or none of them. They argue that people who would own the system would have physical and political power in the camp because people are desperate for access to energy which might lead to disruptions in the camp. Thus, the idea was halted until this issue is resolved.

Funding the energy projects
Investment from funding partners such as the IKEA Foundation has been tried. They provided UNHCR with almost $100 million in Ethiopia alone. The problem was that the UNHCR didn't have a plan on how to spend the money. They only hired people with engineering or technical background with two to six months of contracts -which certainly was not enough time to implement any project. Other options for funding come in the form of corporate social responsibility from companies like Shell that conducted an ethical, informed research into the topic. The funding is not the main problem now, it is the lack of expertise within humanitarian and development organizations' officials responsible for energy projects.

Actions needed
There is a severe lack of technical expertise within humanitarian organizations engaging in energy projects. The other thing that we need to work on is capacity building. The ineffective management of funds resulted in a divergence of funds from these organizations to energy companies who would design, install, and operate energy solutions and hand it over to the managing partner through power purchase agreements or leasing. At the same time, more and more organizations started to hire energy experts and the humanitarian energy sector has been growing fast with initiatives like GPA and Clean Energy Challenge.

Interview 3

Name of the interviewee: Jose Carrasco Montejano
Position: Team Leader at Energy for Refugees
Location: The Netherlands
Date: 15/09/2020

Organization's role in promoting energy access for displaced communities?
We provide sustainable renewable energy solutions for people in refugee camps by funding, designing and installing the system.

Roles and responsibilities within the organization
I've been working as the team leader of Energy for Refugees for almost two years. My main responsibilities are guiding the team on all phases of the project and making sure that we move according to our long-term strategies.

Selection of project location
Our technical team evaluates the feasibility of the projects in different camps and through constant communication with our partners in the field, we come up with a project for the camp.

Preparation phase
We scout for refugee camps where we can execute a project. We contact the humanitarian organization that is responsible for managing the camp. Since we have limited budget for the projects, we are dependent on our contact in the field for identifying energy needs. After we do a site survey, a tailor-made system that meets the specific needs of the camp is designed. Then we travel to the camp one more time for installing the system.

Design phase
The technology we use depends on what the needs are in the camp. To illustrate, the Registration and Identification Center in Lesvos, Greece, was connected to grid but the grid was not very reliable, especially in winter months. Therefore, we designed a grid-connected solar PV system of 24 kWp that would support the main grid. In one of our ongoing projects in Nigeria, the camp residents have no electricity or lighting. Thus, the project aims to provide solar street lighting. The inclusion of different energy needs depends on the structure of the camp and the regulations that mandate whether refugees can be involved in income-generating activities.

Performance indicators for a successful project
Safety is our utmost priority. Since we are a student organization, we make sure that all team members have the technical training required for installing a solar PV system safely. We aim for projects that bring most impact with low cost. That's how we decided to double the system size by eliminating the batteries and connecting to the main grid in Moria project.

Challenges for realizing a solar mini-grid project in refugee camps
The political circumstances in a country greatly impact the policies that might improve the quality of lives of vulnerable populations. Some of the governments want to give the impression that the refugee crisis is temporary. This is supported by using diesel generators which are modular and easily transportable. However, as these situations become protracted, the costs for fueling the humanitarian response activities becomes high and displaced populations suffer from lack of energy access. The type of displacement settlement significantly affects the system design. If the settlement is like a transition center where people stay until their asylum application is processed, then it is likely that people do not spend more than 1-2 years in the camp. However, if the camp has been in place for years and almost become a city, then both governments and camp residents take actions that reflects that permanency.

Coordination with the national and local government
Most of the times the humanitarian organization operating the camp has coordinates the communication with government authorities. We make sure that the project respects the rules and regulations on mini-grid development in the specific country and collect permits to install the system.

Ownership of the system
We make a rental agreement with the camp management which states that we are the owners of the system. The system is rented to the camp management free of charge as long as the system is used to meet the energy needs of camp residents. This way, we create a binding agreement for both sides.

Funding
The project is funded by university, NGOs, private sector organizations, and donations. Non-monetary support that we get might be in the form of free solar PV system installation training or discounted prices for system components.

Payment scheme
The payment system depends on the conditions in the camp and attributes of community. If people have the means to pay for the system, it is a great way to build a sense of ownership and improve the lifetime of the system.

Needed actions
I think the first point of action is education. Lack of know-how on the available energy technologies within camp management and communities results in a situation where camps are stuck to using costly and pollutant diesel generators. Another important issue is that energy solutions should reflect the needs of the community that will use them. Therefore it is important to take values, traditions, and expectations of the community into account during co-creation sessions. Because solar PV systems are considerably easier to manage than let's say, wind turbines, camp residents can get basic training and execute maintenance operations themselves.

Future of refugee camps
The number of displacement situations is likely to increase with the effects of climate change. We already see people fleeing drought or floods in Sub-Saharan Africa. In order to meet energy needs without contributing to greenhouse gas emissions, solar mini-grids hold a great potential. The communities in rural areas and vulnerable situations can increase their resilience through decentralized renewable energy solutions.

Interview 4

Name of the interviewee: Anonymous 3
Position: -
Location: -
Date: 25/09/2020

The Kigeme refugee camp
Practical Action works in Nyabiheke, Gihembe, and Kigeme refugee camps in Rwanda that are all housing Congolese refugees. The refugees have been in those camps for extended periods, and often having lived in those camps for the more than ten years, there are big population of children, young children who have lived their whole lives in those camps. So they are long-term established camps.

Practical Action and the RE4R project
Practical Action particularly looks at market development and strengthening markets and the idea was bringing those skills to a humanitarian context for energy access. The project is funded by the IKEA Foundation. It is been delivered in a partnership with UNHCR, and the sort of intend is there that UNHCR have the humanitarian experience and expertise and skills and the protection mandate for the refugees, and then Practical Action can bring these approaches from a development background and try bring those complementary skill sets together to try to bring some of that approach in a much more sustainable way, in a much more community focused way. The main goal of the project is trying to reshape the humanitarian response which is trying to move away from supporting refugees to an aid distribution model to a much more sustainable, much more engaged, much more economically resilient model. So when we talk about reshaping the humanitarian response, it's not just kind of energy access but energy access' sake it's to transition away from this aid dependency which is clearly not sustainable is not desirable for refugees its not desirable for the people who are funding it and so on and so forth.

