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Singh, Abhigyan

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Conceptualizing Inter-Household Energy Exchanges

An Anthropology-through-Design Approach

Abhigyan Singh

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by

Abhigyan Singh

Master of Arts in New Media Design, Aalto University, Finland
born in Korba, India.

This dissertation has been approved by the promotors.

Composition of the doctoral committee:

Rector Magnificus,	chairperson
Prof. dr. D. V. Keyson	Delft University of Technology, promotor
Dr. ir. H. W. van Dijk	NHL Stenden University of Applied Sciences, copromotor
Dr. N. A. Romero Herrera	Delft University of Technology, copromotor

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Prof. ir. D. J. van Eijk	Delft University of Technology, reserve member

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For Kabir, Noopur,
and my parents.

Contents

Summary

With the growth of decentralized, off-grid, and distributed renewable energy systems across the globe, an arena for energy exchanges between households is opening up. As compared to traditional 'centralized' energy supply systems, in these emerging energy systems households are imagined to acquire agency in inter-household energy exchanges within neighborhoods or villages. This agency can be manifested by householders taking a more active role, where they will have some choice and control over local exchanges of energy between households while being both consumers and producers of energy.

The dominant vision of inter-household energy exchange is marred with many assumptions. The existing literature on energy exchanges is mostly rooted in a techno-economic analysis built upon visions of rational choice approaches. The existing literature on energy exchanges lacks discussion on the sociocultural dimensions of energy exchanges, or in other words how energy exchanges are grounded in the social and cultural reality of people's everyday life. Similarly, there is an absence of a theoretical and conceptual discussion on non-market energy exchanges, such as social and personal energy exchanges that are structured without the mediating role of neoclassical market principles. The two main goals of this dissertation are:

- To develop conceptual knowledge of inter-household energy exchanges by investigating the social and cultural embeddedness of energy exchanges in a system where householders can decide with whom to exchange locally produced energy.
- To conceptualize a research approach that utilizes 'design,' more especially a 'design intervention,' as an instrument for constructing anthropological knowledge of 'non-dominant' phenomenon such as inter-household energy exchange.

This research work utilizes theoretical perspective from economic anthropology to study the phenomenon of inter-household energy exchanges. The methodological approach followed in this research takes inspiration from discourses in the fields of design anthropology, research through design, and ethnography. As part of the methodological approach, a design intervention is designed, implemented, and investigated in a longitudinal multi-method study conducted at two off-grid villages in rural India for 11 months (1 February 2016 – 31 December 2016). The design intervention consisted of an installation of an off-grid energy distribution infrastructure to enable exchanges of solar-lighting in the villages. The design intervention allowed one household in each of the villages to be a giver for their respective village. The householders had complete control of the energy infrastructure installed and freedom to structure returns, as they desired without any involvement of the ethnographer. The research followed an iterative, emergent and explorative approach where the field observations shaped the research direction.

The main contributions of this research are presented in three chapters, *Conceiving Mutual Energy Exchanges*, *Exploring Peer-to-Peer Returns*, and *Envisioning Anthropology-through-Design*, in this dissertation. As a whole, this interdisciplinary research contributes to the fields of (a) energy studies and (b) design anthropology.

Conceiving Mutual Energy Exchanges: Chapter 2 defines 'mutual energy exchange' (MuEE) as a social and personal transaction of energy between an energy-giver and energy-receiver, which is mutually structured and negotiated. The word 'mutual' refers to the anthropological discourse of 'mutuality.' The ethnographic data analysis reveals two types of mutual energy exchanges: 'mutual energy sharing' and 'mutual energy trading.' The chapter defines a 'mutual energy sharing' as a social and personal energy exchange where an energy-giver and energy-receiver participate for the sake of social relationship between them. In contrast, 'mutual energy trading' is a social and personal energy exchange where an energy-giver and energy-receiver participate in a calculated exchange for the sake of a commensurate material or monetary gain. The chapter describes how different types of social relations and diverse cultural values influenced energy exchanges. The chapter shows that the 'mutual energy sharing' and 'mutual energy trading' are rooted in different moralities and ethical judgments, which are complex, diverse, some-

times conflicting and at other times converging. The chapter introduces a 'circle of mutual energy exchange' as a conceptual, analytical and descriptive unit for understanding such energy exchanges. It defines a 'circle of mutual energy exchange' as a conceptual arena for the social construction of a mutual energy exchange, which is modeled by social relations between energy-giver and energy-receiver and is constituted by diverse social and cultural values.

Exploring Peer-to-Peer Returns: Chapter 3 showcases a classification of returns consisting of three types, i.e., in-cash, in-kind, and intangible. In-cash return is a payment made by an energy-receiver to energy-giver for the energy provided in the form of currency notes and coins. In-kind return is a payment made by an energy-receiver to energy-giver for the energy provided in the form of a thing or work of economic value. Intangible return is a return in the form of unmeasured and unquantified social gestures and actions, such as goodwill or social support, made by an energy-receiver in favor of energy-giver for the energy provided. The chapter presents a sociocultural understanding of these returns utilizing four ethnographic vignettes. It demonstrates how people's preference for a type of return varies with the nature of their social relationships, i.e., their social connectedness with each other. The chapter proposes a conceptual model of 'return-continuum,' which advocates viewing all the three types of returns as a coexisting, overlapping, dynamic, and continuous spectrum of returns. The conceptual model recognizes that all the three types of returns have different values for people in different contexts of energy exchanges and acknowledges people's ability to use different types of returns simultaneously. In concluding, the chapter argues that configuring a return is not merely an economic act but a complex sociocultural process.

Envisioning Anthropology-through-Design: Chapter 4 defines Anthropology-through-Design (AtD) as a research approach that aims to generate anthropological knowledge about a social and cultural phenomenon through the use of a design intervention in the real world. The object of AtD inquiry is a 'non-dominant' sociocultural phenomenon that is not yet occurring in the social life of people, or is still in its nascent form with limited performances to be observed in the real world. 'Design intervention,' a vital engine of the proposed AtD approach, is grounded in the notion of providing material and conceptual space for such a sociocultural

phenomenon to take shape in situ or in other words to become observable for an anthropological inquiry. The chapter includes a description of AtD framework at an outline-level with four key phases, namely, framing, design intervening, emic understanding, and etic understanding, and the associated steps of each of the phases. The framework demonstrates how in the AtD approach, 'design' becomes an instrument of anthropology. Overall, the chapter serves to describe the knowledge generation in the AtD approach as a collaborative and intersubjective; reflexive and relational; and performative and dialogic process.

Overall, the research showcases that householders, when having choice and control in structuring inter-household energy exchanges, do not engage in energy exchanges using only utilitarian economistic logic as rational choice approaches describe. Instead, householders' structure and participate in energy exchanges by employing a range of social, cultural, moral and economic notions.

1

Introduction

1

1.1. ABOUT ENERGY EXCHANGES

'Exchange' is a universal and pervasive phenomenon [1, 2]. We all knowingly or unknowingly participate and experience various types of exchanges in our daily life. For instance, buying something from a grocery store, giving a gift to a friend, a university awarding an academic degree to a student, and using a car sharing service or Couchsurfing[1] are all common examples of exchange. Simultaneously, we also witness more complex forms of exchanges across societies, such as political lobbying, paying road and water taxes, tithing to a religious organization, informal caregiving, sharing of knowledge and skills, bribing, and stealing. Hence, it is not surprising that anthropologists consider exchange to be central to the social life of humans [1, 2]. Anthropology broadly describes 'exchange' as *'transfer of things between social actors,'* ([2]: 271) where 'things' include tangible materials; such as goods, commodities, living things, totems, and gifts; as well as various intangible entities such as knowledge, information, goodwill, spells, and labour [2–4]. Similarly, a participating 'social actor' (an exchanger) in an exchange can be individual, household, clan, group, state, as well as entities such as gods and spirits [2, 4, 5].

A new arena of exchange - energy exchanges between households - is opening up with the growth of renewable energy systems across the globe. A simple scenario of inter-household energy exchange is a household using their solar panels to provide energy to a household of a neighbor. Figure 1.1-a illustrates this scenario of an inter-household energy exchange by means of electricity network and cables. Some upcoming initiatives that are enabling such energy exchange are Jouliette[2] and Powerpeers[3] in The Netherlands, Brooklyn Micro-grid[4] in the USA, SOLShare[5] in Bangladesh, and Okra[6] in Cambodia.

Similarly, another trivial but relevant example of inter-household energy exchange is a household with solar panels in an off-grid village charges mobile phones and batteries of other villagers who do not have access to an electrical

[1] https://www.couchsurfing.com/
[2] https://spectral.energy/news/jouliette-at-deceuvel/
[3] https://www.powerpeers.nl/
[4] http://brooklynmicrogrid.com/
[5] https://www.me-solshare.com/
[6] http://www.okrasolar.com/

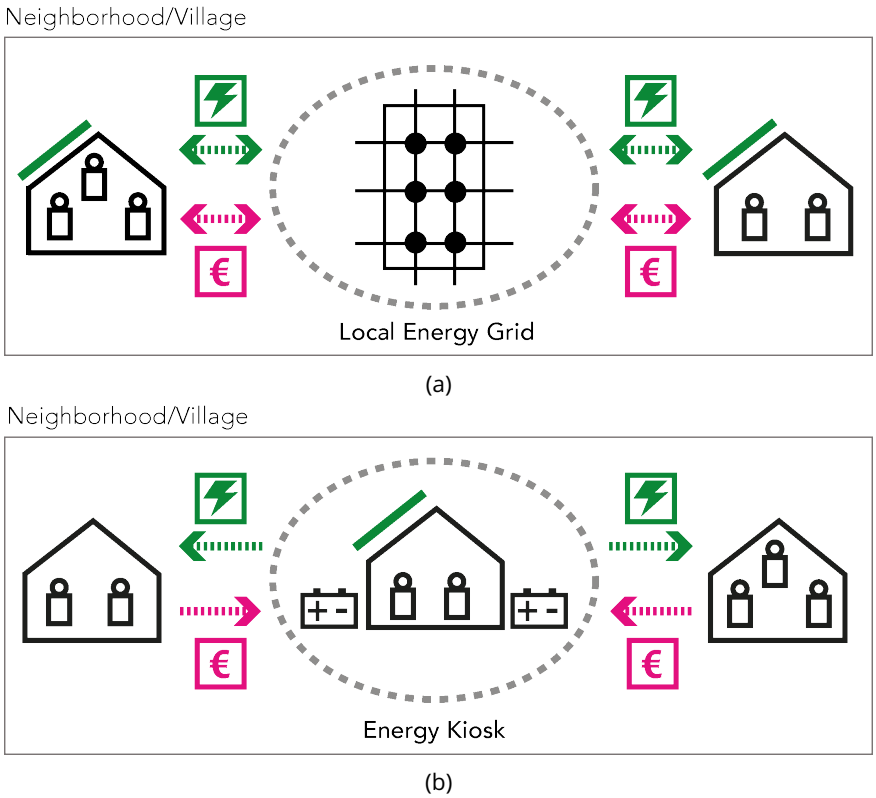

Figure 1.1: A representation of inter-household energy exchanges enabled by: (a) the energy grid and (b) energy storage devices.

energy source. Figure 1.1-b illustrates this scenario of an inter-household energy exchange by means of energy storage devices. Few initiatives that structure such energy exchanges are Ikisaya Energy Centre[7] in Kenya, Lighting a Billion Lives[8] initiative and Rural Spark[9] in India. These setups have been described in energy literature as 'Energy Centre Model' [6, 7], 'Centralized Charging Station Model' [8–11], 'Energy Kiosk Model' [10] and 'Energy Hub Model' [12].

This theme of inter-household energy exchanges is captivating interest of people, academia, governments, and businesses and appears under the guise of various labels, such as peer-to-peer energy [13–15], transactive energy [16–18], en-

[7] https://vimeo.com/57061330
[8] http://labl.teriin.org/
[9] http://www.ruralspark.com/

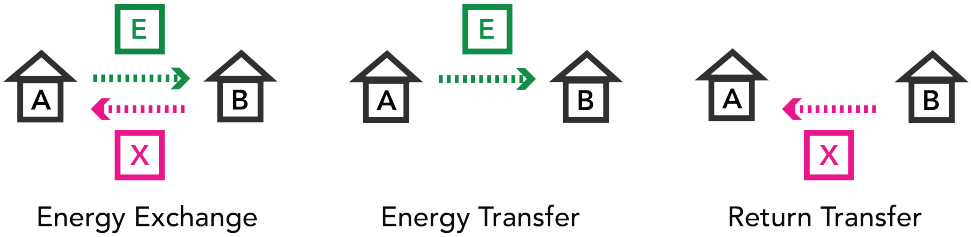

Figure 1.2: Conceptual diagrams of energy exchange, energy transfer, and return transfer.

ergy trading [19–21], energy sharing [22–24]. There are some common features of these emerging scenarios of decentralized, off-grid, and distributed energy systems. First, energy is locally produced through renewable sources such as solar PV. Second, the produced energy is locally exchanged and consumed within neighborhoods or villages. Third, a household as a social unit emerges as a focal site for energy production, consumption, and exchange. As compared to traditional 'centralized' energy provisioning system, in these emergent scenarios households acquire agency in local energy production, distribution, management, and (most crucially in context of this dissertation) in inter-household energy exchanges. For instance, households are imagined to take a more active role, where householders will have some more choice and control over local exchanges of energy between households (for instance, see [21, 22, 25–28]). This feature also indicates why 'household' is a relevant unit for inquiry on energy exchanges.

This dissertation investigates inter-household energy exchanges and describes it as *'a transaction of energy between an energy-giving household and an energy-receiving household'* ([29]: 103). Conceptually, an energy exchange could be viewed as consisting of two types of 'transfers': 'energy transfer' and 'return transfer' (see Figure 1.2). An 'energy transfer' is *a physical or figurative movement of energy units either through cables or storage devices such as batteries from an energy-giver (A) to an energy-receiver (B)* ([30]: 195). In contrast, a 'return transfer' or for brevity a 'return' is *a counter-movement of an entity X from the energy-receiver (B) to the energy-giver (A)* ([30]: 195). In energy literature, a 'return' is often discussed with money oriented terms such as 'rent,' 'payment,' 'tariff,' and 'fee.' For brevity in this dissertation, I use the label 'energy exchange' to refer to 'inter-household energy exchange'.

Similarly, 'energy-giving household' and 'energy-receiving household' are referred to as 'giver' and 'receiver' respectively.

1.2. KNOWLEDGE GAPS

This dissertation addresses five dominant views and associated knowledge gap in the energy literature. This section briefly describes these views and gaps.

1. *Vision of rational choice*: The current discussion on energy exchanges is mostly rooted in a techno-economic analysis built upon visions of rational choice theories (for this techno-economic analysis, see [9, 12, 31–34]). As a hallmark of the dominant rational choice perspective, householders engaging in an energy exchange are imagined as self-interested, calculating individuals, who strive for their profit maximization and are motivated by price incentives (for instance, see [22, 35–38]). In other words, a householder is considered to be *homo economicus* [39, 40], a rational 'economic man.' This rational view fails to explain the decisions of householders when they refrain from being self-interested or renounce making a monetary profit. Moreover, an emerging body of energy literature considers local, social, and cultural aspects of energy systems as crucial for their success and adoption by people [41–46]. However, the existing literature on energy exchanges lacks in focus on the sociocultural dimensions of energy exchanges, or in other words how energy exchanges are grounded in the social and cultural reality of people's everyday life. All the following points mentioned in this section are related to the rational choice vision of energy exchanges.

2. *Energy exchange limited to 'energy trading'*: In the existing energy literature, the concept of energy exchange is usually limited to the notion of 'energy trading' (for instance, see [19, 20, 24, 47, 48]). An energy trading can be described as *an impersonal, anonymous, and competitive buying and selling transaction of energy between an energy-giver and energy-receiver where price is determined by a self-regulating neoclassical market principle* [29]. An energy trading is realized when a household sells or buys a locally produced energy from the local

energy grid by participating in an energy market (see, e.g., [17,35,47]). The existing discussion on energy exchanges miss acknowledging the various distinct types of energy exchanges possible in the real world. Further, conceptualizing energy exchanges as energy trading limits the relationship between an energy-giver and an energy-receiver to that of a buyer and seller. However, in real-life various other types of relationships between an energy-giver and energy-receiver are possible. Overall, the energy studies lack discussion on the influence of social relations between the energy-giver and the energy-receiver on energy exchanges.

3. *Hegemony of market ideal*: A prominent common feature of energy exchanges as discussed in the energy literature is the mediating and pivotal role of markets. Here, 'market' indicates a structure for exchanges of commodities (goods and services) based on neoclassical market principle [29]. This market-centric understanding of energy exchange is discussed under various innovative labels, such as 'peer-to-peer energy exchange' [49], 'peer-to-peer presuming market' [22], 'neighbourhood-level energy trading' [19, 50], 'virtual net metering'[51], 'energy-eBay' [26], 'collaborative smart grid' [20], and 'consumer-centric smart grid' [21]. All these labels are largely based on simulation studies and lab-based prediction models built upon a vision of 'rational choice,' rather than based on empirical evidence from people's everyday social lives. Moreover, the contemporary understanding of energy exchanges presumes universal primacy of logic of market where the householders engage in competitive buying and selling of energy. The energy domain lacks a theoretical and conceptual discussion on non-market energy exchanges, such as social and personal energy exchanges that are structured without the mediating role of neoclassical market principles. For instance, energy exchange where a householder, bypassing an energy grid, uses his/her solar panels to provide energy to a neighbor.

4. *Preponderance of monetary returns*: The existing energy literature on returns is primarily limited to monetary returns, i.e., an energy-giver receives monetary benefits from the energy-receiver as a return for the energy units provided. For instance, in case of an energy exchange pilots, returns are discussed un-

der various labels such as 'rent,' 'payment,' 'fee-for-service,' and 'pay-as-you-go' indicating monetary nature of returns (for instance, see [41, 43, 52–55]). This preponderance of monetary returns is symptomatic of a rational vision that assumes householders' universal and exclusive preference for getting money as a return for energy provided. The existing energy scholarship on returns lacks a critical discussion on the different types of monetary and non-monetary returns possible. Further, critical reflection on (fiat) money as a return is mostly missing in the literature. Additionally, a people's potential preferences for different types of returns as part of energy exchanges have been overlooked.

5. *Value of efficiency, optimization, and maximization*: The ongoing discussion about energy exchanges locates the value of an energy exchange in ideas of efficiency, optimization of resources, and maximization of profit by balancing of energy surplus and deficit (for instance, see, [19–21, 56]). The existing studies on energy exchanges lack discussion on diverse social, cultural, moral, and ethical values that shape energy exchanges when householders get to decide with whom to exchange energy.

In general, the knowledge gaps listed above are necessary to be addressed for three main reasons. First, it helps in comprehending the complex sociocultural nature of energy exchanges. Second, it enables us to appreciate that there is more to energy exchanges than the dominant rational choice perspective of energy trading and helps energy researchers and practitioners to develop a more nuanced understanding of energy exchanges. If we keep developing energy exchanges platforms from a rational techno-economic perspective without a sociocultural understanding; we are likely to face long-term issues of social adoption and acceptance of energy exchange platforms by society at large. Third, knowledge addressing these gaps is crucial for designing and developing energy exchanges mechanisms that are more 'people-centered' or in other words mechanisms that correspond better with people's social, cultural, moral life and caters to people's preferences and choices. At the time of writing of this dissertation, most of the existing energy exchange pilots in the real world were observed to be small-scale test-beds, the large-scale

introduction, adoption, and acceptance of energy exchanges systems have yet to happen.

1.3. ECONOMIC ANTHROPOLOGICAL PERSPECTIVE

To address the crucial sociocultural knowledge gaps mentioned in the previous section and to move beyond the rational choice thinking of energy exchanges, this research engages with theoretical perspective from economic anthropology to study the phenomenon of inter-household energy exchanges. In this section, I provide an overview of economic anthropology and in the process presents the relevance of it for this research.

Economic anthropology is a sub-discipline of (social and cultural) anthropology. In a broad sense, economic anthropology is a study of people's economic life from an anthropological perspective [3]. There are two key dimensions to this definition: elements of 'economic life,' and embracing an 'anthropological perspective.'

An 'economic life' designates universal as well as locally specified '*activities [and practices] through which people produce, circulate and consume things*', and as also mentioned earlier 'things' include both materials as well as immaterial entities such as service, labor, knowledge, and goodwill ([3]: 4). Economic anthropology does not limit understanding of 'economic life' to people's participation in markets, which it considers to be one part of people's everyday economic life. Economic anthropology emphasizes and also gives theoretical attention to people's non-market economic participation [57, 58]. Some examples of non-market economic participation are neighbors sharing their food produce, strangers bartering and swapping things, people donating things for a cause, family members pooling resources within a household, and fishermen community self-regulating who gets to fish when and where. Correspondingly, many economic anthropologists are critical of the idea of 'utility maximization' as a universal determinant of people's behavior when they transact things with each other [1, 3, 57]. Overall, economic anthropology analyses people's economic choices, decisions, activities, and practices in the context of their social and cultural life, and in relation to aspects of societies they inhabit [3, 59].

The concept of exchange has been a critical topic of investigation in economic anthropology. Anthropologists have produced a wealth of conceptual and ethnographic texts on various types of exchanges, such as, trading, sharing, gifting, allocation, and barter that go beyond the rational choice perspective (see, e.g., [1, 39, 60]). It is worth mentioning that anthropologists have not written about the anthropology of energy exchanges. Probably, this is due to a dearth of real-world situations where the phenomenon of energy exchanges can be systematically observed and ethnographically investigated for an extended period. This limitation brings us to the significance of 'anthropological perspective' in the definition of economic anthropology. In an all-encompassing way, an 'anthropological perspective' refers to three general viewpoints in (social and cultural) anthropology:

1. The anthropological perspective is empirical, i.e., it grounds the knowledge creation about a phenomenon in empirical observation of people's lives in the real world setting [3]. Ethnography, often seen as the nucleus of anthropology, as a '*process of inquiry*' with methods of immersions in a social world, participant observation, and fieldwork enables anthropology to achieve its empirical goals [61, 62].

2. The anthropological perspective aims for a holistic, bottom-up, and embedded understanding of a phenomenon that starts by building and analyzing 'emic' (insider's or internal) viewpoints. The emic viewpoint is sometimes referred by, '*life as experienced and described by the members of a society themselves*' ([63]: 40). It acknowledges the co-existence of people's multiple realities, perceptions, and logics. (For more on 'emic' perspectives see [63–66]).

3. The anthropological perspective translates 'emic' understanding to 'etic' (external) concepts. The etic viewpoint is occasionally described as '*analytical descriptions or explanations of the researcher*' ([63]: 40). (For more on 'etic' perspective see [63–66]).

Overall, I found the domain of economic anthropology, with its anthropological perspective and comprehensive view of people's 'economic life' that goes beyond rational choice viewpoint, provides a relevant theoretical background for studying

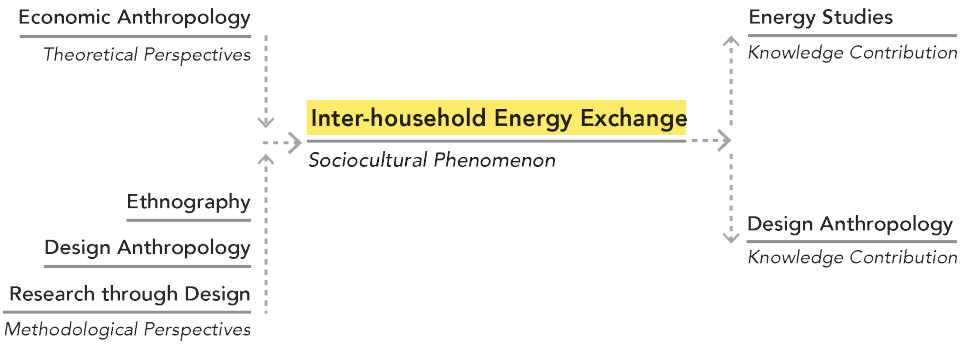

Figure 1.3: Interdisciplinary nature of this research.

sociocultural dimensions of energy exchanges.

1.4. METHODOLOGICAL PERSPECTIVE

The methodological approach followed in this research takes inspiration from discourses in the fields of design anthropology [67–69], research through design [70–72], and ethnography [61, 73, 74]. In this section, I sketch an overview of methodological perspectives followed in this research. For the overall interdisciplinary nature of this research see Figure 1.3.

As mentioned in the previous section, an anthropological perspective grounds the knowledge creation in empirical observation and field engagement with people in the real world. However, in the first three years of this doctoral research, there were hardly any real-world situations in India and The Netherlands, two potential geographical contexts for this research, where such energy exchanges could be systematically and longitudinally observed. The infrastructure for inter-household energy exchanges within neighborhoods or villages was still not available. Overall, this situation raised a challenging methodological question, i.e., how to anthropologically and ethnographically study a sociocultural phenomenon, such as inter-household energy exchange, which is 'non-dominant' in the real world. This research describes a 'non-dominant' phenomenon with the following characteristics: a phenomenon that is in its nascent form with limited or no performances to be observed in the real world, i.e., people are not yet engaging with and performing

the phenomenon in their everyday life. However, the technological, economic, and sociocultural trends indicate that the real-world occurrences of the phenomenon may become a reality or may get established in the near future. A 'non-dominant' phenomenon may be under-specified and in need of better conceptualization. Taking inspiration from the debates and discussion in research through design (RtD) and design anthropology (DA), this research decided to explore 'design intervention' as an engine of anthropological inquiry into the 'non-dominant' phenomenon of inter-household energy exchange.

1.5. RESEARCH OBJECTIVE

There are two goals of this dissertation:

1. To develop conceptual knowledge of inter-household energy exchanges by investigating the social and cultural embeddedness of energy exchanges in a system where householders can decide with whom to exchange locally produced energy.

2. To conceptualize a research approach that utilizes 'design,' more especially a 'design intervention,' as an instrument for constructing anthropological knowledge of 'non-dominant' phenomenon such as inter-household energy exchange.

1.6. RESEARCH QUESTIONS AND APPROACH

The main research question addressed by this thesis is:
Q1: How are energy exchanges between households, in a decentralized energy system where householders can decide with whom to exchange energy, related to the social, cultural, and economic life of the householders?

The main research question (Q1) is further divided into the following sub-questions:
Q1.1: What types of energy exchanges between households emerge when householders are given control of an off-grid energy distribution infrastructure?
Q1.2: How are social relations between energy-givers and energy-receivers at work

in the energy exchanges between households?
Q1.3: What values energy-givers and energy-receivers invoke in the energy exchanges?
Q1.4: What types of returns energy-givers and energy-receivers invoke when they are given control of an off-grid energy distribution infrastructure?
Q1.5: How are these returns related to the social, cultural, and economic life of people?

This research addresses the following key methodological question:
Q2: How can anthropological knowledge about a 'non-dominant' phenomenon, such as inter-household energy exchange, be generated using a design intervention?

To investigate inter-household energy exchanges, a 'non-dominant' phenomenon, a design intervention is designed, implemented, and investigated in a longitudinal multi-method study conducted at two off-grid villages, Rampur and Manpur, in rural India for 11 months (1 February 2016 – 31 December 2016)[10]. The design intervention consisted of an installation of an off-grid energy distribution infrastructure to enable exchanges of solar-lighting in the villages. The design intervention allowed one household in each of the villages to be a giver for their respective village. The householders had complete control of the energy infrastructure installed and freedom to structure returns, as they desired without any involvement of the ethnographer. It is worthwhile to remind the reader that this dissertation is a study of the phenomenon of inter-household energy exchanges in general and is not a study on '*how energy exchanges happen in India*.' This distinction will become more evident in Chapter 2 and Chapter 3. Apart from this longitudinal study, during the initial phase of the doctoral trajectory, I was involved in many shorter studies in The Netherlands and India. Even though these shorter studies are not presented and discussed in the dissertation, these engagements were critical for identifying the requirements for conducting an economic anthropological inquiry on inter-household energy exchanges (details provided in Chapter 4). These studies introduced me to the potential sociocultural knowledge gaps be-

[10] Please note that the real names of villages and all the participants have been changed for the purpose of anonymity.

tween existing knowledge on energy exchanges and real-world situation. Overall, these helped me in framing the research questions and identifying research direction.

1.7. AUDIENCE OF THIS RESEARCH

This dissertation addresses two distinct audience-groups. The first audience-group comprises of energy researchers and practitioners who are interested in the topic of inter-household energy exchanges. The second audience-group consists of design anthropologists, design researchers, and designers who are particularly curious about ways 'design' can facilitate construction of anthropological knowledge or in general about design anthropology.

As indicated in Figure 1.3, this interdisciplinary research makes knowledge contribution to the fields of (a) energy studies and (b) design anthropology. Primarily, the knowledge generated in this research has been disseminated in the form of two published journal articles; one journal manuscript that is under review at the time of printing of this dissertation; two short conference papers; and an interactive visualization that has been exhibited at Mind the Step exhibition at Dutch Design Week 2017[11] (see Appendix-A for screenshots of the visualization). Knowledge dissemination in relation to this doctoral research was also enabled via many presentations and talks to a broad academic and industrial audience.

1.8. PROJECT CONTEXT

This doctoral research was conducted as a collaboration between Faculty of Industrial Design Engineering (IDE) at Delft University of Technology (TU Delft) and Serious Gaming Research Group at NHL Stenden University of Applied Sciences, Leeuwarden. Both of these academic institutions are located in The Netherlands, and this Ph.D. research forms part of a research programme of the University Campus Fryslân (UCF), which is financed by the province of Fryslân in the Netherlands.

[11] http://www.mindthestep.nl/mind-the-step-2017.html

Due to the interdisciplinary nature of this research, I consider relevant for a reader to be aware of my academic background as it puts this research and its output in an appropriate context. My formal educational and professional experience is in design and engineering with bachelor's in Information and Communication Technology (India) and master's in New Media Design (Finland). As part of my doctoral education, for the last three years, I have been involved in anthropology related courses as well as engaged in detailed discussions, feedback and supervision by Dr. Alex T. Strating, an economic anthropologist from the University of Amsterdam. Before the start of this Ph.D. research, I began self-educating myself in ethnographic approaches. This self-education has included attending seminars on anthropology, discussions with trained anthropologists, and conducting design ethnographic field-studies (see, for instance, [75–82]).

1.9. THESIS OUTLINE

The section presents the structure of the thesis. See Figure 1.4.

Chapter 2, '*Conceiving Mutual Energy Exchanges*,' conceptualizes social and personal exchanges of energy between households that are mutually structured and negotiated. It addresses three (sub) research questions of this dissertation: Q1.1 (What types of energy exchanges between households emerge when householders are given control of an off-grid energy distribution infrastructure?), Q1.2 (How are social relations between energy-givers and energy-receivers at work in the energy exchanges between households?), and Q1.3 (What values energy-givers and energy-receivers invoke in the energy exchanges?). The chapter is based on the ethnographic data collected at Rampur village, one of the field-sites, for the initial three months of the field research. The chapter builds upon and extends the theoretical work by Stephen Gudeman, an economic anthropologist, to conceptually discuss inter-household energy exchanges that emerged during the study. The chapter describes how social relations and diverse cultural values influence on inter-household energy exchanges. The chapter describes two co-existing and dialectically connected modes of energy exchanges: 'mutual energy sharing' and 'mutual energy trading.' Further, the chapter introduces the 'circle of mutual en-

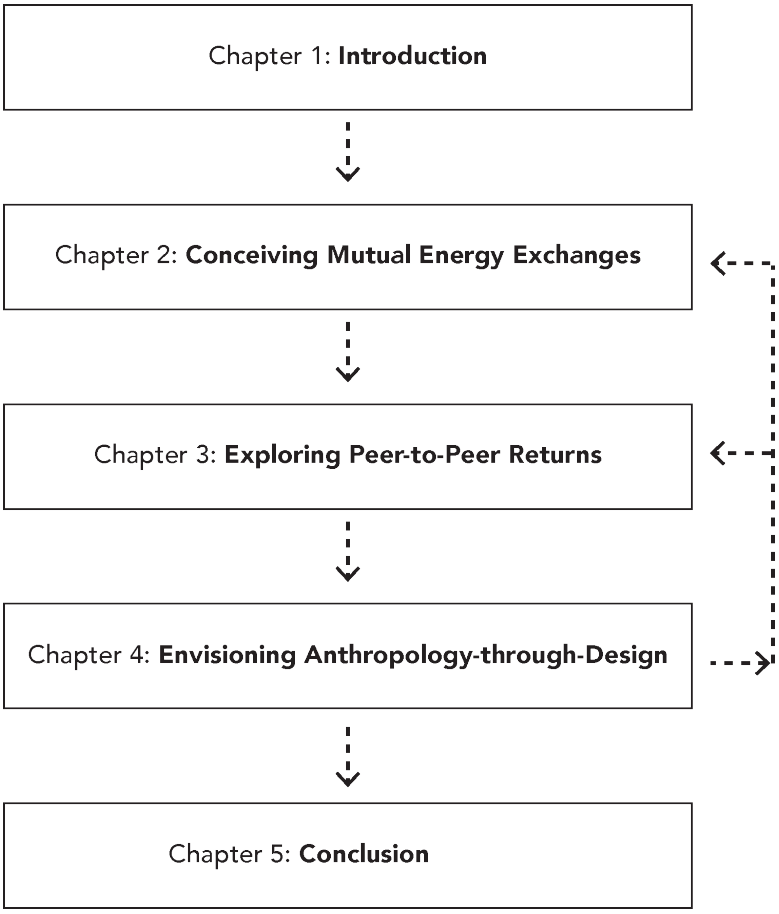

Figure 1.4: Thesis Outline.

ergy exchange' as a conceptual, analytical and descriptive unit for understanding such energy exchanges. Chapter 2 in its entirety is a published article in the journal Energy Research and Social Science.

Chapter 3, '*Exploring Peer-to-Peer Returns*,' focuses on the conceptualization of returns that are constituents of inter-household energy exchanges. It addresses two (sub) research questions of this dissertation: Q1.4 (What types of returns energy-givers and energy-receivers invoke when they are given control of an off-grid energy distribution infrastructure?) and Q1.5 (How are these returns embedded in the social, cultural, and economic life of the villagers?). This chapter is based

on the ethnographic data collected at Rampur and Manpur villages for the eleven months of the field research. The chapter showcases a classification of returns consisting of three types, i.e., in-cash, in-kind and intangible. It presents a sociocultural understanding of returns and demonstrates various limitations of fiat money as a return. The chapter, utilizing four ethnographic vignettes, demonstrates how people's preference for a type of return varies with the nature of their social relationships with each other. The chapter proposes a conceptual model of 'return-continuum,' and it connects the types of returns with the modes of energy exchanges described in Chapter 2. Overall, the chapter argues that configuring a return is not merely an economic act but a complex sociocultural process. Chapter 3 in its entirety is a published article in the journal Energy Research and Social Science.

Chapter 4, '*Envisioning Anthropology-through-design*,' proposes an anthropology-through-design (AtD) approach that aims to generate anthropological knowledge about a 'non-dominant' sociocultural phenomenon through a design intervention. It addresses the primary methodological question Q2 (How can anthropological knowledge about inter-household energy exchanges, a 'non-dominant' phenomenon, be generated using a design intervention?) of this dissertation. The chapter provides details of the four key phases of the AtD process: framing, design intervening, emic understanding, and etic understanding, and associated steps of each of the phases. It demonstrates how in the AtD approach, 'design' becomes an instrument of anthropology. Overall, the chapter describes the knowledge generation in the AtD approach as a collaborative and intersubjective; reflexive and relational; and performative and dialogic process. At the time of printing of this dissertation, Chapter 4 is under review for publication in a design journal.

Finally, Chapter 5 provides a general conclusion of this research. The chapter presents a reflection on the limitations of this research, potential themes for future research, and an overall contribution of this dissertation.

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2

Conceiving Mutual Energy Exchanges

Many energy researchers and practitioners envision householders to have an active role in local energy distribution in emerging energy systems. In the energy literature, the dominant view of local energy distribution, grounded in the rational choice perspective, sees exchanges of energy between households as energy trading. The existing energy literature lacks conceptualization of social and personal exchange of energy between households that is mutually structured and negotiated. This chapter builds on the theoretical works of an economic anthropologist, Stephen Gudeman, to conceptually discuss such energy exchanges. This chapter reports from an 'ethnographic intervention' study conducted at an off-grid village in rural India for three months (1 February–30 April 2016). The ethnographic data analysis reveals how social relations and diverse cultural values influence on energy exchanges between households in the village. The chapter introduces 'circle of mutual energy exchange' as a conceptual, analytical and descriptive unit for understanding such energy exchanges. The chapter describes two co-existing and dialectically connected modes of energy exchanges: 'mutual energy sharing' and 'mutual energy trading.'

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2.1. INTRODUCTION

Across the globe, with the increasing adoption of renewable energy technologies, many energy researchers and practitioners envision electrical energy provisioning systems go through a systemic shift towards distributed, decentralized or off-grid energy systems [2–6]. Two key features are central to this shift: first, energy is locally produced, stored, distributed and consumed. In the energy literature, this is also referred to as micro-generation [7, 8] or small-scale energy generation [9]. Second, householders are considered as active participants in local energy management [2, 10–13]. Many energy scholars envision these energy systems to become more social where householders acquire diverse, active roles not just in energy production and consumption but also in local energy distribution [2–4, 14, 15]. They expect that energy distribution scenarios in the near future will enable householders to choose with whom to exchange locally produced energy [2–4, 16–18]. This kind of engagement of householders in local energy distribution enables energy exchanges. This chapter refers to an 'energy exchange' as *a transaction or an exchange of energy between an energy-giver and energy-receiver*. Technically, there are several ways an energy exchange can take place: one of the means is by use of electricity network and cables. Some upcoming initiatives that are enabling such energy exchange are: Vandebron[1] in The Netherlands, Brooklyn Micro-grid[2] in USA and SOLShare[3] in Bangladesh. Another way for an energy exchange to take place is by use of energy storage devices. Few initiatives that structure such energy exchanges are Ikisaya Energy Centre[4] in Kenya, Lighting a Billion Lives[5] initiative and Rural Spark[6] in India.

In the emerging body of energy literature, 'energy trading,' a particular type of energy exchange, is widely considered to be an innovative approach to incentivize and actively engage householders in energy systems (see, for energy trading, [6, 10, 11, 19, 20]). This energy-trading or market-centric approach for energy exchange is

[1] https://vandebron.nl/
[2] http://brooklynmicrogrid.com/
[3] https://www.me-solshare.com/
[4] https://vimeo.com/57061330
[5] http://labl.teriin.org/
[6] http://www.ruralspark.com/

discussed under various innovative labels, such as 'peer-to-peer energy exchange' [14], 'peer-to-peer prosuming market' [3], 'neighbourhood-level energy trading' [6, 21], 'virtual net metering' [22], 'energy-eBay' [16], 'collaborative smart grid' [10], and 'consumer-centric smart grid' [2]. All these labels are mostly based on simulation studies and lab-based prediction models (e.g. [6, 14, 17, 23]), which are built upon a vision of rational choice, rather than based on empirical evidence from people's everyday social lives.

An energy trading is realized when a household sells (or buys) a surplus of locally produced energy either to (or from) the local grid by use of an energy market (see, e.g., [11, 20, 24]). Here, the term 'market' indicates a structure for exchanges of commodities (goods and services) based on neoclassical market principles. Within the dominant rational choice perspective, householders engaging in an energy exchange are viewed as self-interested individuals, motivated by price incentives, aiming to maximize their monetary profit and minimize household expenses [3, 5, 7, 11, 24–26]. This prevailing view limits the relationship between energy-giver and energy-receiver to that of a buyer and seller. Furthermore, this rational perspective universally locates the value of energy exchange in ideas of efficiency and optimization of resources, and maximization of financial benefits by balancing of energy surplus and deficit (see, e.g. [2, 5, 6, 10, 23]). This rational choice lens heavily dominates the concept of energy exchange and limits its meaning to energy trading. This chapter describes this dominant notion of an 'energy trading' or a 'market energy exchange' (MaEE) as *an impersonal, anonymous, and competitive buying and selling transaction of energy between an energy-giver and energy-receiver where price is determined by self-regulating neoclassical market principles*. Such energy trading is formalized, regulated and structured by the mediation of utilities and regulatory bodies. Usually, an energy trading is monetary such that a householder selling energy receives monetary benefits in return. Overall, there appears to be a lack of understanding in energy literature on the influence of social relations between energy-giver and energy-receiver on energy exchanges; and diverse local cultural, moral, and ethical values that shape energy exchanges. This understanding is a needed to comprehend the complex social nature of local energy distribution and to appreciate that there is more to energy exchanges than the

dominant rational choice perspective of energy trading.

The existing literature on local energy distribution lacks conceptual understanding of 'mutual energy exchange' (MuEE), which this chapter describes as *a social and personal transaction of energy between an energy-giver and energy-receiver, which is mutually structured and negotiated*. The word 'mutual' is in reference to the anthropological discourse of 'mutuality'. Mutuality refers to people's ability to socially associate with others, form relationships and live life through these social ties [27]. The notion of 'mutuality' is crucial in this context as it provides a conceptual lens to transcend the purview of rational choice and to support research on how energy exchanges are socially and culturally embedded, which is one of the key arguments of this chapter. When two householders configure an energy transaction between them, they structure a mutual energy exchange. An example of mutual energy exchange: a person, bypassing an energy grid, uses his/her solar panels to provide energy to a household of a neighbor. Another trivial but relevant example of a mutual energy exchange: in an off-grid village, a household with solar installation charges mobile phones and batteries of other villagers who do not have access to this energy source. In contrast with energy trading, a mutual energy exchange is informal, unregulated, mutually structured by an energy-giver and energy-receiver, and could include both monetary and non-monetary benefits. Some empirical evidence on mutual energy exchanges is visible in the academic literature on off-grid solar-lighting projects in 'developing' countries (see, e.g., [28–32]). This literature reports on an interesting setup that enables some types of mutual energy exchanges: in an off-grid village where a solar powered centralized charging location charges mobile phones and batteries of other villagers who do not have access to an energy source [28–32]. This chapter is based on a similar setup in rural India. Ulsrud et al. [28] note that research on centralized charging systems have been limited to techno-economic perspectives and they have called for greater focus on sociocultural dimensions. In general, such energy systems and rental models have been investigated on a range of issues such as sustainability, energy access, financial viability and scalability, energy poverty alleviation, socio-technical change, development, governance and rural electrification (see, e.g., [28, 29, 31–36]). All these issues are vital; however, there is another dimension of exchange (of energy) that

requires research attention, i.e. how such energy exchanges with the local community are socially and culturally embedded.