Total Energy Access approach
When we started the project, we did an extensive assessment phase of three camps, looking at quantitative and qualitative data and doing market assessment. During this extensive assessment of those three camps, we looked in detail at the energy usage for households, for enterprises and also for institutions. That approach is called Total Energy Access approach, which Practical Action have used in other contexts. This approach looks at energy needs for all those different facets of what is neces-

sary to make a community function and to provide the levels of energy access that make all of those things work and build that kind of resilience and the support for the communities themselves. It puts the communities at the heart of all those solutions. Community building activities increased awareness about sustainable energy solutions among refugees. After we did the assessment phase, we went through a co-design and a co-selection process of what interventions we wanted to actually deliver on the ground. And we selected four interventions looking at a spread of providing energy access for these households, enterprises and institutional energy usage. We selected solar home systems for household energy use, through sort of private sector facilitation, and that's kind of well in the way, that's the sort of the supplies we facilitate to enter the space that have been operating in the camps from over 12 months now. And we have seen extensive take up of those products.

Energy access in the Kigeme refugee camp
When we first did the assessment back in 2017-2018, the levels for energy access particularly for households, were almost non existent. The vast majority of the households had no access to electricity within their homes, no access to renewable energy in particular. The energy that was being used was sort of battery powered or very very low levels of access to power any kind of electrical appliances in the house, mobile phones, and low level lighting. We selected solar home systems, and clean cooking for the sort of household energy access, then community solar, solar street lighting for the community wide energy access. We also aim to surround those four interventions with a bigger awareness raising by providing unbiased non-marketing type information to refugees about what the benefits of renewable energy would be and the kind of things that could help them support their lives. We also focus on productive uses of energy for livelihoods components which are supporting small enterprises and small businesses within the package of business mentoring, financial support and technical support. The people are now able to use those electrical appliances to boost their income, build employment, build businesses within the camps.

Governance of energy systems in the Kigeme refugee camp T: In terms of ownership, especially when there is a diesel system, it is usually owned by UNHCR and this is usually procured by their procurement department. These are just mostly brought during emergency situations but stay there all through the protracted situation. UNHCR owns the system, and then there is an informal obligation given to American Refugee Council, which is now ALIGHT, to operate and maintain the energy systems in the camp. They hire in Nyabiheke, and those people are responsible for going for the fuel, bringing it, making sure that the generators are running. If there is a technical fault, they sort it out, unless it's too big. Otherwise, they can call UNHCR for support. When we looked at the Nyabiheke system, there were no particular steps you needed to follow in order to connect to the system. The diesel generators at least in Nyabiheke were used mostly for institutional operations, community facilities, water pumping, and not much for households or for all businesses, just a few of them. In terms of the operation costs, UNHCR is the one who pays these costs. All the institutions do not pay for their own costs.

Camp management
In Rwanda, the management of the camps is completed by the Rwandan government through MINEMA, so the camps are actually managed by government employees. There is a refugee camp manager in each camp and they come under the Rwandan government. Thus, the camp management itself is by the Rwandan government whereas the refugee protection mandate is of UNHCR. So they have slightly different roles and slightly different mandates but they are both very much the gatekeepers to both supporting and protecting refugees and overall managing the camp. Sometimes these roles are a little bit organic in terms of who is doing what where.

Refugee executive committee
The Refugee Executive Committee, is an executive committee for the overall camp. They have eight members in each camp and they have various responsibilities, so there is one who is responsible for the youth, there is one who is responsible for disabilities, one of them is a president, vice president, so they have various roles and various specialisms within the camp. They are elected by the refugees, to represent refugee voices in refugee coordination meetings or the refugee coordination mechanism. Each of the camps is split into quarters and villages, and the same structure is replicated there as well. They have somebody who is responsible for energy, I think they also have somebody who is representing livelihoods and economic activity. Refugee Executive Committee, NGOs like ALIGHT who run and operate the diesel system, UNHCR, different enterprises (both the ones who are connected to the system and the ones who'd like to be connected).

Distribution of roles and responsibilities
I think the roles and responsibilities are sort of laid out but the problem is following through with those roles and responsibilities. I think sometimes UNHCR is very overwhelmed at the ground level meaning that they are not able to keep up on top of everything. One thing that they have wanted to do in Rwanda is to establish a working group of all the actors, especially energy actors so that they can know who exactly does what in energy, how can we coordinate better which might happen in the future.

Decision-making about energy projects in the camp
We have a direct relationship with UNHCR. We have joint decision-making, but even if we did not have that if you wanted to build or do any kind of installation in the camps, that would have to go through UNHCR and MINEMA. What we did with RE4R was a very detailed analysis of the options and presented our recommendations. I think UNHCR Rwanda is very aligned with our recommendations up until the point when they realized that they'll pay for the national grid connection. The Rwandan refugees are allowed to work and trade and move freely in and out of the camp but if private sector companies want solar home systems to be available in the camp, they have to get permission from MINEMA to be able to enter the camp base.

Information sharing
The refugee coordination meetings and refugee coordination mechanism are primarily the structures in place for all of the partners to keep each other informed and

identify the priorities and issues. We participate in that now, since the project has been ongoing, so that's our space to interact with everybody. Of course we have our own kind of project coordination mechanisms, but they are very much focused on the primary project partners. UNHCR and Practical Action primarily interact with MINEMA to our own registration at local level in Rwanda. More informally, we have field coordinators who are permanently based in the camps, who are our eyes and ears in the camps. That's pretty common for implementing partners in the camp to also have that kind of presence and footprints. What we did not wanna do was to duplicate or replicate coordination mechanisms. Refugee coordination mechanism is supposed to be the forum where everybody comes together and that is replicated at country level and the camp level as well.

Outcomes
RE4R is a massive project, and is a project that uses Total Energy Access, so tries to do everything for everyone, so it is very different but we have been able to make very good progress. I think our mission statement to reshape humanitarian response is very ambitious because this means that we want to change the way humanitarian actors do things such as how UNHCR does things and how they respond to energy needs. Although we are moving towards that goal we have not achieved that yet. When we first introduced the solar home systems project, people said that refugees will not be able to afford to buy solar home systems and questioned why we were moving away from an aid based system to a market based system. And now there are over 3,000 systems sold in three camps and refugees are using these systems. Although the end of the project is in 2022, I think we still have a lot to do and especially in global scope by bringing evidence from the ground.