This study started with an installation of a small-scale and off-grid energy distribution infrastructure to enable exchanges of solar-lighting in a village in India. The infrastructure was installed at a volunteering household in the village, and the household was given complete control to manage the energy distribution. The installation enabled us to conduct an ethnographic inquiry to address three key research questions: (a) how are social relations at work in energy exchanges between households? (b) what energy exchanges between households emerge with the use of the installation? (c) what values are invoked in the energy exchanges between the households?

Based on a comprehensive survey, Sovacool ([37]: 26) states, *'Energy production, distribution, and consumption all have both technical and human components... Energy analysis therefore needs to look beyond the dimensions of technology and economics to include these social and human elements'* and invites energy researchers to engage with anthropology and investigate cultural specific engagement of people with energy systems. The domain of economic anthropology is relevant for studying sociocultural dimensions of energy exchanges as it has highly developed scholarship on a broad range of exchange concepts such as gifting, barter, trading, and sharing (see, e.g., [38–40]). This chapter builds on theoretical works of an economic anthropologist, Stephen Gudeman, to conceptually discuss the mutual energy exchanges. This chapter brings attention to energy exchanges as a subject of inquiry. To our knowledge, energy exchanges between households have not yet been investigated from an economic anthropological perspective. The chapter introduces *'circle of mutual energy exchange'* as a conceptual, analytical and descriptive unit for understanding the mutual energy exchanges. Based on ethnographic data analysis, the chapter describes two co-existing and dialectically connected modes of mutual energy exchanges: *mutual energy sharing* and *mutually energy trading*.

The remaining part of this chapter is organized as follows. Section 2.2 introduces the theoretical background of this chapter. Section 2.3 describes the field setting of the study. Section 2.4 presents the research design and methods uti-

lized. Section 2.5 showcases the analysis of ethnographic data, and this is followed by an extended discussion and conclusion of the findings in Section 2.6.

2.2. Theoretical background

2.2.1. Dialectic in economy

Taking support from various ethnographic studies, economic anthropologist, Stephen Gudeman [27, 41, 42] argues that across cultures, people acquire and distribute goods and services using two dialectically connected strategies. The first one is described as 'market realm' of an economy where self-interest is exalted, in which Gudeman highlights how *'in part, individuals live from the competitive trade of goods, services, and money that are separated or alienated from enduring relationships. People exchange with others to transform or substitute what they have for something else'* ([42]:4). Self-interest refers to an individual's ability to focus on the personal gain by calculating a means to an end [27]. The second part of the dialectic is described as *'mutual realm'* of an economy where *'mutuality'* or social relations are paramount, where Gudeman argues that *'people also live from goods and services that make, mediate, and maintain social relationships. Through mutuality or community things and services are secured and allocated, by means of continuing ties'* ([42]:5). As already mentioned in Introduction of this chapter, mutuality refers to people's ability to socially associate with others, form relationships and live life through these social ties [27]. Gudeman reasons that mutuality takes prominence in the household and community life of people, i.e. in a mutual realm of economy. He adds that mutuality is less visible but has a presence in market engagements of people, i.e. in a market realm of economy. Gudeman([27]:10) indicates relevance of mutuality in a market realm when he writes, *'economic transactions are contained within larger social commitments that they use and subvert, and are influenced by sociality on the small scale.'* Gudeman states that between the dialectic of mutuality and self-interest exists an innate tension that is fundamental to all economies. People secure their living by employing both the realms, but the significance of each side is dynamic, fluid and varies with time and contexts [27]. The dialectical con-

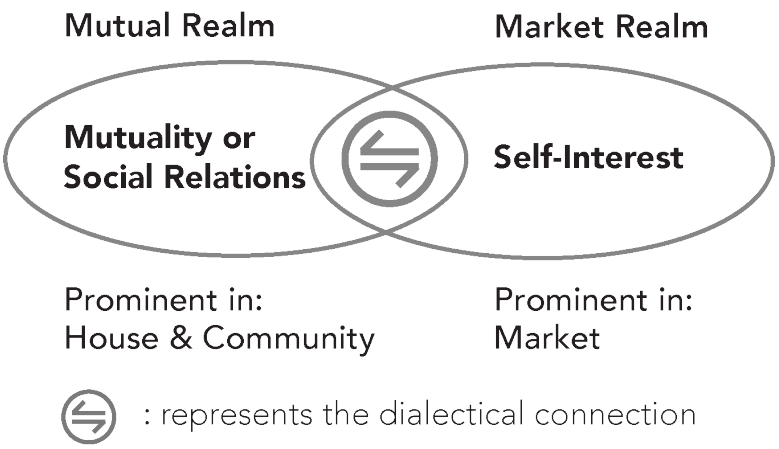

Figure 2.1: Dialectic in economy based on Gudeman [27, 41, 42].

nection highlights a unique feature of these two realms of an economy: each side depends on the other while at the same time they oppose, overlap and repel each other [27, 41, 42]. See Figure 2.1.

This chapter builds upon the Gudeman's conceptualization of dialectic in an economy and focuses on the mutual realm (household and community) of energy exchanges (see Figure 2.2 for a classification of energy exchanges). The following sub-sections describe how the dialectic reflects in (a) exchanges (b) social relations, and (c) values.

2.2.2. EXCHANGES

Gudeman [41, 42] informs that exchanges of goods and services in a mutual realm are different from a market realm. The principle mode of exchange in a market realm is trading [41, 42]. In contrast, he describes exchanges in a mutual realm as 'sharing' [27, 41, 42]. He delineates sharing as a non-market process of allocation of tangible entities, such as resources and equipment, as well as intangibles, such as knowledge and skills to other [27, 41, 42]. The significance of mutuality differentiates sharing from trading. Sharing creates mutuality [41] and is a process of *'making and maintaining community'* ([42]:86). He criticizes market-centric of many economists for overlooking non-market exchanges, such as sharing [27]. Gudeman

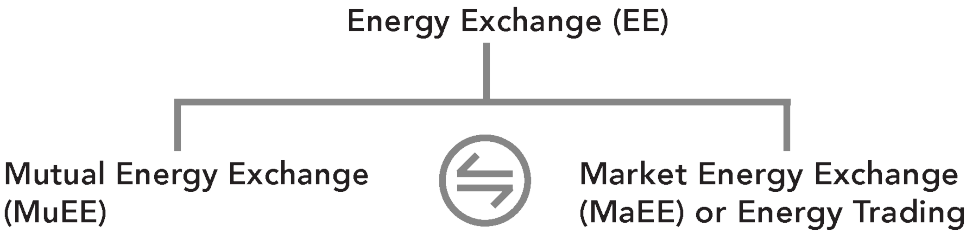

Figure 2.2: A classification of energy exchange.

and other scholars forewarn that sharing should not be confused and conceptually limited to notions of generosity or altruism [27, 43, 44].

2.2.3. SOCIAL RELATIONS

Gudeman [27] states that a mutual realm consists of diverse types of social relations that could be based on kinship, ethnicity, religion, nationality or other ideas. These social relationships are dynamic, vary with time, change in their significance, some can be perpetual (such as kinship bonds), while others can be short-lived associations to tackle a common problem [41]. Gudeman explains differences between social relationships in the market and mutual realm as *'the market realm revolves about short-term material relationships that are undertaken for the sake of achieving a project or securing a good. In the communal [or mutual] realm, material goods are exchanged through relationships kept for their own sake'* ([42]:10). The material life in the mutual realm is established and sustained through enduring social relationships [27].

2.2.4. VALUES

Gudeman describes mutual and market realms as two distinct 'value contexts' [42] or 'value domains' [27]. In the market realm, efficiency in distribution and rational choice takes prominence [41]. The exchanges in the market realm are valued for utility maximization and profit generation [42]. Here, the value is commensurable and is often measured against the scale of money [42, 45]. A mutual realm comprises of heterogeneous values that are anchored and defined in local cultural

contexts and social situations [41, 42]. He describes a mutual realm as consisting of diverse values that are not measurable and are incommensurable [41, 42].

2.3. THE FIELD SITE

This chapter is based on field research conducted at Rampur[7] village, an un-electrified village, located in Bodhgaya block, Gaya district of Bihar state in India. Bihar is a federal state located in eastern part of India with a large rural population. For decades, the state struggled with poor public infrastructure, high corruption levels, and violent insurgency by the extreme-left Naxalite movement [46, 47]. Since the first decade of the twenty-first century, the state has made noticeable progress on many of these fronts, but still, a lot of ground is yet to be covered. Gaya is the fifth largest district of Bihar with a population of 4.39 million persons [48].

Rampur is around 15 km away from the city center of Gaya and comprises of around 200 households. A joint family group residing within a house is very common in Rampur. Such joint family group consists of patrilineal kin, i.e. membership of the group is based on patrilineal descent. The rule of residence is patrilocal, i.e. after marriage, the wife leaves her family and goes to live with her husband and his patrilineal kin. This prevalence of patrilocality makes her very dependent on acceptance or goodwill of her in-laws. All the inhabitants of Rampur are Hindu by religion. The caste hierarchy is an important aspect of Indian social structure and plays a significant role in everyday life of Rampur. Manjhi, Ravidas, and Yadav caste groups form the majority of the population in Rampur. Manjhi and Ravidas caste groups belong to the lowest caste. As a socio-political unit, they both define themselves as 'Dalit' ('oppressed') highlighting the social discrimination they have suffered due to untouchability practiced by non-Dalit castes. Recognizing them as a historically disadvantageous group, they are listed in the 'Scheduled Caste' (SC) category of the Indian Constitution. Manjhis are the economically poorest group in Rampur. The Manjhi and Ravidas households do not own any agricultural land. In contrast to the Manjhi and Ravidas caste groups, Yadav is a non-Dalit caste and

[7] Name of the village and key informants have been changed in this chapter for the purpose of anonymity.

hold a higher caste status as landowners and peasants.

Rampur does not receive any electricity supply from the centralized electricity grid. As per Indian Government's Rural Electrification Corporation's (REC) data[8] of February 2017, in Gaya district, there are only 35.01% of rural households that are electrified with 1707 villages that electrified less than 50%. The villagers rely on Kerosene oil for various purposes: it is used in a traditional lamp ('dhibri') as a primary source for lighting; it is also utilized for burning woods, cow-dung cakes, and twigs for cooking. Thirty households report having small solar panels (4W-40W) installed. Out of this total, fourteen solar panels belong to Ravidas households, four panels to Manjhi households, and ten panels to Yadav households. All of these solar panels are 'privately' owned by the households. These solar panels are used primarily for basic home lighting and are used to power CFL bulbs mounted on walls in households. Other uses of solar panels are charging of mobile phones and to power small music players. Some forms of energy exchanges using the existing solar installations can already be observed in the village. For instance, a person from a household without solar panel charges his/her mobile phone at a neighboring household. On most occasions, this 'informal' service is offered for 'free,' but in some extreme cases householders report to ask for a 'charging fee.' The villagers highly value lighting and cell phone charging practices. Many ubiquitous devices visible in urban Gaya such as television sets and electric fans are absent from the landscape of Rampur. Rampur is close to various retail and wholesale marketplaces. Market-based trading, i.e. buying-selling of goods are part of an everyday experience for the villagers. The village also hosts a few shops that sell small items for daily use.

2.4. RESEARCH DESIGN AND METHODS

This interdisciplinary research combines ethnography with design research activities [49] and is situated in the emerging field of 'design anthropology' [50]. The research approach consists of an 'intervention' where a technical infrastructure is introduced into a social space as a precursor to an ethnographic investigation

[8] http://garv.gov.in/garv2/dashboard/main

on people's use of the infrastructure. This technique also appears in literature as 'ethnography by design' [51] and 'research-through-design' [52]. The first author of this chapter was the ethnographer in the field research. A solar energy expert, who has been working in the villages of Gaya for past four years, volunteered in the field-study as a research assistant.

2.4.1. 'INTERVENTION'

The overall aim of the 'intervention' was to enable a research setup for ethnographic investigation. The field engagement started with visits to many un-electrified villages in the Gaya district. Rampur was selected as the field-site as it fulfilled the following pre-identified criteria: (a) Rampur was un-electrified; (b) the villagers had experience with solar technology and desired better solar lighting solutions; (c) Rampur had a heterogeneous mix of population belonging to different castes; (d) physical access to Rampur was not too difficult; (e) it was feasible for the ethnographer to stay in the village for extended period; and (f) a household in the village was willing to volunteer as a 'giver ' for the study and had formed a rapport with the ethnographer that made collecting rich ethnographic data possible. The 'intervention' comprised of an installation of a small-scale energy distribution infrastructure consisting of solar lanterns, power-banks, LED bulbs, solar panel, and energy routers at the household of the giver (see Table 2.1 and Figure 2.3). This infrastructure facilitated exchanges of 'solar-items', i.e. solar lanterns, LED bulbs and power banks, in the village. Each solar-item was imprinted with a unique numeric code to facilitate tracking of energy exchanges (see Table 2.1). In total, thirty-three solar-items, i.e. fourteen LED bulbs with power banks and nineteen solar lanterns were available for use and exchange. The total cost of the energy distribution infrastructure was 40,000 Indian Rupees (INR) (around 560€). Some of the key criteria for selecting a giver for this study were: (a) skills, experience and comfort with managing solar-based equipment; (b) social relations with different castes at Rampur; (c) ability to write and maintain records (necessary for self-reporting diary, see 2.4.2); (d) willingness and motivation to become the giver; and (e) possibility and ease of communication with the ethnographer.

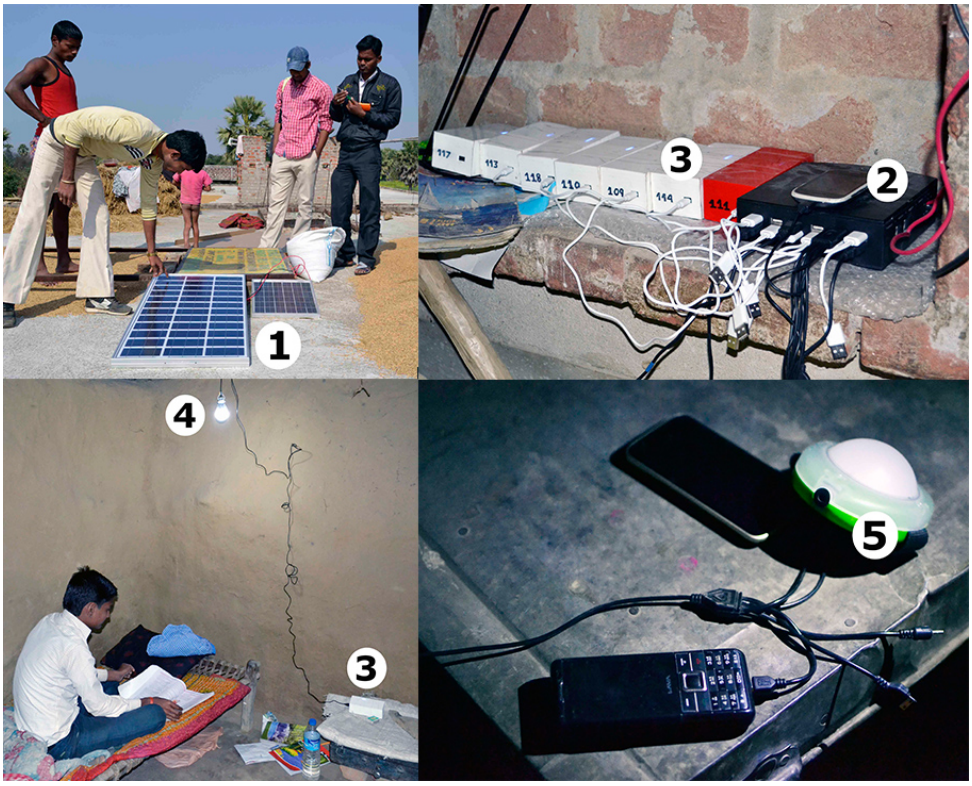

Figure 2.3: Energy Distribution Infrastructure. Note the labels: '1': Solar Panel; '2': Energy Router; '3': Power banks; '4': LED Bulb; '5': Solar Lantern.

A strategic decision for the research setup was to provide the giver ownership and complete control of the energy distribution infrastructure but without asking the giver to make a financial payment for the infrastructure. By setting up the 'intervention' like this, the authors felt it will provide most room for the giver to act according to their social, cultural, moral, and ethical values without the pressure of making the setup financially sustainable. As this research focused on investigating the underlying social, cultural and moral logic of energy exchanges that emerged, not asking for payment for the infrastructure was a crucial choice. Even though readers of this chapter may consider this choice as a bias or limitation of the study, it gave the ethnographer a better understanding of the underlying logic of the energy exchanges. It is typical for village-level centralized charging setups for rural lighting/electrification that the cost of installation is paid by an 'external' agency

Table 2.1: Key Components of Off-Grid Energy Distribution Infrastructure for Solar Lighting.

Item	Quantity	Comments
Power Banks	14	These portable power banks provide 5Volts Direct Current (DC) current output to two Universal Serial Bus (USB) ports, which can be used to power a LED light (below) and/or charge a mobile phone. Each power bank was assigned a unique three digits numeric code with the first digit of '1'(e.g., 100, 101, 102...).
LED Bulbs	14	These are bulb shaped 3W LED lights that work only when connected to the power banks as these lights do not have battery components. Each LED Bulb was given a unique three digits numeric code with the first digit of '2' (e.g., 200, 201, 202...).
Solar Lanterns	19	These are rechargeable LED lights. The difference between a LED bulb (above) and the solar lantern is that a solar lantern is fitted with a battery and hence does not require connection with power bank to function. Each Solar Lantern was given a unique three digits numeric code with the first digit of '3' (e.g., 300, 301, 302...).
Solar Panel (75W)	1	To charge the solar lanterns and the power banks.
Energy Routers	2	An interface between the solar panel and the chargeable items (solar lanterns and power banks).

(NGO, local governments) and the villagers only pay for the cost of operation and maintenance [28, 31, 32].

2.4.2. ETHNOGRAPHY

This research's engagement with ethnography comes close to O'Reilly ([53]:3) description of ethnography as, *'iterative-inductive research (that evolves in design through the study), drawing on a family of methods, involving direct and sustained contact with human agents, within the context of their daily lives (and cultures).'* Similarly, this research followed an iterative, emergent and explorative approach where the field observations shaped the research direction. To investigate social relations in

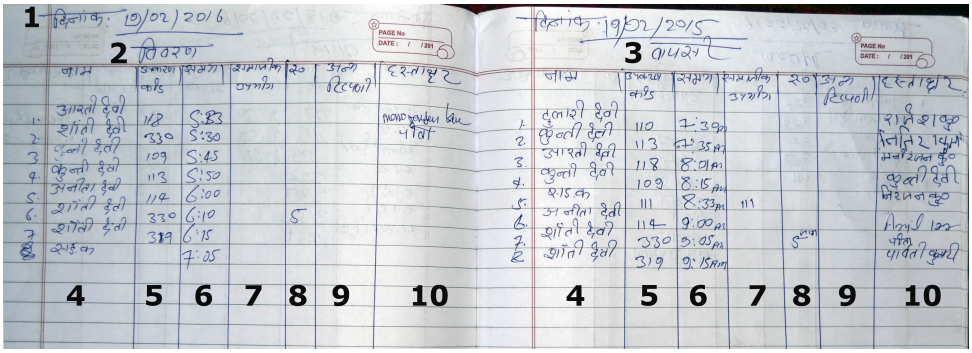

Figure 2.4: A sample of diary entry documenting exchanges of lights on 19-Feb-2016. Note the labels for information documented: 1: 'date'; 2: 'distribution'; 3: 'return'; 4: 'name'; 5: 'item-code'; 6: 'time'; 7: 'social use'; 8: 'rent'; 9: 'any comment'; 10: 'signature.'

energy exchanges, a research approach of 'personal network research,' which is a type of 'ethnographic network mapping' was adopted [54]. The 'personal network research' centers on 'index' or 'focal' individuals and explores their social network using a range of ethnographic methods.

Observations, Interviews, and Conversations

Following the 'installation,' the first author acquired a role of a participant observer. In this case 'participant observation' [55] consisted of direct and indirect observations by participation in the daily life of the villagers. The interviews and discussions ranged from semi-structured interviews [56], unstructured group discussions, casual chats and conversations [57] with villagers. When given consent by the informants, these interviews and conversations were audio recorded. Field-notes [58] were maintained throughout the field study. The field-study also included discussions with renewable energy officials working in Gaya.

Self-reporting diary

A self-reporting diary was provided to the giver to document information about each energy exchange. See Figure 2.4 for the various attributes documented. The diaries are considered beneficial for triangulation [59, 60]. The diary entries were discussed and cross-checked during interviews with the giver and receiver.

2.4.3. QUALITATIVE DATA ANALYSIS

The ethnographic field study was accompanied by an in-depth qualitative data analysis of the field-notes, diary entries, and interview transcripts. NVivo[9], a qualitative data analysis software, was used for in-depth exploration of the data. The overall approach for data analysis consisted of iterative cycles of coding, 'memoing' and creating thematic texts [58, 61]. Coding is relevant for summarizing, reducing and condensing the data [61]. 'Memoing' captures the analytical reflection, emergent categories, and themes from the data analysis [58, 61, 62]. The emergent findings were discussed with the co-authors and crosschecked with the villagers[10].

2.4.4. START OF ETHNOGRAPHY

The ethnography started with two visits to Rampur to identify and select a potential household to be the giver for this research. This task consisted of the ethnographer visiting eight households in RP belonging to different castes and trying to gauge the suitability of the households to become a giver for the study. The ethnographer's initial approach was to identify a Manjhi household to be the giver as they belong to the lowest in caste and class hierarchy. The ethnographer had shortlisted two Manjhi households for the role of giver, but both of the households declined. The ethnographer realized that his identity of an upper caste, educated, male and 'outsider' to the village had created doubts among Manjhi and Ravidas households. Eventually, the ethnographer selected Nita Yadav, and she agreed, to be the giver for this study. Nita, a female in her mid-forties, belongs to Yadav caste. Nita's nuclear family consists of her son (Ranjan), daughter and husband (C-Yadav[11]). Nita was selected to be the giver because of the following key reasons. First, Nita volunteers as a community-mobilizer for a village-level woman Self-Help-Group (SHG). This work requires her to engage with households belonging to all castes regularly.

[9] `http://www.qsrinternational.com/what-is-nvivo`

[10] After leaving the field in March 2016, the first author has maintained telephonic contact with the villagers and the research assistant. Since April, the research assistant visited Rampur once in a month to follow-up on the developments and capture photographs of the diary entries.

[11] Three key informants in this research, Nita Yadav, Ranjan Yadav (Nita's son), and Mahesh Yadav (Nita's father-in-law), are referred by full names. These names have been changed for the purpose of anonymity. All the other actors in this research are referred with scheme of 'Initial-Surname' such as, 'C-Yadav'. The surname indicates the caste identity of the person.

Second, she maintains written records for the SHG. Hence, she was experienced and comfortable with record keeping and documentation required for the use of the self-reporting diary. Third, Nita and her family members were experienced with the solar technology as they have been using a solar home lighting kit. They demonstrated proficiency in performing various simple tasks, such as charging of solar-items, for the operation of the energy distribution infrastructure. Fourth, Nita was enthusiastic and willing to be the giver. Fifth, Nita lives near various families of her in-laws (details in section 2.5.3 and 2.5.4). This situation provided an opportunity for understanding the influence of social relations based on kinship and gender role (of daughter-in-law) on energy exchanges. Sixth, the ethnographer was able to quickly form a rapport with Nita, her son, father-in-law, and brother-in-law. They let the ethnographer participate and observe their everyday life and were comfortable in sharing intricate details of their social relations. This facilitated 'rich' ethnographic data collection for the study.

Other relevant information for this 'intervention' concerns Nita's economic condition: Nita's husband (C-Yadav) works small day jobs in a distant city and returns to Rampur for a couple of months per year. Nita's husband sends back five thousand Indian rupees (around seventy euros) every month for the family's sustenance. The money barely covers the family's expenses, and Nita narrates how her nuclear family struggles to deal with perils of economic poverty on a regular basis. The difficult economic condition of her nuclear family made her serious and sincere towards the use of the energy distribution infrastructure provided. She stated that the installation would fetch her desirable financial benefits to supplement her family's income.

On 1 February 2016, the energy distribution infrastructure was installed at Nita's household. As part of the 'intervention' a formal contract was signed that made Nita the owner of the infrastructure. It was communicated and established that Nita can decide to use the infrastructure in whichever way she feels appropriate. She can decide whom to give or not give a solar-item, keep the solar-items for herself or her nuclear family, give these items for free or rent, and in any way she deemed appropriate. It was clarified that there is no right or wrong way to exchange the solar-items. A restriction placed as per the contract was that she can-

not sell any of the equipment for the next six months. It was also specified that any maintenance or repair of the infrastructure is the responsibility of Nita and the 'intervention' will not cover these costs. Nita and her nuclear family took pride in being selected to be the giver for the entire village. She appreciated that she had been given control and made 'owner' of the infrastructure.

It is important to state that Nita and her household did not consider that the infrastructure provided to them as given for free. They considered that operating the setup, maintaining daily records of exchange, and taking responsibility for the maintenance and repair required considerable effort from their end. They considered this effort to be an appropriate 'return' for the infrastructure provided to them. Throughout the study, Nita behaved as the owner of the setup even though she did not make a financial payment or investment to acquire the infrastructure. Nita and her son determined every aspect of the energy exchanges and the ethnographer refrained from any involvement in structuring the energy exchanges.

Immediately after the installation, Nita's house was visited by a large number of villagers enquiring about and requesting the solar-items. The villagers were aware of various benefits of solar lights. It is worthwhile to note that the demand for solar-items at Rampur was much more than the possible supply, i.e. thirty-three solar-items with Nita. Hence, Nita had to strategize and choose receivers amongst the households asking for the solar-items. Within a couple of days, most of the solar-items were already in circulation. A common cycle for this circulation was: a receiver took a charged solar-item, used the item for few days in the house, brought back the discharged item for charging, and once the item was re-charged the item was taken back for use. Nita and her son decided to allocate each solar-item in circulation to a particular receiver so that they could identify misuse of the solar-items. They decided that the receivers would be asked to pay rent based on the number of charging done and hence keeping account of charging became crucial for them. Initially, Nita had decided that the rent for each charging of a solar-item would be five rupees. Most of the receivers found this amount to be high and started negotiating with Nita and her family. Finally, Nita and the receivers mutually agreed at three rupees as the rent for each charging. Nita and her son created a 'charging rule,' i.e. the receivers should always charge the discharged solar-items

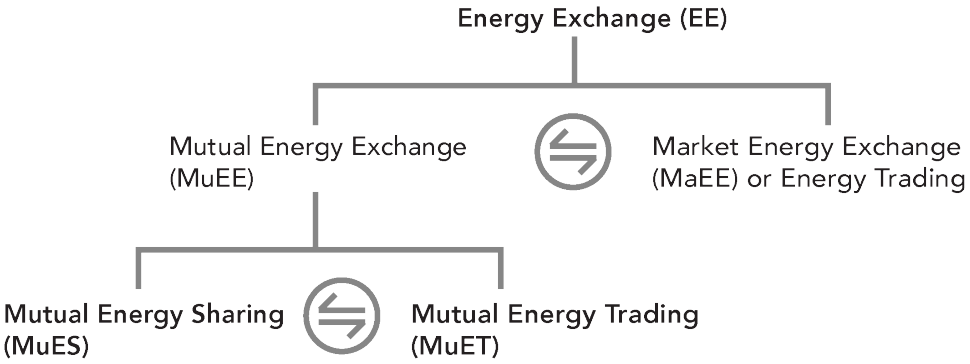

Figure 2.5: Mutual energy sharing and mutual energy trading as two types of mutual energy exchanges.

at Nita's household. The charging rule was created to stop receivers from charging discharged solar-items at other locations in Rampur. Nita's family constructed a social sanction for violation of the charging rule, i.e. the energy exchanges with the violating receiver would be temporarily paused or entirely terminated. Overall, twenty-six unique households became receivers over the period of this study. Five hundred and two energy exchanges were documented in the self-reporting diary during this period.

2.5. ETHNOGRAPHIC RESULTS

2.5.1. MUTUAL ENERGY SHARING AND MUTUAL ENERGY TRADING

The ethnographic data analysis reveals two types of mutual energy exchanges: 'mutual energy sharing' and 'mutual energy trading'. The authors define 'mutual energy sharing' as *a social and personal energy exchange where an energy-giver and energy-receiver participate for the sake of social relationship between them*. In contrast, 'mutual energy trading' is *a social and personal energy exchange where an energy-giver and energy-receiver participate in a calculated exchange for the sake of a commensurate material or monetary gain*. The mutual energy trading is distinct from energy trading because it is active in a mutual realm of economy (home and community) in contrast with energy-trading which is operational in a market realm. See Figure 2.5.

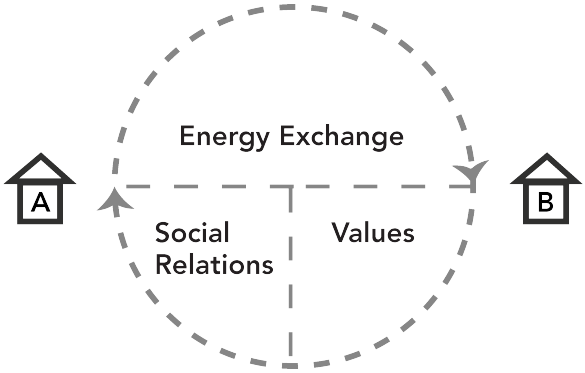

Figure 2.6: A visual representation of a circle of mutual energy exchange where 'A' is an 'energy-giver' and 'B' is an 'energy-receiver.'

2.5.2. CIRCLE OF MUTUAL ENERGY EXCHANGE

The authors define a 'circle of mutual energy exchange' as *a conceptual arena for social construction of a mutual energy exchange, which is modeled by social relations between energy-giver and energy-receiver, and is constituted by diverse social and cultural values*. See Figure 2.6. The word 'circle' is used to highlight the notion of *'[circle as] the area within which something acts, exerts influence'* (dictionary.com). A giver and a receiver can implicitly or explicitly compose these circles of mutual energy exchange. This concept is a result of the data analysis and connects with Gudeman's theoretical work on the dialectic of 'sharing' and 'trading' as described in Section 2.2 of this chapter. The concept of the circle of mutual energy exchange incorporates three dimensions: (a) the energy exchange between a giver and receiver, (b) social relation between the giver and receiver, and (c) and values invoked in these exchanges.

At Rampur, this study identified five circles of mutual energy exchanges: two circles of mutual energy sharing and three circles of mutual energy trading. A circle of mutual energy sharing indicates prominence of mutual energy sharing as a mode of energy exchange. In contrast, a circle of mutual energy trading indicates a preference for mutual energy trading as a mode of energy exchange. The following sub-sections present these five circles of mutual energy exchange. See Table 2.2 for a summary of these circles.

Table 2.2: Summary of five different Circles of Mutual Energy Exchanges in the mutual realm at Rampur

Circles of Mutual Energy Exchanges			
Case	**Energy Exchanges**	**Social Relations**	**Values**
Circle 1: Energy Exchanges with the **Joint Family Group**	**Mutual Energy Sharing**, Monetary rent not desired, intangible and immeasurable benefits	Daughter-in-law and Joint Family Group	Maintaining social relations, Cordiality, Moral obligations of a daughter-in-law
Circle 2: Energy Exchanges with *Gotiya* (**Local Patrilineage**)	**Mutual Energy Sharing** 'In-kind' gestures, Immediate rent payment in cash not desired	Daughter-in-law and gotiya	Maintaining social relations, Avoiding conflicts, Profit inappropriate, Moral obligations of a daughter-in-law
Circle 3: Energy Exchanges with **Non-Dalit Households**	**Mutual Energy Trading**, Commensurate monetary rent desired	Co-inhabitants of the village, Non-Kins	Monetary earnings, Embedded in changes in socio-economic life
Circle 4: Energy Exchanges with **Ravidas Households**	**Mutual Energy Trading**, Commensurate daily rent desired	Co-dependent patron-client, Yadav (non-Dalit) – Ravidas (Dalit)	Monetary earnings, Consideration for co-dependency and prior social relations
Circle 5: Energy Exchanges with **Manjhi Households**	**Mutual Energy Trading**, Commensurate monetary rent desired, 'In-kind' returns (possible)	Yadav (non-Dalit) – Manjhi (Dalit), Cultivator-labour	Monetary earnings, Fear of financial debt embedded in the history of caste relations

2.5.3. Circle of Mutual Energy Sharing within the Joint Family Group

Energy Exchanges

This case of energy exchanges within Nita's joint family group belongs to a circle of mutual energy sharing. Nita lives in a house comprising of a joint family group made of four nuclear families. These families are bound by patrilineal links with Nita's father-in-law (Mahesh Yadav). The four nuclear families are of Mahesh and his three married sons: C-Yadav (Nita's husband), J-Yadav and M-Yadav (Nita's brothers-in-law). All the adult members, except J-Yadav and J-Yadav's wife, of the

joint family group each received a solar-item each. Nita explained that she willingly gave solar-items to everyone to avoid piquing anyone in the family. When probed further, she answered with a rhetorical question, *'if I had not given these to the family members, would I be able to [happily] stay in the house?'* Nita considered it inappropriate and immoral to consider monetary rent for sharing within the joint family group. Nita did not specify or mention any monetary rent for these receivers. Similarly, receivers did not offer or pay any rent. She firmly stated that if someone from her joint family group offered her money for the solar-items, she would straight away refuse it. Any benefits, if at all, were in the form of intangible and immeasurable entities, which were neither numerically calculated nor asked for. For instance, Nita spoke of gaining the social support of her joint family group as one benefit of sharing of solar-items. This support is useful in case of a dispute with any other household in the village, especially considering the extended periods of absence of her husband from the household.

SOCIAL RELATIONS

In this case, Nita's obligations as a daughter-in-law of, and social differences within, the joint family group shaped the energy exchanges. Nita's joint family group is dealing with social disputes and tensions between the nuclear families. C-Yadav and J-Yadav have a bitter relationship with each other. Recently, J-Yadav bought the house from Mahesh and had asked Nita's nuclear family to vacate the house. Nita explains that for the time-being she has negotiated her family's stay in the house, but eventually she would have to build a house on a nearby plot of land within Rampur, which will be a substantial economic investment for her nuclear family. Despite these social differences, Nita has moral obligations as a daughter-in-law within this patrilineal and patrilocal social setup. These obligations include the sharing of things and resources that are also needed or desired by others in the joint family group. A relevant observation was that Nita on few occasions offered to give a solar-item to J-Yadav's wife (Nita's sister-in-law), but she refused to accept the light. By offering to share lights, Nita attempted to mend her social relations with her sister-in-law and negotiate more time for her family's stay in the house. By refusing the offer, J-Yadav's wife avoided getting into an energy exchange rela-

tionship with Nita and in consequence any resulting social obligation and niceties towards Nita's nuclear family.

Values

In this circle of mutual energy sharing with the joint family group, the values invoked were of maintaining social relations, and cordiality within the joint family group. These energy exchanges were performed for the sake social relations and not for making any monetary benefit. The local cultural values, as seen in Nita's moral obligations for her joint-family group of which she is a member by 'law' (marriage) not by 'blood' (birth), were invoked in these energy exchanges.

2.5.4. Circle of mutual energy sharing with the local patrilineage

Energy Exchanges

This case covers mutual energy sharing exchanges between Nita and six households belonging to Mahesh's (Nita's father-in-law's) *gotiya*. *Gotiya*, a Hindi word, refers to a local patrilineage of a person. In this case, the *gotiya* consists of households of Mahesh's four brothers and two cousins. All the households belonging to the *gotiya* received a solar-item each from Nita. Some of these families requested her, while others demanded her, to provide the lights. She spoke of the difficulty in ignoring these calls, *'how could I refuse giving lights to them? People will start quarreling with me. After all, they are part of the gotiya. Everyone needs this light.'* She and her family members reasoned that immediate and calculated rent payment in cash resembles *'buying and selling from a shop'* and wish to avoid such exchanges with the *gotiya*. Nita did state the rent of three rupees for each charging of a solar-item to the *gotiya* but was reluctant and cautious to enforce it. She later clarified that the *gotiya* supported her with in-kinds gestures and also with monetary returns acknowledging the energy exchanges and her efforts involved in the operation of the installation. Of the six households in this case: one household provided Nita access to their tractor for work on her agricultural land, and another family irrigated her

field with the use of their diesel irrigation pump. Three other households paid the rent in-cash at the end of each month, and one of the remaining households did not provide any cash or in-kind return for the exchanges. A subtle yet important observation is that both the giver and receivers did not view and structure these as tit-for-tat exchanges. Any precise monetary calculations and commensurations were avoided.

SOCIAL RELATIONS

In the patrilocal and patrilineal setup of Rampur, Nita is also considered a daughter-in-law of the *gotiya*. She is dependent on the *gotiya* for various aspects of her social identity and acceptance, as well as for her family's sustenance. Her role as a daughter-in-law and associated (social) power relationship were at the fore in the energy exchanges. She had to sensitively deal with these energy exchanges as they had a potential to impact her social relations with the *gotiya*. In this regard, an unexpected and illustrative event happened at the end of March. Nita facing an urgent economic crisis asked a *gotiya* household, which had not provided any cash or in-kind return, for some financial support. When the household refused her request, she claimed the financial support as a return for the solar-item she had been regularly providing them. The household was aggravated by her claim and interpreted this as a culturally inappropriate act to earn a profit from *gotiya*. Ultimately, the household did not make any monetary payment and stopped receiving solar-items from Nita. The household's relationship with Nita had been strained since then. She mentioned that her relation with the household before the 'intervention' had also gone through many ups and downs. She and other villagers informed that such tensions with members of *gotiya* are common and were part of the everyday life of an in-marrying female living in a patrilocal setup.

VALUES

In this circle of mutual energy sharing with the *gotiya*, values of maintaining social relations and avoiding conflicts were of prime emphasis. In the local setting, an exchange with a member of *gotiya* to make a profit is viewed as culturally inappropriate. Nita distributed the solar-items neither to maximize monetary profit nor

out of altruistic feelings for others but due to obligations as a daughter-in-law in her unequal power relation with the *gotiya*. As in the case of the joint family group, these exchanges were primarily for the sake of social relations and not to make a commensurate material gain.

2.5.5. Circle of mutual energy trading with non-Dalit households

Energy Exchanges

This case comprises of mutual energy trading exchanges between Nita and eight households of non-Dalit castes, six Yadav, one Teli and one Brahmin. These eight households are non-kins, i.e. they do not belong to Nita's father-in-law's patrilineage. Nita began giving solar-items to most of the households in this group obliging to their repeated requests. She firmly stated that acquiring monetary benefits was the main aim of these exchanges. In contrast to the previous two cases, in this case, Nita was very vocal, precise and calculative about commensurate monetary rent each receiver was required to pay. Nita relentlessly pursued monetary benefits, and the receivers responded with lengthy negotiations in an attempt to avoid rental payment altogether. Eventually, the rent for this group was also established at three rupees for each charging of a solar-item. By the end of February 2016, seven of the receivers complied and made the rental payments. However, by the end of April 2016, Nita terminated exchanges with three receivers as they stopped paying rent. Overall, Nita found energy exchanges with these receivers to be inconvenient as the receivers were irregular in making rental payments and she had to put considerable effort to collect the dues.

Social Relations

Nita described her social relation with these receivers as of co-inhabitants of the village, and she often referred to them with a phrase such as *fellow village men*. This aspect of her social relation with these receivers framed the energy exchanges. She provided the solar-items only to those receivers with whom she and her family had

a prior social relation. These relationships comprised of cohesive notions of co-operation, cordiality, and co-existence as well as feelings of competition, hostility, and jealousy. They often comparatively and competitively described each other by referring to accumulated material wealth of households such as land-holdings. In this regard, a fascinating play of social relations was observed. The non-kin Yadavs tried to invoke their caste affinity with Nita (also a Yadav) to get a waiver from rent payment. Nita disregarded her caste affiliation with the non-kin Yadavs and continued to pursue monetary rent.

VALUES

In this circle of mutual energy trading with non-Dalit households, the value of monetary earnings became an overarching purpose. The values invoked are embedded in changes in the socio-economic life of Rampur. The villagers reported that monetary exchange between non-kin and from the same caste have become common and morally acceptable over the past few decades. For instance, it is now a common practice for a villager to rent a tractor or a diesel pump set from a fellow villager of the same caste. In contrast to the previous two cases, here it was not immoral to speak and aim for making a material benefit and profit.

2.5.6. CIRCLE OF MUTUAL ENERGY TRADING WITH RAVIDAS HOUSEHOLDS

ENERGY EXCHANGES

This case of energy exchanges between Nita's family and nine Ravidas households belong to a circle of mutual energy trading. Ravidas are Dalits and have the lowest caste status at Rampur. Right from the start of the study, Nita overtly demonstrated her interest in providing solar-items to Ravidas households. Her interest also explains the increase in the number of Ravidas receivers from seven at the start to nine receivers by the end of March 2016. She personally invited five of these households to receive the solar-items. As in the previous case, she specified that gaining monetary benefits was the main aim of these exchanges. Initially, Nita had decided that the rent for each charging of a solar-item would be five rupees. The Ravidas

receivers found this amount to be high and started negotiating with Nita and her family. Finally, they mutually agreed at three rupees as the rent for each charging, and all the households regularly made the payments.

Social Relations

These energy exchanges are embedded in Nita's co-dependent patron-client relation with the Ravidas households and her higher caste status. Nita describes these Ravidas householders are skillful as they demonstrate a range of proficiencies such as masonry, carpentry, and agricultural tool making. At Rampur, there is a high rate of economic migration of 'working age' Ravidas men to work in the big cities of India. This migration has improved their economic class in the village. Nita's family is dependent on Ravidas for a variety of services where she paid them monetary wages. A co-dependent patron-client relationship between a Yadav (patron) and a Ravidas (client) is typical. These energy exchanges were an extension of this co-dependency and were facilitated by trust between the giver and Ravidas receivers. Nita found Ravidas easy to negotiate with. She reported that Ravidas households usually oblige to her requests. Her higher caste status was at work here. Surprisingly, she voiced exchanges with Ravidas as more desirable than exchanges with non-kin Yadav indicating her preference to maintain a functional co-dependency with Ravidas over her caste affinity with non-kin Yadav.