Commitment from the actors
T: So I think there are two levels, there is the field level and there is the global level and sometimes there is a disconnection between the two. So, at the field level, only at the start of the project, there was little being done on energy and people did not talk about energy. There was no strategy or commitment or specific coordination unit for energy. This has been a problem but what refugees have started to realize what renewable energy can do and how they can study better, do business, support my family, stay longer after dark, and go to the washroom and not be in fear of the dark or fear of anything happening to me if they have energy. And it is not only the refugees but also the actors are starting to realize the benefits of renewable energy. At the global scope, i think also, when we started the project, the discussion was much around energy is important this is why we should provide the energy in the camps, and now it's slightly moving to how do we provide this energy, what have others done, how can we do it better, how do we involve the community in decision making, how do we create systems that work for refugees, and particularly productive users of energy, how do we use energy to help refugees to become self sustaining in the future.

Ownership models
We did have a challenge with UNHCR to see if we could have a community as more

of a stakeholder, but I think the issue is that it needs a lot of groundwork. The capital cost was so significant for a system of that size, it makes it quite hard for refugees to be owners because they would never be able to afford to pay for the system in its entirety. What we did not wanna do we just buy a system and give it to the refugees we kind of we were very much trying to avoid that we have seen examples where that has not worked in the past. So what we were trying to do was to build something which did have market based principles at its core and provide affordable payment schemes for refugees.

Transfer of ownership
The micro-grid is associated with the school and the system is likely to be handed over to WorldVision. What is wanted is not the handing over of the assets but it is building a model to make sure that the system is taken care of in the long term. That's particularly challenging for the type of asset that has been installed in the HEED project because it is in a school. People aren't paying to use the school, so they are looking at other options like using that space for income generating facilities. One of the intentions for HEED was that it would be handed over to community ownership but that has been completely scattered by coronavirus. So, they were in the process of setting up community group boards, but now they are not allowed to meet face to face, we are not allowed to go there to do face to face facilitation or the training. Because the project is coming to an end, they made a decision to try and hand over to one of these institutions who may want in the future to do some kind of community ownership. The intent of heed was to do a community ownership model but that was supposed to be done in April, which is a coincidence since Kigeme has been on complete lockdown for the last three months. There was a period when they were in a very strict lockdown, then restrictions were started to ease and then the lockdown came back. So now they do things on a two weeks rolling basis. At the moment, moving in and out of the camps is restricted, you have to get special permission to go there either for central work. For example health, food and water staff are allowed to come in and out of the camps whereas we are getting some special dispensations to do maintenance on some of the assets.

Challenges for the energy provision in camps
The challenges depend on the particular intervention because something like a solar home system is very different from a mini-grid. The short funding cycle of UNHCR is a major challenge when you want to do anything that requires two or three years of funding. Although we are trying to engage the private sector, the private sector have the mindset of reaching their target sales, and we are trying to bring in the community awareness, so that people can actually understand what is the importance of renewable energy. Affordability is a big challenge now and it will still be a big challenge in the future. The income for the refugees is just not enough, and what people are looking at is doing more projects that involve more productive use of energy and economic activities and that will be a good thing to see in the next few years. Another thing I think is coordination. So as much as UNHCR is trying to coordinate things in the camp and trying to make sure they know who is doing what, you can still find an actor trying to build a mini-grid and another one is also trying

to make an assessment for a mini-grid in the same location which makes things very complicated. So the coordination part is still not sorted out, and it needs to be monitored very closely.

Interview 5

Name of the interviewee: Bertram Peterson
Position: Solar Energy Professional
Location: The Netherlands
Date: 15/09/2020

Experience in mini-grid projects
I have five years of engineering experience in solar energy sector. I've worked in several projects for residential and commercial use such as a movie theaters, a factory, a shopping mall, a university, and for electrification of rural areas and humanitarian settings.

Pre-planning
Both for humanitarian and non-humanitarian projects, it is the customer who reaches out because they want to provide electricity at a cheaper price. The initiative comes from the people with the need, not from the developers.

Preparation phase
The site survey is conducted to understand what customer needs: whether they need an improvement on their energy efficiency or a solar energy system. If the latter is the case, then sizing of the system can be determined in three different ways: measuring the energy consumption, utility, or simply installing as much as possible regardless of consumption.

Design phase
There are several decisions to be made about the system: whether it is going to be connected to the grid, off-grid with batteries, or a solar water pump system. Sizing of the system is almost always constrained by one of these three factors: annual energy consumption, available space, and budget.

Funding
In commercial or residential projects, the system is paid by the user of the system. This is not the case for the humanitarian projects as the users of the system (humanitarian organizations and refugee camp residents) do not pay for the system but donor agencies provide the funding.

Advantages of using solar mini-grids in refugee camps
It is a much cheaper option than diesel generators and certainly more environmentally friendly and reliable.

Performance indicators
Safety is the most important factor. The risk assessment should be made thoroughly during the site survey. The system should be properly designed while respecting laws and regulations. Especially the installation of the system requires attention as electricity can inflict considerable damage. Reliability is another indicator for good performance which can be measured in a number of ways: the length of blackouts over a certain period of time, the number of people affected by a blackout, the amount of energy not used, and etc. To achieve this, the system should be sturdy enough and of required capacity to supply electricity throughout its lifetime.

Maintenance of solar mini-grids
The frequency of maintenance needed depends on the size of the system. In a refugee camp setting, maintaining the system once a month would be appropriate. The regular maintenance would involve checking all the system components such as solar PV modules, inverters, charge controller, and batteries if used. It is important that the system is readily available for people who are responsible for operating and maintaining it and not so much for people without these responsibilities.

Needed actions
Instead of short-term investments and solutions, long-term planning is needed. Even for camps like Moria which functions as a transition and identification center, a refugee spends 1-2 years in the camp but the camp is there for more than 5 years.

Interview 6

Name of the interviewee: Philip Sandwell, PhD
Position: Humanitarian Energy Research Associate at Imperial College London
Location: United Kingdom
Date: 16/09/2020

Renewable Energy for Refugees (RE4R) project
We worked on energy access in Gihembe, Kigeme, and Nyabiheke refugee camps in Rwanda with Practical Action. Through surveys and interviews, we prepared a report that gives detailed information on energy access in these camps.
Kigeme refugee camp The Kigeme camp hosts Congolese refugees so it could be said that it has an ethnically homogeneous community. The camp has two sites separated by the main road which makes it more accessible than other camps.

Energy provision in the camp
For households, the main energy needs are cooking and lighting. The households are not connected to the national grid or any mini-grid. There have been clean cooking projects that were not very successful due to a lack of fuel in the camp. For electricity, market-based solutions such as solar lanterns and solar home systems are used.

Affordability of energy products
It is hard to define affordability in a refugee camp situation. The camp residents

receive cash-based assistance from the World Food Programme that they can use to buy solar lanterns or solar home systems. The sales data for solar home systems show that a considerable percentage of the target group was able to afford the initial costs and monthly payments. For the monitoring and evaluation, our priority was to make sure that people could pay for electricity without giving up on other basic needs like food.

Decision-making process
The UNHCR decides and organizes and facilitates the distribution of cooking fuels or solar products within the camp. They prioritize vulnerable people within the community and make sure that they get access to fuels and products.

National or district-level rules that affect energy provision
Rwanda is a unique country in terms of its approach to the refugee crisis. The country accepted the Comprehensive Refugee Response Framework (CRRF) and has rules and regulations for the political, economic, and social inclusion of refugees. Recently, the Rwandan government introduced a national ban on using firewood. This was a challenging situation as UNHCR had to quickly adapt to a policy change that affected their daily operations.

Evaluation of mini-grids as an option to meet household electricity needs
One of the guiding principles in humanitarian operations is to make sure that the aid is available for everyone. Considering the extremely limited and short-term budgets of UNHCR, it might not be feasible for them to invest in mini-grids which have long payback time and high initial costs. In this case, a small-scale grid would not be preferred as it would not be available for everyone. Therefore, it is more favorable if private sector actors install and run these systems and provide power purchase agreements for UNHCR.

Needed actions
The humanitarian energy sector is a newly developing area that gained more global attention in recent years with initiatives like UNHCR's Clean Energy Challenge and Global Plan of Action. The scarcity of data is one of the main factors hindering the improvement of energy access in camps. Knowledge sharing might be difficult for an organization that implemented a small-scale energy project in already difficult conditions presented in refugee camps. These organizations often do not have the resources like staff and time to share their project, data, or findings. I think there needs to be a lot of trial and error so that people in the humanitarian energy sector would learn from each other's successes and failures and build from that.

C | ACTORS INVOLVED IN THE HUMANITARIAN ENERGY SECTOR

The actors involved in the decision-making processes regarding improving energy access in refugee camps are humanitarian and development organizations, nation states, and local governments, business associations, think tanks, funded partnerships, funders, private sector actors, and academic and research organizations. This categorization of actors builds on the list by Rosenberg-Jansen (2019) and describes the roles, responsibilities, and projects of each actor in detail.

C.0.1 Humanitarian and development organizations

- *Energy4Impact*: is a non-profit organization aiming to improve energy access in Africa by working with local businesses.
- *Food and Agriculture Organization of the United Nations (FAO)*: is a UN agency leading the international efforts to eradicate hunger aiming to achieve food security around the world for all.
- *International Committee of the Red Cross (ICRC)*: is a humanitarian organization given a mandate to protect and assist victims of conflict and violence by the Geneva Convention in 1949.
- *International Organization on Migration (IOM)*: is an intergovernmental organization striving to ensure an ordered and humane management of migration, motivate coordination on an international level, help to find practical solutions for migration-related problems, provide humanitarian relief to migrants in need.
- *International Renewable Energy Agency (IRENA)*: is an intergovernmental organization providing a platform for cooperation, the advancement of knowledge, and support for countries who wish to realize the transition to renewable and sustainable energy.
- *Médecins Sans Frontières (MSF)*: is an international, independent medical humanitarian organization that provides assistance to people affected by conflict, epidemics, and disasters.
- *Mercy Corps*: is a humanitarian and development organization that operates on the front lines of humanitarian crises globally and aims to alleviate suffering, poverty, and oppression.
- *Norwegian Refugee Council (NRC)*: is an independent humanitarian organization providing aid to forcibly displaced people.

- *Oxfam*: is a group of independent non-governmental organizations that came together to share knowledge and combine efforts in order to address issues such as conflict and disasters, inequality, food, climate, gender justice, and water and sanitation.
- *Practical Action*: is an international development organization working across several issues such as agriculture, electricity and clean cooking, water and waste management, and climate change and disasters.
- *United Nations Development Programme (UNDP)*: is the UN's global development branch working for the eradication of poverty, inequality, and exclusion by supporting countries in policy development, leadership, partnership, institutional capabilities to achieve sustainable development targets.
- *United Nations Environment Programme (UNEP)*: is the UN body working on the coordination of UN's environmental activities, leading partnership in global environmental agenda, and promoting environment in sustainable development.
- *United Nations High Commissioner for Refugees (UNHCR)*: is the global organization that aims to save lives, protect rights, and build a better future for forcibly displaced people.
- *United Nations International Children's Emergency Fund (UNICEF)*: is a UN agency in charge of saving children's lives, defending their rights, and contributing to their development.
- *United Nations Industrial Development Organization (UNIDO)*: is a UN agency responsible for promoting industrial development for reducing poverty and ensuring environmental sustainability in development.
- *United Nations Institute for Training and Research (UNITAR)*: is the training branch of the UN that provides learning solutions to individuals and organizations to support global decision-making and country-level action.
- *United Nations Foundation*: is a partner institution of the UN by mobilizing ideas, people, and resources to supports the UN's work.
- *World Food Programme (WFP)*: is a UN agency focusing on ending hunger through emergency assistance, relief and rehabilitation, and development aid.