Values

In this circle of mutual energy trading with Ravidas households, value emphasized was of monetary earnings but with consideration for co-dependency and prior social relations. This value is also signified in Nita's act of reducing the rent even though the local demand for the lights was high. She could have remained firm at the higher rent and found other receivers who were willing to pay the higher rent. As in the previous case, here as well it was morally acceptable to voice and pursue monetary gains.

2.5.7. CIRCLE OF MUTUAL ENERGY TRADING WITH MANJHI HOUSEHOLDS

ENERGY EXCHANGES

This case of energy exchanges between Nita's family and two Manjhi households belong to a circle of mutual energy trading. Manjhis are Dalit, have the lowest caste status, and are the economically poorest at Rampur. At the start of this study, Nita estimated a high number of Manjhi households would become the receivers. This estimate was far from the reality that followed. Only two households of P-Manjhi and D-Manjhi, whom Nita personally invited, reluctantly became receivers. The rent for this group was three rupees for each charging of a solar-item. Nita realized that it is hard for Manjhis to make rental payment in cash due to their poor economic condition. She strategized 'in-kinds' rent payment such as through commensurate amount of work in her agricultural field. D-Manjhi's family appreciated Nita's offer of in-kind payment, but they eventually paid the rent in cash for the duration of this study. In contrast, the exchange with P-Manjhi illustrated tensions in these energy exchanges. After paying monetary rent on a couple of occasions, P-Manjhi stopped bringing the solar lantern for charging to Nita's place fearing accumulation of financial debt. P-Manjhi's family found a way to charge the solar lantern at another Manjhi household. Nita realized that the exchanges with P-Manjhi would not fetch her financial gain unless the 'charging rule' is diligently followed. Eventually, Nita terminated energy exchanges with P-Manjhi. A conversation between Nita's family and wife of P-Manjhi followed:

> P-Manjhi's wife [in an angry tone]: *[You] took the light away*.
> Nita: *It is not about the light. You can take the light back right now, but you have to charge here*.
> Ranjan: *You have to give money*
> P-Manjhi's wife stated that a rent of three rupees is beyond her means and remained silent on making payment in-kinds. She added: *You are earning from us. If you add the money due and the interest, then what will we do, give our house to you'*

Social Relations

These energy exchanges are dominated by the history of social relations with the two Manjhis households and Nita's caste identity of a Yadav. Manjhi men and women work as agricultural laborers who are hired for daily wages by Yadav landowners and cultivators at Rampur. Over the years, the wives of P-Manjhi and D-Manjhi have worked in Nita's fields for various tasks, such as husking of wheat. For their labor, Nita either paid them a wage or a commensurate amount of food grains. She stated that these families agree to her work requests, and this was one of the key reasons for offering them solar-items. A startling observation was that even though Manjhi households desired the solar-items, they were unwilling to request for these from Nita. Some Manjhi households added that even if Nita offered a solar-item, they would firmly refuse it. Many Manjhis feared to get into an exchange relationship with Nita's family and were mistrustful of Yadavs in general. Manjhis saw these exchanges as part of the history of caste relations with Yadav, who have held considerable social and economic power over them.

Values

In this circle of mutual energy trading with Manjhi households, the value of monetary earning was predominant for Nita but with consideration for their economic conditions. This value was highlighted in Nita's offer of 'in-kinds' rent payment. In contrast, Manjhis valued independence from Yadav. Overall, the fear of financial debt and mistrust embedded in the history of caste relations between Manjhis and Yadavs proved detrimental to mutual energy trading.

2.5.8. Use and Status of Solar-Items

The ethnographic account in this chapter primarily focuses on the energy exchanges between the giver and receiver and little on how the villagers used the solar-items. However, a few key points about the use of solar-items and how these items are differentiated from other commodities are briefly provided here as it explains their role in energy exchange. A majority of the existing solar home instal-

lations in Rampur consisted of lights mounted on a wall and hence the lights were fixed to a location. The solar-items provided as part of the 'intervention' were desired because of their portability, quality and aesthetics of the light emitted. Most common uses of the solar-items were: for villagers' work and mobility in the field after sunset; for studying as a replacement of oil-based lamps, which were considered unsafe; and for illuminating cooking places. Some creative uses of solar-items were also observed over the course of this study. For instance, some evenings Nita's father-in-law mounted the LED bulb from the terrace of his house to light a public space where he and other seniors of the village gathered to talk. He described this setup as a 'streetlight' and took pride in asserting his house as the only building in Rampur with a 'streetlight.' Overall, the solar-items facilitated these range of practices that in turn shaped the 'demand' for these items and hence contributed to the energy exchanges. The ethnographer also observed exchanges of other everyday items at Rampur. These observations revealed how the villagers differentiated the solar-items from other commodities. Nita and other Yadavs refuse to accept water, milk, any form of cooked food, uncooked food grains (rice, wheat, lentils) and other food items (cooking oil, salt, sugar) from any Dalit (Ravidas and Manjhi) household, although vice-versa is performed. Deeply rooted cultural notions of purity, hygiene, and caste bind exchange decisions of these items. However, there is also a category of commodities that villagers describe as 'machines' such as agricultural tools, bicycles, or mobile phones, which are more liberated from such cultural notions. The villagers placed the solar-items and energy in this category. This placement explains why Nita did not have any cultural objection to receiving an 'un-charged' solar-item from a Dalit household. Further, these observations clarify the differentiated status of energy as a commodity among other commodities that are exchanged in the village.

2.6. Discussion

2.6.1. Energy exchanges

The ethnographic findings and conceptualization of mutual energy sharing are consistent with Gudeman's [27, 41, 42] description of 'sharing.' The authors suggest mutual energy sharing as a *'complex social phenomenon'* [63] that should not be construed as a tit-for-tat rational exchange. As demonstrated in cases of mutual energy sharing, energy exchanges were performed for the sake of social relationships between the giver and receiver. The commensuration in a case of mutual energy sharing was inessential and imprecise. The benefits, if at all, for the giver were based on a tacit acknowledgment of the act of sharing by the receiver. In cases of mutual energy sharing, the giver shunned being a rational, self-interested, and calculative individual.

An interesting finding of this study is that a sharing based mode of energy exchange (mutual energy sharing) does not fill the entire spectrum of exchanges in a mutual realm, as Gudeman's works [27, 41, 42] seems to suggest. As the ethnographic results described, the mutual realm also contained a self-interested and calculative mode of exchange, which this chapter defines as mutual energy trading. The description of mutual energy trading is an extension of Gudeman's conceptualization of trading. Gudeman sees trading as a competitive, anonymous, and impersonal exchange limited to the market realm of an economy and governed by market principles. Whereas the findings of this study indicate a presence of a mutual energy trading, which is calculative, personal, social and mutually structured by an energy-giver and energy-receiver in the mutual realm. One of the key dimensions that distinguish mutual energy trading from mutual energy sharing is that while former is performed and strategized for the sake of material gain, the latter is practiced for the sake of social relations. In cases of mutual energy trading, a negotiation with argumentation for the personal and material benefit was not problematic. The commensuration was essential and precise. An important point to note is that although the desire for material and monetary benefits dominates mutual energy trading, it conceals the mutuality that makes such exchanges

possible. For instance, in all the cases of mutual energy trading reported in the ethnography, prior existing social relations such as co-dependency, work engagement, and associated trust formed a base for the mutual energy trading to take place.

As demonstrated by the ethnography, the two modes of mutual energy exchanges, i.e. mutual energy sharing and mutual energy trading, can be co-present. The authors view these two modes as conceptually distinct and dialectically conjoined to each other. It indicates a manifestation of a dialectical tension between mutuality and self-interest in the mutual realm. The dialectic of mutual energy sharing and mutual energy trading also implies that a householder can be self-interested and focus on mutuality simultaneously. Both sides of the dialectic were relevant and important for the giver. As demonstrated in cases of mutual energy sharing, mutuality or importance of social relations was at the foreground emphasizing morality, sociability, and sociality. On the other hand, mutual energy trading has self-interest at the forefront and accentuates calculations, strategizing for material benefits, profit, economistic and rational thinking. The social gestures and other benefits of mutual energy sharing are incommensurable to the material returns from mutual energy trading. One may argue that the mutuality side of the dialectic is nothing more than another instance of self-interest. For long, similar arguments have been the cornerstones for debates between economics and economic anthropology [27, 42]. Such an argument would rob mutual energy sharing of the critical and conceptual attention that it requires. Both of these modes of mutual energy exchanges are conceptually discrete and worthy of further research inquiries. Many studies fail to make a conceptual distinction between 'sharing' and 'trading' of energy and these either use these concepts interchangeably (see [10, 19]) or at times 'sharing' is used when conceptually the authors imply 'trading' (see [11–13, 17, 20, 64, 65]). The authors encourage energy researchers to investigate mutual energy sharing and mutual energy trading in emerging contexts of local energy distribution initiatives across diverse social settings and contexts.

2.6.2. Social relations

The ethnographic findings described how different types of social relations influenced mutual energy exchanges at Rampur. In the case of Nita, the energy exchanges were embedded in varying dimensions of her social relational identity of a daughter-in-law, a female and a Yadav. Kinship and caste defined types of social relations which had a strong influence on mutual energy exchanges at Rampur. The existing energy literature lacks attention to the role of kinship in energy exchanges. These results on the role of kinship and associated obligations seem to be consistent with that of Mehlwana [66] who reported kinship as a significant factor in inter-household exchanges of lighting fuel (kerosene) in low-income urban settings in South Africa. Some previous studies (e.g., [67–69]) have briefly suggested the relevance of kinship in a context of energy consumption in households, but these do not provide any ethnographic evidence for a role of kinship in energy exchanges.

Similarly, the role of caste in energy exchanges is left unexplored in the energy literature. The historic nature of caste relations and its potential impact on mutual energy exchanges had been particularly visible in case of energy exchanges with Manjhi receivers. In this case, the historicity explained the breakdown of mutual energy exchange as well as the unwillingness of Manjhis to get into an exchange relationship with the giver despite their desire and the need for the solar-items. At the same instance, it is significant to note that this historic structural element such as caste is not static. Instead, this aspect of social relation is dynamic. This dynamic aspect of caste relations and its impact on mutual energy exchanges was visible in the case of energy exchanges with Ravidas receivers where historical caste barrier was transcended due to the emerging dynamics of co-dependency between the giver and Ravidas receivers. Hence, the authors' recommendation for energy researchers and practitioners is to understand mutual energy exchanges in connection with relational identities of people involved as well as to the dynamics of structural elements that shape these social relations.

2.6.3. VALUES

The ethnographic findings of this study demonstrate that the mutual energy exchanges at Rampur invoked diverse values. On the one hand, in the case of mutual energy sharing, values were beyond financial benefits or maximization of economic value; price calculations were not desired and even refused by the giver. Both the giver and receiver in the cases of mutual energy sharing considered it immoral, unethical and culturally inappropriate to use the measuring scale of money or aim to earn a profit. On the other hand, in the reported cases of mutual energy trading, financial benefits were sought for, a scale of money was utilized, and earning profit from others was considered morally appropriate and ethical. Hence, it appears, first, that the mutual energy exchanges are encapsulated in diverse moral, ethical, social and cultural values. The values invoked in the mutual energy exchanges are plural, varied in nature and emerges in the exchange. The values observed in these mutual energy exchanges transcend the dominant notions of economic rationality as suggested by the rational choice approach. It seems worthwhile to consider that when energy becomes a contender for a mutual energy exchange, it flows through *'regimes of value'* [70].

Second, the mutual energy sharing and mutual energy trading seem to be rooted in different moralities and ethical judgments, which are complex, diverse, sometimes conflicting and at other times converging. This suggestion is consistent with Widlok's [43] and Gudeman's [41] argument that 'sharing' and 'trading' embrace distinct moralities. The ethnography indicates that there is a lack of a unified, uniform and normative frame for moral and ethical valuation that is used by the giver and receivers engaging in a mutual energy exchange. As noted in the Introduction to this Special Issue ([71]:3), *'great diversity exists in how people make ethical judgments about the role of energy in the types of 'good societies' they imagine for themselves. . . there is no singular set of values that are shared equally at all times by all actors*.' The ethnography suggests that instead of taking a homogenizing and universal viewpoint of locating the value of energy exchanges in ideas of efficiency, optimization of resources and maximization of financial benefits; one needs to be sensitive to people's notion of moral obligations and ethical judgments. Energy

practitioners and researchers attempting to enable energy exchanges should be responsive to this diversity of values as these have potential to explain emergence or disappearance; adoption or rejection; and success or failure of particular types of energy exchanges between a giver and receiver. The recommendation here is that energy practitioners and researchers rise above the limited view of the rational choice approach and embrace a culturally sensitive approach to understanding values invoked in energy exchanges. Further research and discussion by energy researchers and practitioners are required on a different type of rationality, one that is embedded in social relations and local cultural values.

The authors speculate that if the infrastructure used for this study was given to a shopkeeper at Rampur, then the energy exchanges may have been entirely cash-based. In contrast to the case of Nita, the shopkeeper may not have encouraged negotiation on rent or accepted in-kind payments but may have provided a discount on rent to some of his/her personal connections in the village. The authors also postulate that in case Nita had made a financial investment to acquire the infrastructure provided the energy exchanges with all the groups, except the *gotiya*, would have remained the same. As already mentioned in section 2.4.4, Nita did not consider that the infrastructure has been given to her for free, and she had established her ownership since the start of the study. Even in this scenario, her decisions would be shaped by her relational identity and values. She would still have given the solar-items to members of her joint family group without asking for a monetary rent. In the case of energy exchanges with the *gotiya*, she may have been more forthright in asking for a return, but she would still have preferred in-kind gestures.

2.6.4. CIRCLE OF MUTUAL ENERGY EXCHANGE

This chapter presented circle of mutual energy exchange as a descriptive, conceptual, and analytical unit for understanding mutual energy exchanges. As a descriptive unit, a circle helps to focus on characteristics of social relations and cultural values, and how these shape mutual energy exchanges. As a conceptual unit, a circle provides a space to understand structuring and negotiations that carve different

types of mutual energy exchanges influenced by the elements of social relations and cultural values. From an analytical perspective, a circle acts as a tool to explain why certain mutual energy exchanges can and cannot happen in a particular sociocultural environment. During the time-frame of this study, five circles of mutual energy exchanges were observed at Rampur. The study also demonstrates that multiple circles of mutual energy exchange can co-exist in a mutual realm.

The concept of *'circle of mutual energy exchange'* takes a relational and cultural view of energy exchanges. Each circle of mutual energy exchange defines a mutually constituted relational and cultural boundary for energy exchanges. The concept is relational as it centers on and acknowledges the influence of social relations in shaping energy exchanges. For instance, Nita's social relation as a daughter-in-law of the joint family group and the *gotiya* shaped the energy exchanges that ensued. The concept of the circle of mutual energy exchange is cultural as it incorporates and is sensitive to diverse local cultural values that contour energy exchanges. A circle outlines what types of exchanges within the circle can be considered culturally appropriate or inappropriate. For instance, Nita considered monetary rent collection as culturally inapt in the circle of mutual energy sharing within the joint family group, but it was culturally acceptable in the circle of mutual energy trading with the Ravidas households. Overall the concept illustrates a social and cultural embeddedness of mutual energy exchanges. Different social environments and contexts would produce other types of circles of mutual energy exchange based on the three dimensions that describe a circle of mutual energy exchange. This conceptualization of a circle of mutual energy exchange supports Sovacool's [37] emphasis on cultural values in people's engagement with aspects of energy.

At the level of ethnography the case reported in this chapter is specific to rural India but the authors consider the conceptual output of circle of mutual energy exchange of this chapter to be relevant for other 'developing' countries where similar infrastructure to the one used in the ethnography can be found. The authors consider the concept of the circle of mutual energy exchange to be relevant for rental or 'fee-for-service' models of off-grid rural electrification initiatives in 'developing' countries. Some of these models are operational at 'Ikisaya Energy Centre' in Kenya [28, 29], Mini-Grid project in rural Uganda [36], 'Millennium Villages Project'

in Malawi [72], as well as in various locations in South Asia [30, 33]. An instance of mutuality influencing some aspects of rental exchange can be seen in Eder et al.'s [36] writing on Mini-Grid project in Malawi:

> '*three interviewees [villagers] believed that the secretary charged different connection fees and prioritised certain households depending on their personal relationships*' ([36]:52), and '*it should also be noted that households were connected to the grid not only because they could afford the investment costs but also because of social complications. For example, it was revealed that some villagers were connected to the grid earlier because of their personal relationship with the secretary*' ([36]:51).

We suggest that by utilizing the concepts proposed in this chapter, energy researchers and practitioners would be able to develop a holistic understanding that involves the role of diverse social relations and cultural values in shaping the rental exchanges at these sites.

We consider the concept of the circle of mutual energy exchange to be relevant for some emerging and envisioned contexts in the 'developed' world. Gudeman's cross-cultural approach systematically and convincingly contends, that the dialectic of mutuality and self-interest in exchanges is not limited to 'small-scale economies' in developing countries but is also present in 'developed market economies' in western countries [27]. Take for example visionary energy systems such as 'Smart MicroGrids' [73] or 'Decentralized Energy Systems' [74, 75], where householders are imagined to get a certain degree of control, choice and an active role in local energy distribution. Such systems allow mutuality to gain prominence in local energy distribution and therefore mutual energy exchanges could emerge. In such scenarios, the concept of circles of mutual energy exchange may help researchers and practitioners to develop a realistic understanding of people's choices and decision-making in energy exchange. Vandebron, in the Netherlands, also described as '*Airbnb for green power*' [76] in popular media, is an example where emergent traces of mutuality in a context of energy exchanges in a western country can be seen. These aspects can be noticed in Vandebron's Facebook web page where stories of social interactions, social gatherings and face-to-face encounters of energy-givers

and energy-receivers are presented. An important topic for future research is to investigate what forms of mutuality emerge in upcoming energy initiatives in the western world such as Vandebron, where digital platforms seem to be playing a vital role in energy exchanges.

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3

Exploring Peer-to-Peer Returns

Within the areas of distributed, off-grid, and decentralized energy, there is a growing interest in local energy exchanges. A crucial component of energy exchange is a return provided by an energy-receiver to an energy-giver for the energy provided. The existing energy literature on such returns is primarily limited to monetary returns and lacks a critical discussion on the different types of monetary and non-monetary returns possible and variation in people' preferences for these. Based on an ethnographic 'research intervention' study conducted at two off-grid villages in rural India for 11 months, this chapter presents a sociocultural understanding of returns. The chapter presents a classification of returns consisting of three types, i.e., in-cash, in-kind and intangible, and proposes a conceptual model of 'returns-continuum.' The chapter showcases how people's preference for a type of return varies with the nature of their social relationships with each other and suggests that configuring a return is not merely an economic activity but a complex sociocultural process. Finally, the chapter recommends to energy researchers and practitioners to enable diversity in returns, to acknowledge dynamics of social relations in returns, to interconnect energy economy with the local in-kind economy, and to engage with ethnographic approaches.

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3.1. Introduction

The theme of local or inter-household energy exchanges is increasingly gaining attention in the academic as well as in the business world. Within the realm of distributed, off-grid and decentralized energy, the topic of energy exchange appears under the guise of various labels, such as peer-to-peer energy [2–4], transactive energy [5–7], energy trading [8–10], energy sharing [11–13], and mutual energy exchange [14]. Some off-grid pilots in the global south are utilizing local energy exchanges to provide access to clean energy to underprivileged population of the world (see, for instance, Lighting a Billion Lives[1] and Rural Spark in India[2], SOLShare[3] and Grameen Shakti[4] in Bangladesh, Ikisaya Energy Centre[5] in Kenya). In many of the off-grid initiatives, energy exchanges are structured in the form of a rental service, where a central location in a village is set as a charging station for solar products such as solar lanterns and battery packs, and villagers access these products by paying a rent [15–18]. Such a setup has been described in energy literature as 'Energy Centre Model' [19, 20], 'Centralized Charging Station Model' [16, 21–23], 'Energy Kiosk Model' [22] and 'Energy Hub Model' [24]. These models are hailed as innovative ways to address energy poverty and lauded for increasing local community's participation by giving members of the community a central role in the management of a local energy system [17, 19, 25–28]. Often external agencies (NGOs, utilities, governments) initiate an energy exchange pilot in an off-grid setting by creating a local energy market, where a return structure is constructed based on a socioeconomic evaluation of a local community gauged by willingness-to-pay metric and the local community is engaged in the payment collection (see [18, 29]). In such settings, returns are discussed as 'rent,' 'payment,' 'fee-for-service,' and 'pay-as-you-go' (see [15–18, 24, 28, 30–33]).

Conceptually, from an anthropological perspective, an energy exchange in such a system could be viewed as consisting of two types of 'transfers': 'energy transfer' and 'return transfer' (see Figure 3.1). In this chapter, we extend Robert C.