C.0.2 Nation states and local governments

- *Rwanda*
- *Uganda*
- *Kenya*
- *The Republic of Korea*
- *Yemen*

- *Nigeria*
- *Somalia*

C.0.3 Business associations, think tanks, and funded partnerships

- *Alliance for Rural Electrification (ARE)*: is an international business association supporting decentralized renewable energy, promoting markets for affordable energy access, and creating inclusive economies and job opportunities.
- *Clean Cooking Alliance*: is a global network of actors targeting to improve access to clean cooking to the three billion people who don't have the access. The partnership works on propelling customer demand, organizing investments for scalable business models, and promoting an environment for the clean cooking sector to thrive.
- *Chatham House*: is an independent non-government not-for-profit think tank that works on issues such as global health; energy, environment, and resources; global economy and finance; international law; and international security.
- *Energising Development (EnDev)*: is a partnership funded by six donor countries the Netherlands, Germany, Norway, United Kingdom, Switzerland, and Sweden aiming to provide energy access to rural areas through training retailers, establishing mini-grids, stimulating biogas production for household use.
- *Global Off-Grid Lighting Association (GOGLA)*: is an independent not-for-profit industry association for the off-grid solar energy sector that supports its members through market intelligence, knowledge-sharing, policy advocacy, and creation of industry standards and guidelines.
- *Global Plan of Action for Sustainable Energy Solutions in Situations of Displacement (GPA)*: is a partnership between key stakeholders in the humanitarian and development fields working towards increasing access to energy for displaced populations.
- *International Lifeline Fund (ILF)*: is a non-profit organization striving to provide cost-effective technological solutions to vulnerable populations.
- *Moving Energy Initiative (MEI)*: is a collaboration between Energy4Impact, Chatham House, Practical Action, NRC, UNHCR, and the UK Department for Foreign, Commonwealth Development Office (FCDO) aiming to promote clean, affordable, and reliable energy access for displaced communities through policies, private sector engagement, evidence-based research, and collaboration with nation states.
- *Renewable Energy for Refugees (RE4R)*: is a project established as a partnership between Practical Action UNHCR, supported by the IKEA Foundation and in collaboration with Chatham House, Energy4Impact, and the Norwegian Refugee Council that aims to provide energy access in refugee camps.

- *Safe Access to Fuel and Energy (SAFE)*: is an initiative endeavoring to provide reliable and safe fuel and energy for cooking, heating, lighting, and power to populations affected by crises.

- *SEforALL*: is an international organization working with nation states, private sector, and civil society to reach SDG 7.

c.o.4 Funders

- *African Development Bank (AfDB) Group*: is an international organization that aims to promote sustainable economic development by supporting electrification projects in Africa, working on reducing poverty, and providing emergency assistance to refugees.

- *Asian Development Bank (ADB)*: is a regional development bank that works towards a prosperous, inclusive, and resilient Asia and the Pacific through poverty reduction programs.

- *Bill Melinda Gates Foundation*: is a foundation that works to eradicate extreme poverty and health problems in developing countries, and education while also partnering with UNHCR to provide emergency relief to refugees.

- *Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)*: is a German development organization that advises countries to achieve their goals within its 2030 Agenda.

- *Economic Community of West African States (ECOWAS)*: is a regional union that works towards economic integration of 15 countries and hosted forums to promote market-based approaches for energy provision in displacement settings.

- *European Union*: is a group of 27 countries in Europe that funds solar power projects in refugee camps in Africa.

- *Federal Foreign Office of Germany*: is the foreign Ministry of Germany that focuses on supporting development projects around the world.

- *Foreign, Commonwealth Development Office (FCDO)*: previously the United Kingdom (UK) Department for International Development (DFID), is a UK ministerial department providing development funding around the world and supports the Moving Energy Initiative.

- *IKEA Foundation*: is a foundation working across several themes such as climate action, agricultural livelihoods, renewable energy, special initiatives and emergency response, and employment and entrepreneurship.

- *KfW Bank Group*: is a German development bank focusing on poverty eradication, economic development, education and healthcare, environmental protection and supported solar projects in Jordan where Syrian refugees reside.

- *SNV Netherlands Development Organisation (SNV)*: is a not-for-profit international development organization that aims to help people in poverty by providing expertise in agriculture, energy, and water, sanitation and hygiene.
- *Swedish International Development Cooperation Agency (SIDA)*: is a government agency working towards reducing poverty around the globe that provides supports for financial services for refugees and host communities.
- *World Bank*: is a global partnership that aims to find sustainable solutions for reducing poverty and building prosperity in developing countries that partnered with UNHCR to create a data center for forced displacement.

c.0.5 Private sector actors

- *Bboxx*: is an energy company operating in Sub-Saharan Africa that provided solar home systems to the Kakuma refugee camp in Kenya in partnership with MEI.
- *Energias de Portugal (EDP)*: is an energy company that worked with UNHCR to bring solar public lighting, flashlights, furnaces, and mini-grids in camps.
- *ENGIE Mobisol*: is a solar home system company that worked in refugee camps in Kenya, Rwanda, and Tanzania.
- *Eurelectric*: is a sector association within Europe that partnered with UNHCR to provide sustainable and reliable energy for refugees.
- *Inyenyeri*: is a Rwandan social benefit company that brought clean cooking options for the Kigeme refugee camp in collaboration with UNHCR.
- *Kube Energy*: is a renewable energy service company that implemented assessments of renewable energy options for four refugee settlements with IRENA.
- *Little Sun*: is a solar company that provides lighting solutions for displacement settings in South Sudan, Ethiopia, Rwanda, Nepal, and Greece.
- *MeshPower*: is a company that operates solar-powered microgrids aiming to make sure that low-income and off-grid communities in Rwanda have access to clean and affordable electricity services.
- *Scatec Solar*: is an energy company that builds, owns, and operates solar power plants towards providing a solar energy system for the Humanitarian Hub in South Sudan where humanitarian organizations work.
- *SCENE*: is a social enterprise working towards strengthening community resilience through renewable energy solutions.
- *Schneider Electric*: is a multinational company supplying energy committed to promote sustainable development in displacement settings.
- *Shell*: is a group of energy and petrochemical companies that recently started working on promoting energy access in camps.

c.o.6 Academic and research organizations

There has been an increase in academic research done on humanitarian energy in recent years. Some of the organizations here are part of international partnerships whereas others conduct field studies where energy access is improved in camps.

- *Coventry University*: launched the Humanitarian Engineering and Energy for Displacement (HEED) project that aims to improve energy access for forcibly displaced populations by designing, implementing, and monitoring energy systems for household, community, and productive use in Rwanda and Nepal.
- *KTH Royal Institute of Technology*: supports research on the initial analysis on energy access in refugee camps.
- *London School of Economics and Political Science*: encourages research on solutions like solar cooking in refugee camps such as Goudoubo in Burkina Faso.
- *Politecnico di Milano*: facilitates research on food-energy nexus for displaced populations.
- *Technical University of Denmark*: is part of a partnership with UNEP promoting research and advisory on energy, climate, and sustainable development.
- *University of Oxford*: has a Refugee Studies Centre where Research in Brief: Refugee Energy is published as an initial assessment of the energy situation in displacement settings.