[1] http://labl.teriin.org/
[2] http://www.ruralspark.com/
[3] https://www.me-solshare.com/
[4] http://www.gshakti.org/
[5] https://vimeo.com/57061330

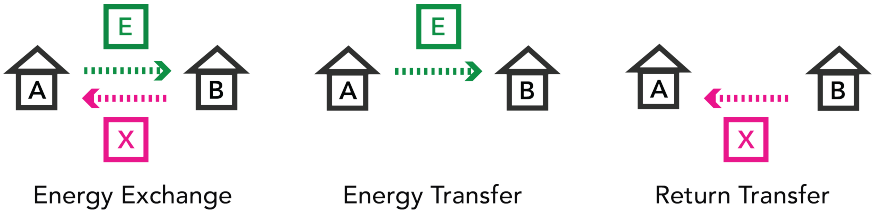


Figure 3.1: Conceptual diagrams of energy exchange, energy transfer, and return transfer.

Hunt's [34], an economic anthropologist, conceptual distinction between a 'transfer' and 'exchange.' An 'energy transfer' is a physical or figurative movement of energy units (E) either through cables or storage devices such as batteries from an energy-giver (A) to an energy-receiver (B). In contrast, a 'return transfer' or 'peer-to-peer return' or for brevity a 'return' is a counter-movement of an entity X from the energy-receiver (B) to the energy-giver (A)[6]. An energy exchange is complete when both A and B recognize X as a return for the energy units provided by A. In this chapter; we prefer to use the word 'return' rather than more commonly used money oriented terms in energy literature, such as rent, tariff, fee, and payment. A 'return' provides a larger conceptual canvas that allows us to include a variety of non-monetary and intangible entities observed in our analysis. Moreover, the concept of 'return' has an established discourse in anthropology (see [35–38]). We prefix 'peer-to-peer' (p2p) to 'return' to indicate specific structural elements of the returns discussed in this chapter, i.e., these are mutually structured, negotiated, and organized by energy-givers and energy-receivers.

In the existing energy literature on off-grid energy systems, there are two main knowledge gaps about peer-to-peer returns that this chapter attempts to address. First, an emerging body of energy literature sees a local, social, and cultural understanding of various aspects of off-grid systems as crucial for their success and adoption by people [17, 18, 39–42]. However, the existing discussion on returns in such energy systems is mostly rooted in a techno-economic analysis [15, 21, 24, 43–45] and lacks an understanding of the sociocultural embedding of the returns, i.e. how these returns are grounded in the social and cultural reality of people's life.

[6]To be concise, we use the word 'giver' to refer to an 'energy-giver.' Similarly, a household who received a solar-item from the 'giver' is referred to as a 'receiver' in this chapter.

Second, the existing energy literature on such returns in off-grid settings is primarily limited to discussion on monetary returns (fiat money) and lacks an understanding of different types of monetary and non-monetary returns possible and people's preferences for these. Moreover, the contemporary understanding of p2p returns in limited to a 'rational market' paradigm that presumes universal and exclusive preference for fiat money and primacy of logic of market where the householders engage in competitive buying and selling of energy in return for fiat money. Such an understanding does not take social and cultural variations and particularities, and diversity in logics into account. To respond to these above-mentioned knowledge gaps, in this chapter, we bring a perspective from the discipline of anthropology to develop a sociocultural understanding of p2p returns. To the best of our knowledge, p2p returns in off-grid energy systems have not yet been explored from an anthropological perspective. In a broad sense, an anthropological perspective focuses on two types of understandings. First, a holistic, bottom-up, and embedded understanding of a (sociocultural) phenomenon which starts by building and analyzing 'emic' (insider's or internal) viewpoints, i.e., people's multiple realities, perceptions, and logics. Second, translating the 'emic' understanding to 'etic' (external) concepts, i.e., an analytical description or explanation of the phenomenon (for more on 'etic' and 'emic perspectives see [46, 47]). Hence, this anthropological perspective attempts to ground the understanding of a phenomenon in everyday realities of peoples' social life.

This chapter is based on an ethnographic 'research intervention' study conducted at two off-grid villages Rampur and Manpur in rural India for 11 months (1 February 2016 – 31 December 2016)[7]. The study started with the installation of an off-grid energy distribution infrastructure to enable exchanges of solar-lighting in the villages. The 'research intervention' allowed one household in each of the villages to be a giver for their respective village. The householders had complete control of the energy infrastructure installed and freedom to structure returns, as they desired without any involvement of the ethnographer. This setup facilitated the ethnographic inquiry to address the following broad research questions: What

[7] Note that the real names of villages and all the participants have been changed in this chapter for the purpose of anonymity.

types of returns givers and receivers invoke when they are given control of an off-grid energy distribution? How are these returns embedded in the social, cultural, and economic life of the villagers?

The ethnographic data analysis reveals the existence of three types of peer-to-peer returns: in-cash, in-kind and intangible returns. The chapter presents four ethnographic vignettes that showcase variations in preference of the three types of returns and demonstrate various issues with in-cash returns. Based on learning from the ethnography, the chapter presents 'returns-continuum,' a conceptual model that proposes the following.

1. The three types of returns can be viewed as a coexisting, overlapping, dynamic, and continuous spectrum of returns.
2. The people's preference for a type of return varies with the nature of their social relationships with each other.
3. A diversity of returns is a better fit for the social, cultural, economic and moral life of people engaged in off-grid energy system than solitary money-centric return.
4. Configuring a return is not merely an economic act but an intricate sociocultural process.

Before moving ahead, we would like to clarify that some references to in-kind and intangible entities appear in energy literature in two broad contexts in which an external agency (non-governmental organization, utility, or state) is either a receiver (see [25, 26, 48–51]) or a giver (see [18, 52–55]) of in-kind or intangible entities as payments. See Table 3.1 for more details on these two contexts. However, these have not been discussed in reference to peer-to-peer energy exchanges.

Apart from the others, this chapter addresses the following key themes relevant for energy research and social science:

1. Beyond techno-economic understanding: Various energy studies' scholars emphasize the need for energy research to investigate the sociocultural di-

Table 3.1: Two broad contexts where in-kind and intangible entities are discussed in the energy literature

Types of payment	Reason	References
Context 1: In-kind payment by a householder or a local community to an external agency for an energy infrastructure installed by the external agency	Land and labor for the capital cost of the energy infrastructure	Baldwin et al.[48], Emili et al. [26]
	In-kind contributions in the form of material and labor as a way to increase local ownership and engagement of people in rural electrification projects	Hirmer et al. [49]
	In-kind contributions in the form of land and labor are utilized to achieve community participation, ownership and engagement in renewable energy initiatives	Sovacool and Drupady [25]
	In-kind payment scheme where the poorer population are allowed to pay by use of cattle dung and fertilizers	Sovacool and Drupady [25]
	In-kind payment for the dissemination of Solar Home Lighting kits amongst householders who are unable to pay by cash	Mainali and Silveria [50]
	In-kind payments as a financing mechanism for off-grid renewable energy access to the poor in Nepal	Glemarec [51]
Context 2 In-kind and intangible entities as compensation, benefits, or subsidies provided by an external agency to a householder or local community for participation in and acceptance of energy infrastructure	In-kind payments such as constructing a visitor center as a 'benefit payment' or 'compensation scheme'	Kerr et al. [52]
	In-kind payments in the form of infrastructure and assets as 'community compensation' to a local wind farm community	Delicado et al. [53], and Upham and García Pérez [54]
	In-kind benefits for fisherman communities in the form of local infrastructure for community acceptance of marine renewable energy	Reilly et al. [55]
	'In-kind donation' of solar lanterns to a local cooperative in rural Malawi	Adkins et al. [18]
	'In-kind transfers' to poor citizens as support for rising energy prices	Freund and Wallich [56]
	'In-kind gifts' as rewards for energy behavior of householders	Camara et al. [57]
	Intangible rewards such as praise, recognition as 'intrinsic rewards' for energy behavior of householders	Camara et al. [57]
	Prestige, an intangible entity, in a village level energy project in rural India	Malhotra [58]
	Intangible benefits of rural electrification to a local community	Zerriffi [28]
	Non-monetary benefits in the adoption of a decentralized renewable energy system	Yaqoot et al. [59]

mensions of energy [20, 60–64]. More specifically on peer-to-peer renewable energy systems, Ruotsalainen et al. [2] have argued for approaching such energy systems within broader social and cultural contexts filled with diverse values.

2. Study from the global south: Many researchers have reported cases from the global south that attend to people's everyday life as underrepresented in energy studies [60, 64–66].

3. Anthropological viewpoint and ethnographic approach: Several energy studies have invited researchers to embrace anthropological [60, 61, 67] and ethnographic [65, 68, 69] research on studying energy systems and society.

4. Extension of our previous publication: The ethnographic observations from Rampur during the initial phase (February-April 2016) of this research were presented in an earlier publication (see [14]). It reported on a classification of energy exchanges and significance of mutuality in energy exchanges. In contrast, here we focus and go deeper into a discussion of types of returns based on long-term ethnographic data from two villages.

The remainder of this chapter is organized as follows. Section 3.2 describes field setting of the study. Section 3.3 provides details of the research approach and methods used. Sections 3.4, 3.5, and 3.6 present the ethnographic results by respectively providing an overview of energy exchanges, showcasing the classification of returns, and presenting four ethnographic vignettes and a coda to the study. Section 3.7 presents the conceptual model of returns-continuum. Finally, Section 3.8 provides recommendations, conclusions and future work.

3.2. FIELD SITES

This chapter is based on field research conducted at two villages, Rampur and Manpur, located in Bodhgaya block, Gaya district of Bihar state in India (see Figure 3.2 and Figure 3.3). India is home to around 1.21 billion people with 68.85% of this population living in rural areas [70]. It is estimated that approximately 300 million

people in India lack access to electricity [71]. Bihar is a federal state of India with 88.7% of its total population of 104 million living in villages [72]. Gaya district, with a population of 4.39 million, is the fifth largest district of Bihar [72].

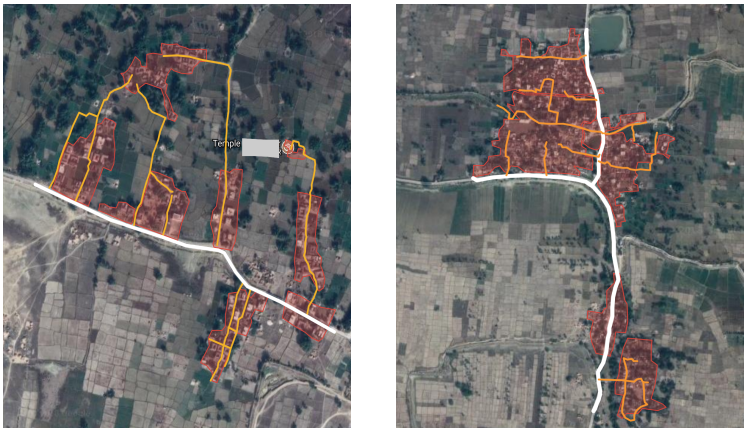
Bihar is one of the least 'developed' states of India [73] and performs poorly on various socio-economic indicators as compared to other states in India [74, 75]. According to the 2011 Census of India [76], only 10.4% of the rural households in Bihar were electrified. However, in the past few years, India and Bihar have made rapid strides in the area of village electrification, which many attributes to a successful implementation of Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY) policy[8] [77, 78]. Latest data on village electrification (as of 7 May 2018), report 96% of the villages [79] and 75% of the households in Bihar to be electrified [80]. Many scholars while laud the government's efforts also point to the rudimentary definition of 'village electrification' used by DDUGJY where a village is considered to be 'electrified' even if only 10% of the households are electrified [71, 78, 81]. Moreover, the current approach to electrification does not take quality and reliability of electric connectivity into account, which remains barriers in rural electrification[78, 81]. Hence, large swaths of households still remain without access to electricity in Bihar[71].

The field engagement started with visits to many un-electrified villages in the Gaya district. Manpur and Rampur were selected as field-sites as they fulfilled some pre-identified criteria (See Table 3.2). Rampur and Manpur are around fifteen kilometers away from the center of Gaya and are four kilometers apart from each other. The route to the villages consists of passage through half-made roads, agricultural fields, and driving on a long, dried and stone-filled riverbed.

Manpur and Rampur comprise of 350 and 200 households respectively. All the inhabitants of the villages are Hindu by religion. Both the villages were off-grid as the villages did not receive any electricity supply from the electricity grid. The villagers rely on Kerosene oil as a primary source for lighting. Twenty-three households at Manpur and thirty households at Rampur report having small solar pan-

[8] Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY) policy was earlier known as Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY) scheme.

Figure 3.2: Map of India with Bihar state and Gaya district highlighted.



(a) (b)

Figure 3.3: Google Map images of (a) Rampur and (b) Manpur. Note red polygon highlights the inhabited land, the white lines represents roads, and orange lines represent streets within the villages.

Table 3.2: Pre-identified criteria for selecting field-sites

	Pre-identified criteria for selecting a field-site	Status of Manpur and Rampur
1	Un-electrified Villages	Both the villages were un-electrified. The villages did not receive any electric supply from the centralized grid and did not have any community based off-grid energy provisioning system
2	Heterogeneous Population	Both the villages had a heterogeneous mix of the population belonging to different castes
3	Physical Access	Physical access to both the villages was not too difficult
4	Experience with solar technology	The villagers had experience of solar technology
5	Feasibility for extended field-research	It was feasible for the ethnographer and the research assistant to stay in the village for an extended period
6	Rapport and Volunteering Households	In each of the villages, a household was willing to participate as a giver for the study. The ethnographer managed to form a rapport with the givers that made collecting rich ethnographic data possible.

els (4W-40W). The existing solar panels are used primarily for basic home lighting, to power small music players and to charge mobile phones. Mobile phones are ubiquitous, and persons without solar panels charge their mobile phones at the households with solar panels. Often this informal charging service is offered for free, but in some cases, householders ask for a charging fee. The villagers report that agricultural outputs are not anymore sufficient for the economic sustenance of a household. They report it to be the main reason for a large-scale migration of working age men from the village to big cities in India.

3.3. RESEARCH APPROACH

This interdisciplinary research is based on a multi-method ethnographic study [14]. The research approach consists of a 'research intervention' where a material infrastructure is introduced into a social space as a precursor to an ethnographic investigation of people's engagement with the infrastructure. This research technique is situated in the emerging field of 'design anthropology' [82] and 'research-through-design' [83].

3.3.1. RESEARCH INTERVENTION

The aim of the 'research intervention' was to enable a research setup that facilitates inter-household energy exchanges for an ethnographic investigation. The 'research intervention' is not intended as a pilot to demonstrate how to structure off-grid energy systems. The 'intervention' comprised of an installation of a small-scale energy distribution infrastructure consisting of solar lanterns, power-banks, LED bulbs, solar panel, and energy routers at the givers' households (see Table 3.3 and Figure 3.4). This infrastructure facilitated the exchange of 'solar-items,' i.e., solar lanterns, LED bulbs and power banks, between households in the villages. In total, thirty-three solar-items, i.e., fourteen LED bulbs with power banks and nineteen solar lanterns were available for use and exchange in both the villages. The total cost of installation of energy distribution infrastructure was 40,000 Indian Rupees (INR) (around 560€).

3.3.2. RESEARCH METHODS

The details of ethnographic methods used in this research were published in an earlier publication [14]. Hence, here, we provide only a brief overview of the methods. To investigate energy exchanges, a research approach of 'personal network research,' which is a type of 'ethnographic network mapping' was adopted [84]. The 'personal network research' centers on 'focal' individuals and explores their social network using a range of ethnographic methods. The givers were the focal individ-

Table 3.3: Key Components of Off-Grid Energy Distribution Infrastructure for Solar Lighting

Item	Quantity	Comments
Power Banks	14	These portable power banks provide 5Volts Direct Current (DC) current output to two Universal Serial Bus (USB) ports, which can be used to power a LED light (below) and/or charge a mobile phone. Each power bank was assigned a unique three digits numeric code with the first digit of '1'(e.g., 100, 101, 102...).
LED Bulbs	14	These are bulb shaped 3W LED lights that work only when connected to the power banks as these lights do not have battery components. Each LED Bulb was given a unique three digits numeric code with the first digit of '2' (e.g., 200, 201, 202...).
Solar Lanterns	19	These are rechargeable LED lights. The difference between a LED bulb (above) and the solar lantern is that a solar lantern is fitted with a battery and hence does not require connection with power bank to function. Each Solar Lantern was given a unique three digits numeric code with the first digit of '3' (e.g., 300, 301, 302...).
Solar Panel (75W)	1	To charge the solar lanterns and the power banks.
Energy Routers	2	An interface between the solar panel and the chargeable items (solar lanterns and power banks).

uals, and we investigated energy exchanges between the givers and each receiver invoked through a family of ethnographic methods, such as participant observation [85], interviews and conversations [86], and field-notes [87]. The first author of this chapter was the ethnographer in the field research. A solar energy expert, who has been working in the villages of Gaya for the past four years, volunteered in the field-study as a research assistant.

A self-reporting diary was provided to the givers to document information about energy exchange. See Figure 3.5 for the various attributes documented. Such diary-based approaches are beneficial for triangulation [88]. The diary entries were discussed and crosschecked during interviews with the givers and receivers.

Figure 3.4: Energy Distribution Infrastructure. Note the labels: '1': Solar Panel; '2': Energy Router; '3': Power banks; '4': Solar Lantern; '5': LED Bulb.

A hand-drawn exchange mapping approach was utilized to (a) to create a spatial map of the energy exchanges, (b) utilize the map to inquire about social relationships between the givers and receivers, and (c) to cross-check preliminary findings from other ethnographic methods and analysis of self-reporting diary entries. The hand-drawn exchange mapping technique used in this research draws inspiration from various visual methods proposed by the Participatory Rural Appraisal (PRA) approach. PRA is a participatory research methodology that utilizes various visual methods to build an understanding of participants' social world [89–92]. PRA encourages adoption of the mapping methods according to the research context and has been used in combination with ethnographic methods [89–92]. Overall, three mapping sessions, one each in February, March and December 2016, were held in both the villages. The energy givers and their family members collaboratively constructed the map. See Appendix-B for the scans of the hand-drawn exchange maps produced during the field-research.

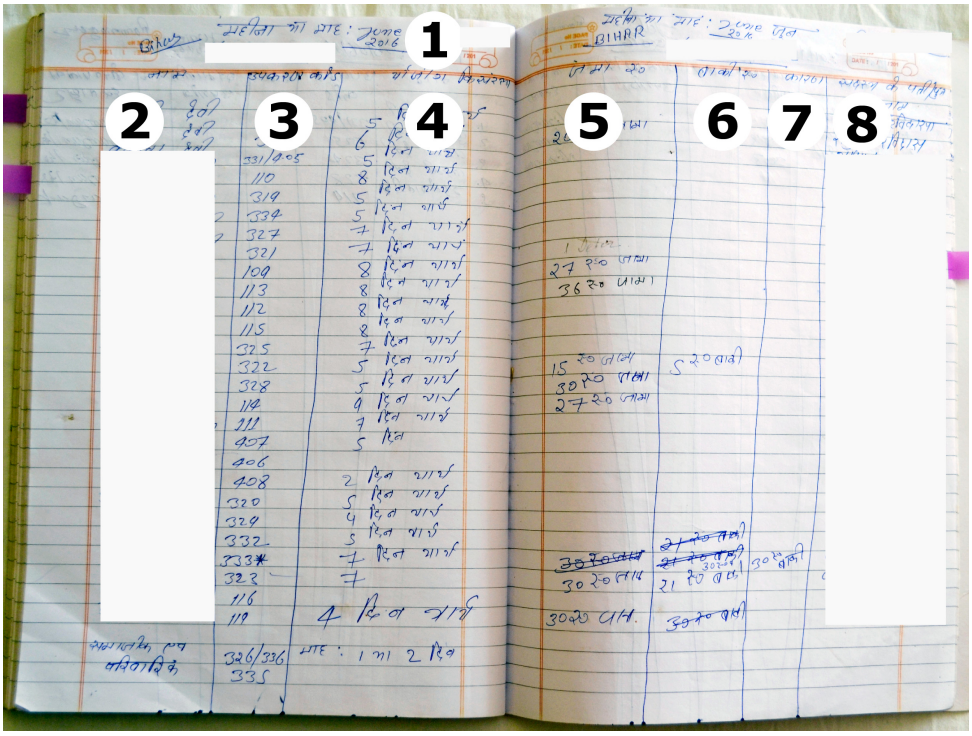


Figure 3.5: A sample of diary entry documenting energy exchanges for June 2016. Note the labels: 1: 'month'; 2: 'receiver name'; 3: 'item code'; 4: 'number of charging'; 5: 'return provided'; 6: 'return due (if any)'; 7: 'any reason/comment'; 8: 'head of the receiver's household'. (We have concealed the names mentioned in the figure to anonymize research participants.)

NVivo[9], a qualitative data analysis software, was used for in-depth qualitative data analysis. The ethnographer crosschecked the emergent findings with the givers and concerned receivers by telephonic and face-to-face interviews[10]. See [14] for more details on data analysis procedure followed in this research.

[9] `http://www.qsrinternational.com/what-is-nvivo`

[10] After leaving the field in March 2016, the first author has maintained telephonic contact with the villagers and the research assistant. Since April, the research assistant visited the field once in a month to follow-up on the developments and capture photographs of the diary entries. The first author revisited the field for a week in December 2016 and utilized the visit to get feedback from the villagers on the emerging themes and categories.

3.3.3. RECRUITMENT AND PROTOCOL

The ethnography at Rampur and Manpur started with two visits to identify and select potential households to be givers for their respective villages. This task consisted of the ethnographer visiting eight households in Rampur and meeting five different householders in MP to gauge the suitability of the households to become a giver for the study. Eventually, the ethnographer selected Nita Devi at Rampur and Aarti Devi at Manpur to be the givers for this study. Nita and Aarti are married females, and while the former is in her mid-forties, the latter is in her late-twenties. Nita's nuclear family consists of her husband (Chandan Yadav), fifteen years old son (Ranjan), and nine years old daughter. Aarti's nuclear family consists of her husband (Ramesh Singh) and her eight months old daughter. Nita and Aarti were selected to be the givers because of the following principal reasons:

1. Both Nita and Aarti volunteer as community-mobilizers for a village-level woman Self-Help-Group (SHG) in their villages. Their work requires them to engage with households belonging to all castes.
2. They were experienced and comfortable with record keeping and documentation required for the use of the self-reporting diary.
3. They demonstrated proficiency in performing various tasks, such as charging of solar-items for the operation of energy distribution infrastructure.
4. Both of them were enthusiastic and willing to be the giver for their village.
5. The ethnographer was able to form a rapport with them and their family members. They let the ethnographer participate in their everyday life and were comfortable in sharing intricate details, which facilitated 'rich' ethnographic data collection.

Additionally, Nita and Aarti were selected to be the givers as females in the villages have a constant presence in the village while 'working-age' men migrate to big cities in India to work and therefore are less regularly present in the villages.

As part of the 'intervention,' a textual contract was made with both Nita and

Aarti. The contract formally established them as the owners of the infrastructure installed in their respective villages. The contract catered to a strategic research design decision: to provide the givers with complete control and ownership of the energy distribution infrastructure without asking them to make any financial payment for the infrastructure. The research team sensed that such a setup would allow the givers to act according to their social, cultural, moral, and ethical values without the pressure of making the setup financially sustainable. Moreover, such a setup is typical for village-level centralized charging models where the cost of installation is paid by an 'external' agency (NGO, local governments) and the villagers only pay for the cost of operation and maintenance [16, 17, 19, 28, 66, 93, 94]. The contract underlined that the energy-giver would get to keep, use and maintain all the components of the infrastructure even after the study has been completed. It was communicated and established that the givers can decide to use the infrastructure in whichever way they feel appropriate. They can decide whom to give or not give a solar-item, give these items for free or for rent, or in any way they deemed appropriate.

3.4. Ethnographic overview of energy exchanges

3.4.1. Start of energy exchanges

The installation and the contracts were signed in the presence of some other villagers and the news of the installation spread through the village. A large number of villagers visited the givers to inquire about the installation and conditions for procuring solar-items. These visits were followed by discussions within the villages about various aspects of the infrastructure. Concurrently, the givers started discussing with their family members on ways to institute energy exchanges. Overall, in both the villages, the solar-items generated considerable enthusiasm amongst the villagers. The givers appreciated that they had been given control, and behaved as owners of the infrastructure. They were aware of the total cost of the infrastructure, deemed it to be expensive, considered it to be a crucial way to add to financial earnings of their households, and therefore as an entity that they to be cautious in

using it.

Within a couple of days since the installation, the givers started assigning the solar-items to receivers. A general way for the exchange was: a receiver visited the giver's home, obtained the assigned and charged solar-item, judiciously used the solar-item in their household for few days, once the solar-item was drained of the charge, the receiver brought the item back to the giver's place for charging.

3.4.2. RENTAL NEGOTIATIONS

The givers decided to ask for rent for providing the solar-item to the receivers. However, the villagers were cognizant that the setups had been provided to the givers without requiring them to make any financial investment. Hence, some villagers questioned the appropriateness of being asked to pay rent. The givers responded by establishing the legitimacy of rent collection. First, the givers reasoned that operating and maintaining the infrastructure, and participating in the research that included keeping daily records required considerable effort from their end. They argued that this effort was an appropriate 'payment' for the infrastructure. Second, the givers established that repair of the solar-items would incur a cost that has to be recovered by rental collection. Third, on many occasions, the givers cited the contract with the ethnographer that made them the rightful and exclusive owner of the infrastructure and empowered them to create their own rules. Finally, the givers were able to socially establish their ownership of the infrastructure and need for a rental collection. Some villagers were still not convinced by the arguments and decided not to take any solar-item from the givers.

Each giver developed the rental strategy independently of the other, i.e., without any consultation with each other. The ethnographer did not inform the villagers about the existence of similar research setup in the other village[11]. This situation also explains the variation in rental strategies developed in both the villages. At MP, Aarti and Ramesh structured a monthly rental scheme where a power-bank and a solar-lantern had a flat rent of 60 rupees (0.79 euro) and 40 rupees (0.53 euro) per

[11] The givers eventually became aware of the setup in the other village but they did not communicate with each other.

month respectively independent of a number of charging. In contrast, at Rampur, Nita started with a rent-per-charging scheme where rent would be charged based on the number of charging performed. She initially stated the rent to be 5 rupees per charging with an assumption that the receivers would charge a solar-item five to eight times per month. However, the receivers considered the rent to be high and started negotiating with Nita, and eventually reached an agreement for 3 rupees as the rent for each charging. Soon, the villagers found ways to charge the solar-items with small solar panels and batteries in the village and avoided making rental payment to Nita. Nita sensing this issue of her scheme revised the rental scheme at the end of April 2016 to a flat monthly rate of 30 rupees, which was independent of the number of charging. She continued with this scheme throughout the study.

Interestingly in both the villages the givers and receivers invoked the price of kerosene oil, the primary source of lighting, as a reference to determine the rent and capacity for the receivers to pay. The receivers estimated the household consumption of oil for lighting to vary between 1-2.5 liters per month, i.e., between 21-105 rupees (0.25-1.3 euros) concerning monetary worth. The givers and receivers attempted to keep the rent for a solar-item to be comparable to a household's monthly expenses of kerosene used for lighting.

3.4.3. Use and benefits

The receivers were highly pleased with the solar-items and reported on many benefits of these. The solar-items were portable, and hence the villagers were effortlessly able to carry these around. The solar-items facilitated work in the field after the sunset. Similarly, people reported an enhanced sense of safety in movement in the village and cooking after dark. The children used the solar-items for studying as a replacement of '*dhibri*' (oil-based lamp) that are unhealthy and unsafe. They also remarked on better range and aesthetics of the light emanating from the solar lanterns and the LED bulbs as compared to '*dhibri*.' The villagers utilized the power-bank (a solar-item) charging mobile phones, which in turn were used for accessing digital video and songs. See Figure 3.6. The infrastructure was successful in pro-

Figure 3.6: Various benefits of the solar-items. Note the labels. '1': lighting interiors of a house; '2' cooking after sunset; '3' mobile phone charging; '4': mobility after sunset.

viding access to solar-lighting to many households. In total 63 distinct households became receivers during the study (see Section 3.5 for more details).

3.5. CLASSIFICATIONS OF RETURNS AND QUANTITATIVE OVERVIEW

The ethnographic data reveals three types of returns, i.e., in-cash, in-kind and intangibles, used by the villagers as part of the rental structure developed in both the villages. This section presents a classification and quantitative overview of these returns. See Table 3.4.

3.5.1. DEFINING IN-CASH RETURN

In-cash return is a payment made by an energy-receiver to energy-giver for the energy provided in the form of currency notes and coins. Here, we use the term 'cash'

Table 3.4: A classification of returns

Dimension	In-Cash Return	In-Kind Return	Intangible Return
Monetary/ Non-Monetary	Monetary	Monetary (calculating monetary worth)	Non-Monetary
Quantitative measurement of return	Yes	Yes	No
Scale of measurement of return	Money	Diverse scales but a translation to monetary worth for commensuration	Not Used
Commensuration	Important	Important	Not Important
Social Relation (between giver and receiver)	Usually with 'Socially distant'	With both 'socially distant' and 'socially close'	With 'Socially intimate'
'Profit'	'Profit' desired	'Profit' desired from 'socially distant'; 'profit' avoided from 'socially close'	'Profit' absent
Type of Energy Exchange	Predominantly in Mutual Energy Trading (MuET)	Can be part of both Mutual Energy Trading (MuET) and Mutual Energy Sharing (MuES)	Predominantly in Mutual Energy Sharing (MuES)
Entities of return	Currency Notes and Coins	Work such as service of irrigation pump-set, tractor; Food items such as potatoes, lentils, corn; Non-food items such as oil, cow-dung cakes	Goodwill, Labor, Social Support, Favor, Friendship

to denote what anthropologists define as '*fiat money*' [36, 95] or '*general-purpose money*' [96], which is a legal tender issued by the state assuring its value. In-cash returns are monetary. In-cash returns are an integral part of mutual energy trading, a type of energy exchange. Mutual energy trading (MuET) is '*a social and personal energy exchange where an energy-giver and energy-receiver participate in a calculated exchange for the sake of a commensurate material or monetary gain*' ([14]:109) Commensuration or '*to compare by use of a common measure*' ([36]:51) is important. It is achieved by use of rental schemes and quantitative measurement of the return using the scale of money. In both the villages, the givers usually pursued in-cash

returns from receivers who were 'socially distant' or less connected to them. The givers described 'socially distant' receivers with the phrase such as *gaon ke aadmi* ('village men') and explained that the relationship between them is of a village acquaintance, where they are familiar with each other but do not have any social bonding or connection with each other. The givers explicitly stated that in the cases of energy exchanges with the village acquaintances making some 'profit' was their primary motive. Here, the notion of 'profit' indicates a value of making some monetary or material gain. The villagers interchangeably referred to a discourse of 'profit' with various Hindi words such as *munafa*, *faida*, or *laabh* and sometimes also with the English word profit. The villagers spoke of munafa exclusively in the context of financial 'profit,' whereas they used the words *faida* and *laabh* to refer to having a financial 'profit' and also to indicate getting some (non-financial) advantage or benefit from something.

3.5.2. DEFINING IN-KIND RETURN

We define in-kind returns as *a payment made by an energy-receiver to energy-giver for the energy provided in the form of a thing or work of economic value. In-kind returns involve four strategic calculations*. (A) A giver identifies the monetary dues for a particular receiver based on the rental scheme mutually agreed by the giver and receiver. (B) The giver measures the quantity of the in-kind return provided by a receiver. This measurement is done using different scales of measurements. For instance, access to diesel-powered irrigation pump-set is measured with the scale of time (per hour basis) whereas medical consultations are measured with the number of consultations provided. (C) The giver and the receiver mutually calculate and agree upon the monetary worth of the quantity of in-kind return provided. Various local and market references are used for this calculation. For instance, an hour of access to an irrigation pump is translated to a monetary worth based on a mutually agreed price, whereas monetary worth of food-grain provided as an in-kind return is calculated based on the ongoing market rate of the grain. This step of translating the quantity of an in-kind return to a monetary worth is essential for a giver's and receiver's satisfaction on commensuration and equivalence in an energy exchange.

This act of monetary translation of an in-kind return is a salient feature of in-kind returns observed during the field-study. (D) Finally, the giver and the receiver determine the overall credit/debit balance. Hence, these in-kind returns are non-cash but still are monetary. It is in contrast to a discussion on in-kind payments in energy literature, where it is referred as 'non-monetary' when essentially researchers indicate its non-cash nature (for instance, see [54, 97]).

In-kind returns were observed in energy exchanges of the givers with both a 'socially distant' as well as a 'socially close' receiver. 'Socially close' refers to a type of social relationship between a giver and receiver where they are closely connected and bonded with each other, such as between members of an extended family (*gotiya* or *gotiya parivar*) or neighbors (*padosi*). A subtle distinction observed between in-kind returns invoked in energy exchanges with 'socially distant' and 'socially close' is in the discourse of 'profit'. In case of energy exchanges with 'socially distant' receivers, the givers emphasized their ambition to obtain a 'profit,' whereas in case of 'socially close' receivers the givers avoided and abstained from a 'profit.' In-kind returns can be part of both mutual energy trading and mutual energy sharing. Mutual energy sharing (MuES) is another type of energy exchange and it is '*a social and personal energy exchange where an energy-giver and energy-receiver participate for the sake of social relationship between them*' ([14]:109).

During the field research, the ethnographer also enquired about local exchanges of other everyday items such as food grains, vegetables, agricultural tools, and utensils. This line of inquiry revealed how the villagers differentiate between the materiality of a solar-item from other entities when considered as a commodity for exchange. In both the villages, people describe a category of entities as 'machine' that includes various types of technological tools such as agricultural instruments, motorbike, diesel generator, mobile phone, and solar-items. They view a 'machine' as expensive and damageable and consider it as an entity that one acquires with considerable investment. Hence, they rationally associate with a 'machine' specifically when making them part of an exchange with other villagers. This view of solar-item as 'machine' also explains the givers' rationale for calculating the monetary worth of in-kind returns provided by the receivers. It was typically observed that a giver allocates a solar-item to a receiver on a financial basis, while

simultaneously gives other non-machine items to the receiver on a non-monetary basis.

3.5.3. DEFINING INTANGIBLE RETURN

We define intangible returns as *a return in the form of unmeasured and unquantified social gestures and actions, such as goodwill or social support, made by an energy-receiver in favor of energy-giver for the energy provided*. The critical factor that differentiates intangible returns from in-cash and in-kind returns is that the giver and receiver neither quantitatively nor monetarily measure intangible returns. Thus, intangible returns are non-monetary. Commensuration is not essential and a notion of 'profit' is absent in case of intangible returns. Intangible returns are constituent of mutual energy sharing. In both the villages, intangible returns were observed in energy exchanges with 'socially intimate' receivers. The givers described their relationship with 'socially intimate' persons by use of Hindi words *kareebi* (close), *mohabbati* (love), *dosti* (friendship) and *parivar* (family). 'Socially intimate' refers to a type of social relationship between a giver and receiver where they feel a strong sense of social connection and solidarity with each other, such as between proximate friends. We consider 'socially intimate,' 'socially distant,' and 'socially close' to be different states of 'social connectedness,' which is a character of social relations between people. We define 'social connectedness' as *a feeling of togetherness, solidarity, and closeness experienced and performed by a person for another*.

3.5.4. QUANTITATIVE OVERVIEW OF RETURNS

During this study, 36 households at Manpur and 27 households Rampur received solar-items from the giver for varying durations[12]. At Rampur, one particular household had three unique receivers; therefore the total number of receivers at Rampur was twenty-nine persons. Figure 3.7 provides an overview of the type of returns utilized by the receivers at Manpur and Rampur. In-cash return was the

[12]There were solar-items used by the Nita, Ranjan, Aarti and Ramesh, i.e. the givers and their nuclear family members. But we have excluded these from the calculations of the number of receivers at both the villages as the focus of the research is on inter-household exchanges.

most common type of returns used: 39% (14 receivers) at Manpur and 52% (15 receivers) at Rampur used in-cash returns without combining those with any other type of returns. 25% (9 receivers) and 28% (8 receivers) at Manpur and Rampur respectively used in-kind returns either solitarily or in combination with in-cash returns. 14% of the receivers in both the village used intangible returns. 22% and 7% of the receivers at Manpur and Rampur respectively did not provide any return during the period of the study. However, at Manpur, Aarti estimated that some of the non-paying receivers might eventually provide an in-kind return to clear the dues. It is crucial that an intangible return is not confused with no-payment. In case of no-payment, a giver expects a return while the receiver provides none, whereas in case of an intangible return a giver qualifies an un-quantified and unmeasured social gesture as a valid return. Figures 3.8, 3.9, and 3.10 show distributions of receivers who provided in-cash, in-kind and intangible returns respectively by the types of their social relations with the givers. Figure 3.8 shows that in-cash returns were more common in energy exchanges with 'socially distant.' Figure 3.9 highlights that in-kind returns were utilized with both 'socially distant' as well as 'socially close.' Figure 3.10 indicates that all the receivers who used provided intangible returns were 'socially intimate' to the givers. In the following section, with use of ethnographic vignettes from the field, we demonstrate the differences between the three types of returns.

3.6. Ethnographic vignettes

3.6.1. Vignette: a desire for and problems with in-cash returns

This vignette describes characteristics of in-cash returns, which the givers usually pursued from 'socially distant' receivers while engaging in a mutual energy trading. Cash (fiat money) is a scarce and highly desired entity in the economic life of the Rampur and Manpur. There is a noticeable variation in the economic class of the villagers with few households economically well-off while a large number of villagers struggle to cope with perpetual poverty. Therefore, it was not surprising that the givers in both the village valued in-cash return, while the receivers, in general,

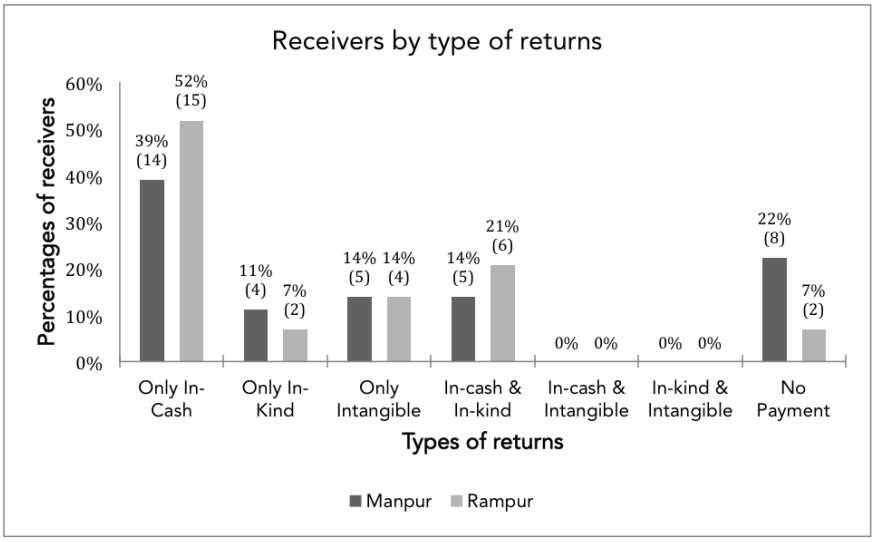


Figure 3.7: Distribution of receivers by types of returns (1 February – 31 December 2016.)

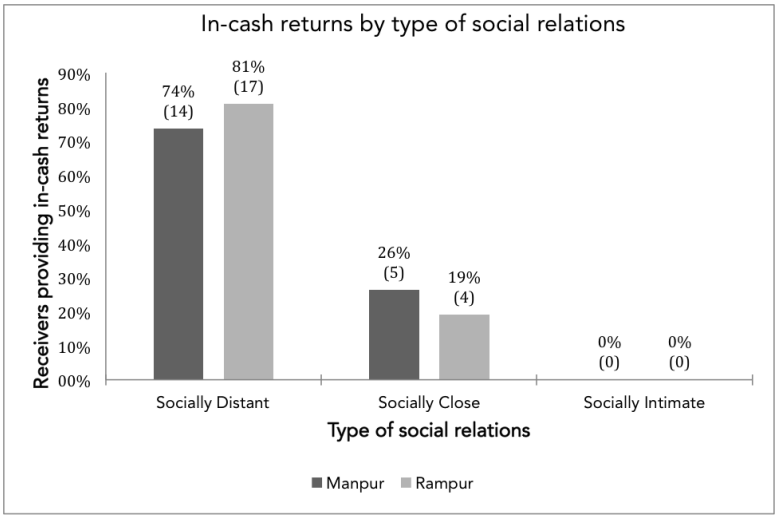


Figure 3.8: Distribution of receivers who provided in-cash returns by the type of their social relations with the givers. (Note that the distribution combines receivers who provided only in-cash returns with those who provided both in-cash and in-kind returns.)

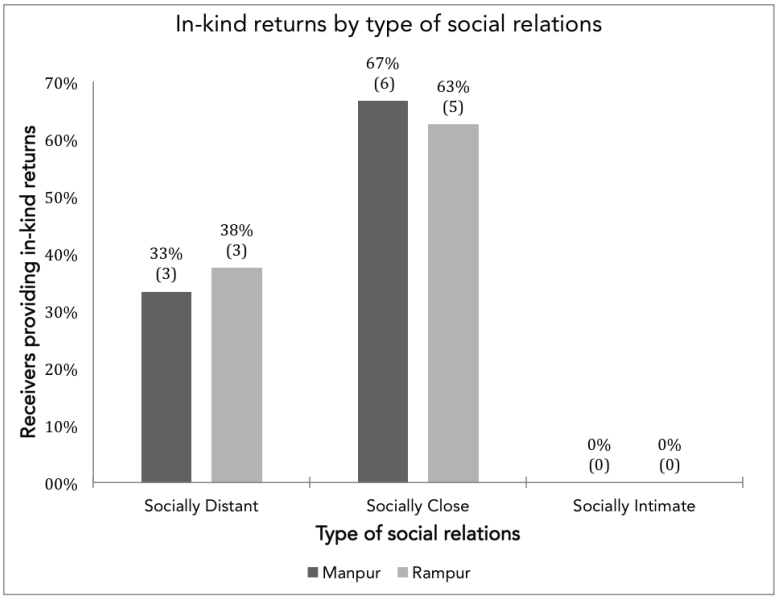


Figure 3.9: Distribution of receivers who provided in-kind returns by the type of their social relations with the givers. (Note that the distribution combines receivers who provided only in-kind returns with those who provided both in-cash and in-kind returns.)