D GLOBAL PLAN OF ACTION FOR SUSTAINABLE ENERGY SOLUTIONS IN SITUATIONS OF DISPLACEMENT (GPA)

Among many initiatives within the humanitarian energy sector, the Global Plan of Action for Sustainable Energy Solutions in Situations of Displacement (GPA) stands out as an overarching partnership between the most influential actors in the field. It is a non-binding framework similar to the previous enterprises and it aims to strengthen instead of duplicating their efforts (GPA, 2018). While investigating to what extent a sustainable solution like community mini-grids would work in a refugee camp, it is necessary to understand how the decisions are made and the coordination between actors is facilitated. For this purposes, the GPA provides a great deal of information on the governance structure through its publications. Therefore, the GPA is selected as point of analysis to explore the decision-making processes and operations of the humanitarian energy sector globally. The policies within GPA are analyzed thoroughly in the following sections.

D.1 ACTORS

The actors in the global level are the collection of actors who are in the decision-making process for planning humanitarian energy projects within the GPA. The GPA partnership is managed by two groups responsible for five different working areas. The Steering Group is in charge of implementation at the global level, management of the Working Groups, and decision-making on the Work Plan. The members of this group are: United Nations Institute for Training and Research (UNITAR), United Nations High Commissioner for Refugees (UNHCR), International Organization for Migration (IOM), Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), World Food Programme (WFP), Food and Agriculture Organization of the United Nations (FAO), the Moving Energy Initiative (MEI), Practical Action, United Nations Environment Programme - Technical University of Denmark (UNEP-DTU), United Nations Development Programme (UNDP), the Clean Cooking Alliance, Mercy Corps, the UN Foundation, and Sustainable Energy for All (SEforALL). The Coordination Unit supports Steering Group in daily operations and coordinates the Work Plan activities. The Work Plan is a work-in-progress document detailing concrete actions by the involved parties. The coordination is operated by the UNITAR and supported by the Federal Foreign Office of Germany, the IKEA Foundation, and Norwegian Capacity (NORCAP) operated by Norwegian Refugee Council (NRC). There are five Working

Groups: Planning and Coordination; Policy and Advocacy; Innovative Finance and Funding; Technical Expertise and Capacity Building; and Data, Evidence, Monitoring, and Reporting. The issues like trust, reciprocity, common understanding, social capital, and cultural repertoire are dictated through frameworks and action plans.

D.2 ROLES AND RESPONSIBILITIES

The positions are interpreted as the seats that the actors hold in the decision-making process and are dictated by position rules. There are three different positions in the GPA: Steering Committee, Coordination Unit, and Working Groups.

- *Steering Group*: is in charge of the general strategy, improvement and operationalization of the GPA at the global label. The Steering Group is comprised of a maximum of 20 humanitarian, development, and energy organizations working towards reaching the targets of the GPA. Each organization has one or two people for representation. For the Steering Group, membership is granted through application. The decision on whether or not to grant membership is made by the Coordination Group. The applicant has to meet all of the eligibility criteria and gain the majority of the votes from the Steering Group. The criteria for membership are being an international organization, supporting the GPA activities through human resources, having a directive for contributing to the Work Plan, fundraising projects that use sustainable energy for displacement settings, and being impartial to available energy options without pushing agendas. Each organization has one vote right regardless of the number of people representing the organization. The membership is reviewed each year and can be terminated if the roles and responsibilities are severely neglected, which is decided through a majority decision of the Steering Group members.

- *Coordination Unit*: Comprised of 3-5 full time staff members, The Coordination Unit is responsible for the operation of the GPA and make sure that the objectives are reached and guiding principles are followed. Currently UNITAR is the main organization responsible for coordinating the activities of the Steering Group and the Working Groups.

- *Working Groups*: develops and delivers the Work Plan through five working groups: Planning and Coordination; Policy and Advocacy; Innovative Finance and Funding; Technical Expertise and Capacity Building; and Data, Evidence, Monitoring, and Reporting. Working Groups consist of various stakeholders from different sectors such as humanitarian and development organizations, member states, governments, private sector, funding and financial institutions, and training and research organizations. If an interested party is not eligible for the Steering Group, they can join the Working Groups instead and become a part of the GPA. The individuals who want to be a part of a Working Group sends an online application declaring their level of commitment. The eligibility criteria for membership are adding value to one of the Working Groups, 30% attendance rate to meetings, promoting activities or ideas that might support

the GPA Work Plan, and sharing the actions of the GPA within their organization to increase outreach.

GPA is a non-binding framework between interested actors formed as a result of collective action. The actors with different expertise work towards the same goal of improving energy access for displaced populations. In line with this, the actors can select their level of commitment and thus, level of control, during the application process as a partner:

- *Level I - Commitment to the development*: by becoming a representative of an organization and declaring commitment to the framework. This requires direct participating or financially supporting GPA's development.
- *Level II - Endorsement the goals*: by becoming a representative of an organization and declaring intention to improve energy access in displacement settings through sustainable solutions. This level of commitment requires sharing publicly available commitments and potential involvement in Working Groups.
- *Level III - Expression of interest*: by signing up as an individual or member of an organization and indicating interest for the GPA. This level of commitment can be increased through participation later.

D.3 COORDINATION

Steering Group coordinates different Working Groups and other stakeholders at the international level. It is comprised of actors with different authority levels and expertise which helps overseeing the activities of Working Groups. The Steering Group helps with the implementation of the projects at field as much as possible. The Coordination Units acts as a secretariat and reports to the Steering Group. It supports the Working Group activities and identifies gap areas, recommends new measures and tools to fill these gaps, and organizes fundraising activities. The Coordination Unit is also responsible for managing and updating the Work Plan. It tries to integrate humanitarian energy into international policies. The coordinators of each of the five Working Groups lead the activities. The Coordination Unit supports the Working Group coordinators in managing, monitoring, and examining activities.

All information available is shared across Working Groups and Steering Group through the activities of the Coordination Unit. Specifically, each group has regular meetings either online or in person. The Steering Group meets once in every three weeks via conference call for a discussion of current activities of GPA, updates, and strategic decisions. Coordination Unit is responsible for setting up these meetings. One face-to-face and one online detailed meetings are held each year to review the GPA. The Working Groups meet via conference calls regularly where information and lessons learned are shared and various opportunities for collaboration and funding are discussed. One, preferably two members of the Coordination Unit attends all Working Group meetings to make sure that the decisions taken in the meetings are in line

with the Work Plan and activities of other Working Groups. One representative from the Coordination Unit communicates the meeting notes to the Steering Group. The other representative is an expert in the sector who can deliver the responsibilities. The current situation shows that information is available to actors in all positions to ensure transparency of activities and efficiency of communication.

The general structure of the GPA is as shown in Figure D.1. All three groups are in constant communication and collaboration with each other to ensure efficacy through the Coordination Unit. The Coordination Unit can be thought of as the main actor responsible for harmonizing overall efforts of the GPA. Steering Group and Coordination Unit together work towards creating international policies, long-term plans for energy access, and platforms for sharing knowledge. The initial works of the GPA resulted in identification of five key challenges encountered in humanitarian energy access. Five Working Groups are established to tackle with each of these challenges. The Coordination Unit makes sure that Working Groups work in synchronization with each other and translate the findings to the Work Plan.

In addition to the current structure, the partnership considers including an Expert Community which endorses the activities of Working Group and take actions for outreach by collaborating with the Coordination Unit and Steering Group. The Expert Community consists of international and local organizations, research institutes, private companies, and NGOs with field expertise. The Expert Community is envisioned to be responsible for providing input and advice to the Steering Group in fields of humanitarian assistance, disaster-risk reduction, financing, and development. The Steering Group is responsible for creating a structure for this networking. These interactions among these actors creates outcomes that are discussed in the next section.

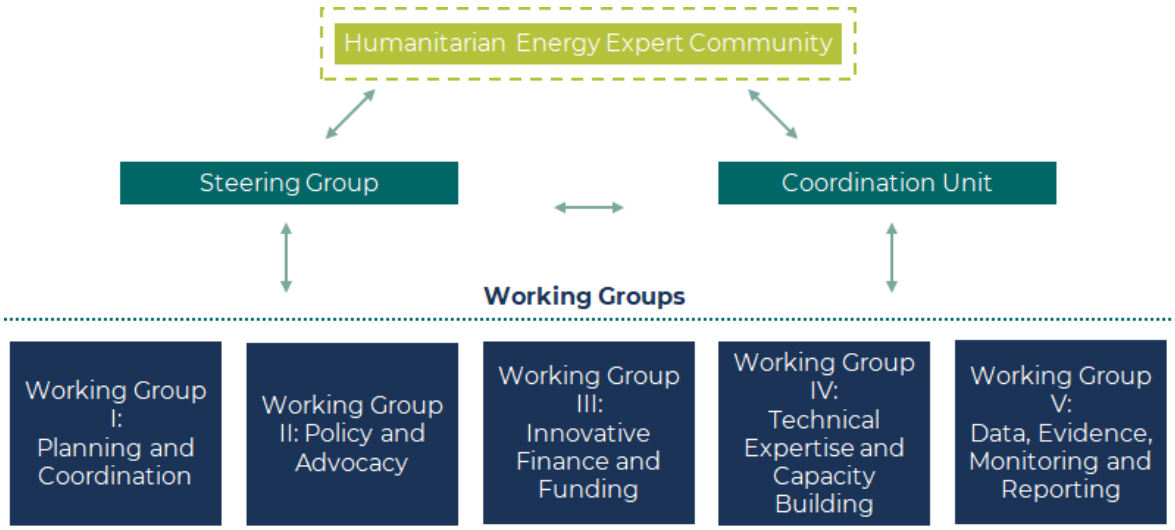

Figure D.1: The structure of the GPA, adapted from (GPA, 2019).

D.4 FRAMEWORK FOR ACTION

The interactions between actors involved in the GPA framework resulted in the creation of "Framework for Action" (GPA, 2018). The framework explains the guiding principles of the GPA as:

- involving displaced populations, host communities and local governments in the planning phase for any project to make sure that their needs are met,
- creating specific solutions for different types of disaster, location, demographic distribution, needs of displaced community, culture, and established norms of host communities,
- understanding the enabling role of energy in promoting food security, shelter, protection, health, natural resources, and resilience,
- putting self-reliance of beneficiaries as a priority when selecting energy solutions,
- considering women and girls who are in a more disadvantageous position due to lack of energy access since they collect firewood which might subject them to sexual and gender-based violence, limit their opportunities for education and income-generating activities, and
- complying with no harm principles and minimizing adversities for displaced populations, host communities, and natural resources.

In addition to the guiding principles, the framework detailed five main challenges and appointed a Working Group for each of them. The framework presented 66 recommendations to tackle with these challenges to provide safe and sustainable energy to displaced populations in July 2018. An overview of these recommendations are presented in Table D.1.

Table D.1: The major challenges in humanitarian energy field and recommendations by the Working Groups, adapted from (GPA, 2018).

	Challenge	Recommendation
Working Group I: Planning and Coordination	Energy is not a formal priority in humanitarian assistance.	I. Formally recognize sustainable energy access as a priority within the humanitarian system. II. Foster 'bottom-up' collaborations and engagement on energy and environment interventions between displaced people, host community members, local experts and energy product/service providers. III. Build energy activities into other humanitarian assistance priorities.
Working Group II: Policy and Advocacy	Displaced people are often not included in national or international energy access agendas.	I. Bring displaced people into the SDG 7 agenda and the Global Tracking Framework with a clear link to the response and resilience agenda II. Encourage and support the design and implementation of response and resilience plans, including attention to energy priorities and energy linkages with other priorities such as housing, water supply, environment, food security and health III. Foster national-level dialogue to enable successful sustainable energy-access interventions at the country level. Provide examples of how clean energy investment and self-reliance create a virtuous circle of beneficial change
Working Group III: Innovative Finance and Funding	Energy in displacement settings is under-funded	I. Conduct further data, mapping and research on the different types of projects or parts of the value chain that require financing, the instruments that would be best suited to each, and how they can be developed through discussions with different stakeholders II. Hold discussions with donors to identify potential sources of funding to test out new financing instruments, with an emphasis of coordinating investment approaches and exploring more innovative financing options III. Design a financing facility or financial instruments that could be used to support energy investments in displacement settings
Working Group IV: Technical Expertise and Capacity Building	Expertise and capacity to implement humanitarian energy solutions is limited	I. Build in-house capacity of staff at the field and international level to plan for multi-year interventions and energy strategies and to implement projects II. Develop tailored training packages according to stakeholders' capacity needs III. Create or adopt a common repository to exchange knowledge, discuss issues and receive support from peers and experts
Working Group V: Data, Evidence, Monitoring and Reporting	Data on humanitarian energy needs and solutions is limited and not widely shared	I. Integrate energy indicators into planning and assessment tools for the humanitarian sector, in collaboration with Working Area I II. Harmonize and standardize the types and forms of data collected to enable comparison and to facilitate effective monitoring and evaluation III. Design and deliver of holistic monitoring, evaluation and learning tools for humanitarian energy programmes, with ways to share data and best practices between the humanitarian, development and private sectors

E | SOCIAL-ECOLOGICAL SYSTEM (SES) FRAMEWORK

Even though the IAD framework has been very useful for researchers analyzing different institutional arrangements, the fact that it treats resource system as an exogenous components which is in fact dynamic in nature, resulted in a search for a broader set of variables to study social-ecological systems (Ostrom, 2009). Social-ecological system (SES) framework, shown in Figure E.1 is created with the intention of studying management of common-pool resources (CPRs) where resource users extract resource units from a resource system (McGinnis and Ostrom, 2014). The framework shows the relationship between four subsystems that are in an interrelated relationship while being influenced by social, economic, political settings and related ecosystems. Ostrom (2009) describes these subsystems as: Resource Systems (water systems, forestry, fishery area), Resource Units (amount and flow of water, trees, fish), Governance Systems (the government and other organizations managing the resource and rules defined for use), and Actors (individuals who use the resource).

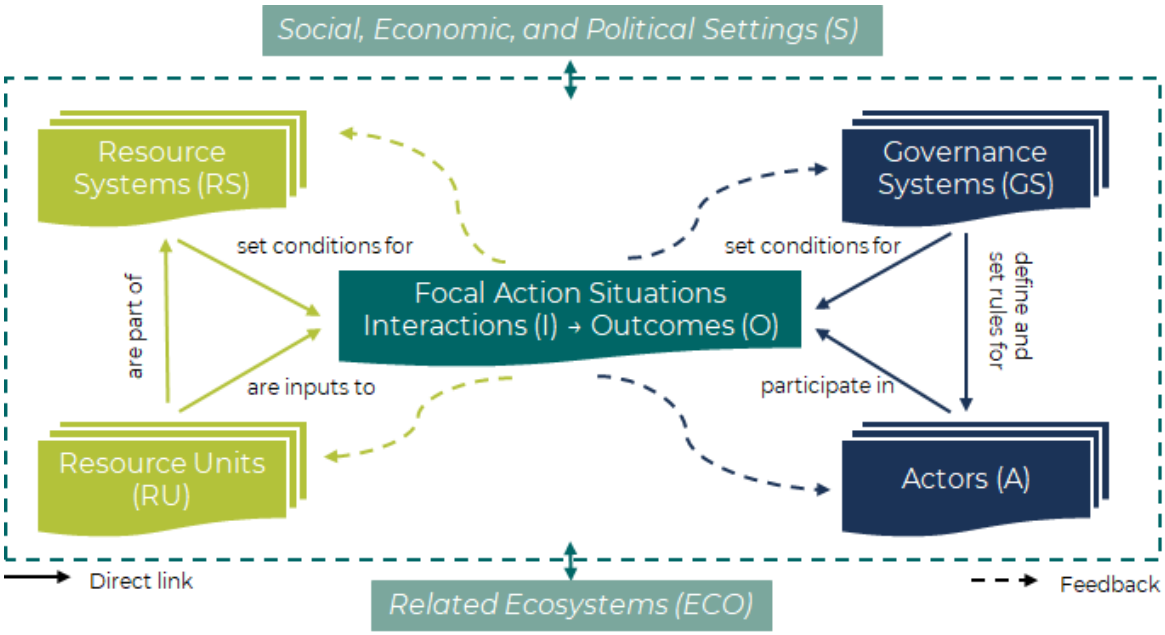

Figure E.1: The Social-Ecological Systems framework, adapted from McGinnis and Ostrom (2014).

Four subsystems (also called first-tier variables) have second-tier variables (such as size of a resource system, collective-choice rules, political stability, number of relevant actors, growth or replacement rate, and pollution patterns) which further explain how the system performs, as shown in Table E.1. These variables provide researcher with a list of vocabulary while studying CPRs.

Table E.1: The first and second-tier variables of Social-Ecological Systems framework, adapted from McGinnis and Ostrom (2014).

First-tier variable	Second-tier variables
Social, economic, and political settings (S)	S1 – Economic development S2 – Demographic trends S3 – Political stability S4 - Other governance systems S5 – Markets S6 – Media organizations S7 – Technology
Resource systems (RS)	RS1 – Sector RS2 – Clarity of system boundaries RS3 – Size of resource system RS4 – Human-constructed facilities RS5 – Productivity of system RS6 – Equilibrium properties RS7 – Predictability of system dynamics RS8 – Storage characteristics RS9 – Location
Governance systems (GS)	GS1 – Government organizations GS2 – Nongovernment organizations GS3 – Network structure GS4 – Property-rights systems GS5 – Operational-choice rules GS6 – Collective-choice rules GS7 – Constitutional-choice rules GS8 – Monitoring and sanctioning
Resource units (RU)	RU1 – Resource unit mobility RU2 – Growth or replacement rate RU3 – Interaction among resource units RU4 – Economic values RU5 – Number of units RU6 – Distinctive characteristics RU7 – Spatial and temporal distribution
Actors (A)	A1 – Number of relevant actors A2 – Socioeconomic attributes A3 – History or past experiences A4 – Location A5 – Leadership/entrepreneurship A6 – Norms/social capital A7- Knowledge of SES/mental models A8 – Importance of resource A9 – Technologies available
Action situations: Interactions (I) → Outcomes (O)	I1 – Harvesting I2 – Information sharing I3 – Deliberation processes I4 – Conflicts I5- Investment activities I6 – Lobbying activities I7 – Self-organizing activities I8- Networking activities I9 – Monitoring activities I10 – Evaluating activities O1 – Social performance measures O2 – Ecological performance measures O3 – Externalities to other SESs
Related ecosystems (ECO)	ECO1 – Climate patterns ECO2 – Pollution patterns ECO3 – Flows into and out of focal SES