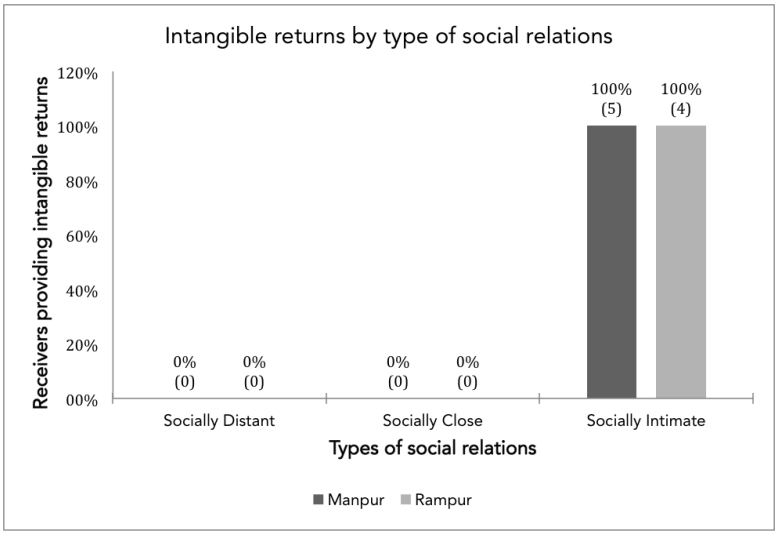


Figure 3.10: Distribution of receivers who provided intangible returns by the type of their social relations with the givers.

attempted to avoid it. When asked about the relevance of in-cash returns in her life, Nita responded, '*with money we get [to pay for] grinding [to make wheat flour], salt, cooking oil, turmeric. With all this, at least some of my [financial] troubles are resolved. . . when I get 20-30 rupees then only I get to buy spices for cooking*'. Ranjan added, '*if we get regular payments, my study fees could easily be covered by the [cash] collection*.' Aarti on many occasions spoke of lack of cash as one of the reasons for economic troubles of her household and hence her interest in obtaining in-cash returns. See Figure 3.11. In the cases of energy exchange with 'socially distant,' the givers desired in-cash returns as well as making some 'profit.' In such energy exchanges, the givers categorically specified monetary rent to the receivers, numerically calculated the in-cash returns and registered the amount of the return provided in respective self-reporting diaries. Commensuration was important for the givers.

Even though at Rampur and Manpur in-cash returns were the most common type of return, these have many limitations, and the givers had to deal with many issues in administrating, operationalizing, and procuring them. A large section of the population reported being cash-starved. Moreover, cash availability in the households varies across the year as agricultural production is seasonal and does not result in regular monthly income for the households. Both the givers reported the in-cash collection to be strenuous, and heavily contested as compared to the cases of in-kind and intangible returns. Nita and Aarti stated that the situation where all the receivers provide in-cash returns at the end of every month could create some problems for them. They fear large quantity of cash in their household would bring unwanted attention to the monetary accumulation, which could lead to demands for small monetary borrowing by other villagers, needless purchasing requests by their family members, and can also make their household vulnerable to theft.

An introduction of in-cash return has potential to strain a social relationship between a giver and a 'socially close' or 'socially intimate' receiver and can turn other ongoing exchanges of goods and services between them to be cash based. The villagers fear such a situation and wish to avoid it. It is common to hear people making statements like, '*when he/she takes money from me so would I*' in an attempt to justify and caution others when asked for any cash payment. It is visible

Figure 3.11: Some examples of returns. Note the labels: '1' shows Aarti calculating in-cash return provided by a receiver seen in the background; '2' shows Vasu Yadav's tractor (Section 3.6.1); '3' displays two spades made by a receiver (RP-R22 in Table 3.5) to be a return; '4' shows Shiv Yadav's diesel-powered pump-set (Section 3.6.3).

in case of energy exchanges of Nita with Vasu Yadav. Vasu Yadav belongs to local patrilineage (*gotiya*) of Nita's husband. Vasu Yadav's family on a past number of occasions has helped Nita without asking for any monetary benefits. Whenever Nita requested them for little access to their tractor, Vasu's family member agreed to plow Nita's field without stressing for money. They asked for a monetary return only when the tractor was needed for a considerable amount of time (see Figure 3.11). Similarly, both the families exchanged small quantities of goods on need basis without any monetary translation. Nita started providing them a solar-item and initially stated that she would not ask for in-cash returns from Vasu Yadav due to close social relations between the families. However, when Nita faced a severe economic crisis in life, she asked for in-cash returns[13]. She cautiously but firmly

[13]In March 2016, Nita's cow died due to an illness. She had bought the cow a few months earlier with a large loan from a bank. This situation was a massive economic crisis for her household. This situation also marked a shift in her approach towards energy exchanges. Monetary returns became even more

emphasized 30 rupees as monthly rent for providing solar-item. Vasu Yadav's family reacted strongly to Nita's demand and Vasu said, '*we help her family a lot, she should not ask for money from us*.' Vasu's family was also bitter that Nita had made the monetary calculation. Nita persisted with her demand, and Vasu's family provided her with in-cash payments to clear some of the dues and made a cautionary statement, '*you have taken money from us. Fine, but when you will need something from us, we will also do the same*'. A few months later, Nita requested them for brief access to the tractor. Vasu responded by asking for a precise cash payment for the tractor and Nita had to agree reluctantly. Since then, both families have started calculating the monetary worth of other goods as well, which were often provided without any monetary translation and this forces them to use cash, a limited resource, as a mode of payment. The bitterness with the use of cash has trickled in their social relations.

3.6.2. VIGNETTE: COMBINING IN-CASH WITH IN-KIND RETURNS

This vignette describes characteristics of in-kind returns that the givers pursued from 'socially distant' receivers while engaging in a mutual energy trading. Further, this vignette showcases how in-kind returns were utilized as the receiver did not have sufficient cash for payment.

Nandan Singh is a middle-aged farmer at Manpur whom Aarti describes as their village acquaintance. He became a receiver at the end of February 2016 and continued to be one since then. Nandan started taking a charged solar-item on a regular basis but did not pay any rent for four months. On a few occasions, Aarti and Ramesh reminded him to pay the monthly rent of 60 rupees. As in the previous vignette, here as well making a 'profit' or a material gain was necessary for the givers. Nandan apologized for the delay due to lack of sufficient cash to pay the rent but assured them to clear all the accumulated dues eventually. Aarti and Ramesh demonstrated their trust and empathy for his economic condition and continued to provide him the solar-item. A fascinating event happened in September 2016 when Nandan provided two kilograms of garlic pods to Ramesh as a return for the

significant for her. She started speaking of energy returns as a way to reduce her financial stress.

solar-item. In the following extract, Ramesh indicated his view on accepting garlic:

> Ethnographer: *Why did he give you garlic instead of cash? Did you need it?*.
> Ramesh: *Yes. I have sown garlic in my field. You will see it outside [pointing to his field]. Garlic was needed for it. He [Nandan] said he was going to sell garlic and then will give me cash [to clear the dues]. I told him as I am in need of garlic, give me garlic instead of cash. He said okay, take it.*.

It is a common practice that the villagers sell any surplus of their harvest to the wholesale market in Gaya. When Nandan brought the garlic pods to Ramesh's house, Ramesh measured them using his weighing scale. At that moment, the market rate of one kilogram of garlic was 120 rupees. Nandan and Ramesh mutually agreed to use the market rate as a reference to calculate the monetary worth of two kilograms of garlic to be 240 rupees. Hence a commensuration in return was achieved. This measurement and agreement were crucial for the satisfaction of both the giver and the receiver as indicated in the following comment:

> Aarti: *both parties [giver and receiver] are satisfied if it is measured. Both will be assured that the amount returned is fair and balanced. If it [return] is unmeasured, then they [receiver] may feel whether they have given more than what was an appropriate amount. Similarly, we [giver] will be assured they have not given less than what it should be.*

Similarly, Nandan also provided Ramesh with one kilogram of corn worth twenty rupees as a return for the solar-item. Over the period of eleven months, Nandan provided 260 rupees through in-kind return and 280 rupees in cash. At the end of 2016, he still owed 120 rupees to Aarti but assured her to clear all the dues using a combination of both in-cash and in-kind returns. See Table 3.5 for details of other 'socially distant' receivers at Rampur and Manpur who used a combination of in-kind and in-cash returns.

A noteworthy finding was that when the giver had a choice between accepting in-kind return in the form of an item they need or an equivalent amount of cash,

they preferred the former. Ramesh in the following conversation eloquently put forth his rationale behind the choice.

> Ethnographer: *If someone asks you to choose between taking cash as rent or an item you need, such as garlic. What will you choose?*
> Ramesh: *As such both are fine. However, if I accept cash eventually, it will be a lesser amount. If he is already selling the item, so I will take the item. Like, I choose to take garlic instead of cash.*
> Ethnographer [indicating obscurity]: *Why will you prefer the item [over cash]?*
> Ramesh: *To get an item, I would have to go to the market. So if someone [any receiver] is going to sell the item by himself, so I will tell him that as you have dues to clear then why don't you give this thing to me as I have to buy it in any case.*

In general, the villagers' value peer-to-peer exchange of locally produced goods, such as food items, over trading in the market. The transaction cost of market-mediated trading of goods is high due to the remote location of these villages and inadequate public infrastructure such as roads and means of transports. Moreover, the villagers wish to circumvent a need for involving a middleman to trade in the market. A common perception amongst the villagers is that the middlemen financially benefit at their expense and trading an item in the market often introduces various intermediaries in the process. Furthermore, it is a common practice for villagers to compensate each other for providing a service by use of an in-kind mechanism. For instance, at Rampur, Nita regularly hires some (landless) villagers to work in her field and commensurate them with rice grains.

At Manpur, six other receivers provided food items as returns (see Table 3.5). An important caveat many receivers explicitly state is that they will use a food item for a return only when they have a surplus of the food item beyond the requirements of their households. Preference for food item over cash is further indicated in Aarti's strategy to not ask for any in-cash returns from a lentil farmer, also a receiver (MP-R28), with whom she has reached an agreement for taking five kilograms

of *moong daal* (green lentils) in late 2017.

3.6.3. Vignette: In-kind return to avoid in-cash return

This vignette describes characteristics of in-kind returns that the givers pursued from 'socially close' receivers while engaging in a mutual energy sharing. This vignette presents a case where a giver and her 'socially close' relation used in-kind returns as they were unwilling to use in-cash returns due to the nature of their social relationship. Shiv Yadav is a farmer at Rampur and belongs to local patrilineage (*gotiya*) of Nita's husband. Shiv requested Nita for a solar-item for her frail and elderly mother, who has failing eyesight that severely restricts her mobility after the sunset, and for his school going children to study after the sunset. Nita readily agreed to the request and assigned a solar-item. However, Nita was hesitant to ask for any in-cash return due to the nature of her social relationship with Shiv and his family. In the local sociocultural setting, taking cash-based payment from *gotiya* is a contentious issue as they can construe it as an act of pursuing 'profit.' The villagers consider profiting from *gotiya* as immoral. However, it is not objectionable for someone to get his/her monetary due but without making any 'profit.' Nita feared Shiv and other members of the *gotiya* would view her as greedy and making monetary 'profit' if she asked for cash-based payment at the end of every month. This situation is in contrast with the previous two vignettes where the value of 'profit' was justified and desired by the giver. This situation was precarious for her as it could socially isolate her from the *gotiya*.

For the first few weeks since the start, Nita continued to provide Shiv with a solar-item without mentioning any rental payment. She started to implicitly convey to Shiv's family and her other members of the *gotiya* through casual talks about the amount of labor that goes into managing the setup. She attempted to first establish a moral and social legitimacy for a rental collection from them. Most of the *gotiya* households acknowledged her efforts and an opinion developed amongst the *gotiya* that her efforts deserved monetary compensation either by providing in-kind returns or a combination of in-cash and in-kind returns. A notable exception was the reaction of Ravi Yadav, who was unsatisfied with Nita's rationale rental col-

Table 3.5: Various in-kind returns utilized at Rampur and Manpur between 1 February-31 December 2016

ID	Village	Relation with the giver	Type of Return Provided	Description of In-Kind Returns
RP-R5	Rampur	'Socially-Close' (*gotiya*)	In-kind (work)	Service of diesel-powered irrigation pump-set for 20 hours and 30 minutes
RP-R6	Rampur	'Socially-Close' (*gotiya*)	In-kind (work) combined with in-cash	Service of diesel-powered irrigation pump-set for 4 hours, access to buffalo and plow, and 150 rupees
RP-R8	Rampur	'Socially-Close' (*gotiya*)	In-kind (work) combined with in-cash	Provided service of his tractor and ploughed Nita's field twice in 2016, and 90 rupees
RP-R9	Rampur	'Socially-Close' (*gotiya*)	In-kind (work) combined with in-cash	Service of diesel-powered irrigation pump-set for 3 hours, and 105 rupees
RP-R10	Rampur	'Socially-Close' (*gotiya*)	In-kind (work) combined with in-cash	Service of diesel-powered irrigation pump-set for 4 hours, and 227 rupees
RP-R21	Rampur	'Socially-Distant'	In-kind (work)	Access to 'jharni,' a tool for husking of grains on three occasions, and 227 rupees
RP-R22	Rampur	'Socially-Distant'	In-kind (work)	Made a wooden ladder and two spades (agricultural tools)
RP-R27	Rampur	'Socially-Distant'	In-kind (non-food) combined with in-cash	8 liters of Kerosene oil and 103 rupees
MP-R12	Manpur	'Socially-Close'	In-kind (work) combined with in-cash	Medical consultations and 60 rupees
MP-R8	Manpur	'Socially-Close'	In-kind (food) combined with in-cash	Provided few liters of milk and 100 rupees
MP-R19	Manpur	'Socially-Close'	In-kind (food) combined with in-cash	250 grams of clarified butter ('ghee') worth 200 rupees, milk, and 120 rupees
MP-R20	Manpur	'Socially-Close'	In-kind (food)	Milk for two months (worth 80 rupees)
MP-R23	Manpur	'Socially-Distant'	In-kind (food) combined with in-cash	7 kilograms of potatoes (worth 120 rupees) and 240 rupees
MP-R31	Manpur	'Socially-Distant'	In-kind (food) combined with in-cash	2 kilograms of garlic, 1 kilogram of corn, and 280 rupees
MP-R27	Manpur	'Socially-Close'	In-kind (non-food)	Cow-dung cakes (worth 180 rupees) and milk (worth 70 rupees)
MP-R29	Manpur	'Socially-Close'	In-kind (food)	Green lentils (worth 150 rupees), cow-dung cakes (worth 100 rupees), 1-kilogram vegetable (worth 20 rupees), and few liters of milk
MP-R16	Manpur	'Socially-Distant'	In-kind (non-food)	Cow-dung cakes (worth 200 rupees)

lection and raised moral questions by stating, '*You would take money from us? You are making a profit from us (humse faida kamati hai)*.' They refused to provide any in-cash or in-kind rent, returned the solar-item and the energy exchanges stopped. In contrast, Shiv's family considered the rent as fair and not 'profit', however, they revealed their unwillingness to part with hard-earned cash for the rental payment. In mid-March, Nita cautiously made an offer to Shiv's family to which they agreed. Nita agreed to regularly provide Shiv's family with a solar-item for the rent of 30 rupees per month. Instead of providing rent in-cash, Shiv would irrigate Nita's field using his diesel-powered irrigation pump-set.

Shiv owns a diesel-powered irrigation pump-set for past many years. As Rampur does not has access to any form of running water, villagers rely on monsoon rains and groundwater extracted by these irrigation pump-sets as the primary means for irrigation. It is a common practice for the villagers to provide service of the pump-sets to other villagers for a locally agreed rate of 30 rupees per hour. In the past, Nita had requested and negotiated with Shiv and other villagers for irrigation and had paid them 30 per hour in cash and in-kind for accessing their irrigation pump-sets. Hence, Nita and Shiv had an ongoing monetary exchange relationship. Shiv irrigated Nita's field for a total of 20.5 hours as a return for the solar-item (see Figure 3.11). At the end of 2016, Nita owed Shiv 285 rupees, which she intended to balance with solar-items in 2017.

In this case, Nita and Shiv quantitatively measured the return by keeping account of the number of hours of access to the irrigation pump. The giver and the receiver achieved commensuration by figurative translation of these hours of use to a monetary worth as indicated by Nita in the following statement, '*rent for one month [of solar-item] is 30 rupees. One hour of irrigation pump is also 30 rupees. So, when I used the pump for six hours, I makeup [sic] for 6 months of [providing] light within the day*'. A vital aspect of these calculations is that the giver performed these as a way to get fair compensation and excluded the notion of 'profit.' See Table 3.5 for details of other 'socially close' receivers at Rampur and Manpur who either provided a combination of in-kind and in-cash returns or used solitary in-kind returns.

An important observation was that whenever Nita had an option to choose

between in-cash return and in-kind return she selected the later. This observation corresponds with the preference for in-kind returns at Manpur as reported in the previous section. In many instances, Nita refused to accept an instant in-cash return from a receiver and negotiated for a delayed in-kind return. In such a situation, Nita could have accepted in-cash return whenever it was offered and used the money collected to pay for the entity (work, service, or commodity) whenever she needed it. In such a way, she could have lowered any risk of non-payment, but the following conversation provides an alternative explanation:

> Ethnographer: *What is better for you if a receiver offers you payment in cash or in-kind, such as by providing work?*
> Nita: *Work is better*
> Ethnographer: *Why is work better?*
> Nita: *Isn't work always better? If one gives me 30 rupees, it will not be of much benefit [to the household's economic condition]. That is why I said to them [receivers], why do you give me 30 rupees [in cash]? Add all the dues and later do some work for me. So this [work] is better. If someone gives us 30 rupees, then it will be spent somewhere but if someone works then some vital work will get done. That is why I prefer work [over cash].*

In the above extract, the reasoning for Nita's choice to prefer for in-kind returns over cash lies in the value of such work and services in these villages. Nita and other villagers narrated difficulty in securing such essential services and resources. Acquiring such service requires a lot of social negotiations, and one has to deal with the risk of disagreement and other crisis. Villagers reported various instances of disputes and arguments over access to such services. Hence, Nita preferred in-kind returns as it secures a need in the future.

3.6.4. VIGNETTE: CASES OF INTANGIBLE RETURNS

This vignette describes characteristics of intangible returns, which the givers pursued from 'socially intimate' receivers while engaging in a mutual energy sharing. This section exhibits the conceptual distinction of intangible returns from the mon-

etary returns (in-cash and in-kind) by describing the cases of Ram Manjhi at Manpur and Nita's joint family group at Rampur.

Soon after the installation, Aarti and Ramesh invited Ram Manjhi to take a solar-item from them. Both of them were eager to provide a solar-item to Ram's family. Ramesh informed that his grandfather and Ram's grandfather were close friends. He proudly stated that close bonding between the families have continued since then and the families have firmly stood by each other. Ram accepted Ramesh's offer and continued to use the solar-item till it was broken-down in November 2016. For the lights provided for ten months (Feb.-Nov.), Aarti and Ramesh did not ask for any rent. Ram did not provide any in-cash or in-kind return, and yet Aarti and Ramesh were satisfied with the exchanges. This behavior was in contrast with energy exchanges with 'socially distant' receivers with whom Aarti and Ramesh were found demonstrating their anguish for non-payment and demanding rental payment either in-cash or in-kind. The ethnographer probed this situation further:

> Ethnographer: *Did you ever ask them [Ram Manjhi] for rent?*
> Aarti: *No. We have not asked them to give us rent. They will give [rent] on their own Ethnographer: So, why have you not asked them for any payment?*
> Aarti: *Well, our families are very close to each other. Our families have a history of being and dining together. We have worked together [indicating their closeness] Ethnographer: For what do you work together?*
> Aarti: *We work together in the field. For instance, sometimes they [Ram Manjhi's family members] help us with agricultural tasks. On some other occasions, we help them. Ethnographer: For the work in the field do you pay each other?*
> Aarti: *No! It is 'adla-badli' [reciprocating/swapping], meaning I do something for you and you do the same for me.*

Ramesh and Aarti gave similar responses for four other receivers consisting of three of his friends and a *gotiya* (Surya Singh). Aarti informed of a noteworthy interaction with Surya. Months after the start of energy exchanges with Surya, he

visited Aarti and gave her 200 rupees. Aarti refused to accept the money, but Surya insisted that the amount was not a rent payment but a contribution to repair and maintenance of the setup. She eventually relented to Surya's insistence. She emphasized that he gave the cash by himself ('*apse se de gaye*') and mentioned that this was without any expectation from her end. She did not count this cash transaction as an in-cash return but as a token of social support. Ramesh later added, '*we will not ask for a monetary return from any family members. They will say that he is giving amongst his own and still asking for money*.' Ramesh and Aarti considered various social gestures and acts such as help in the field, and assistance during the time of need to be appropriate returns from the 'socially intimate' receivers. Similarly, at Rampur, Nita provided a solar-item each to her father-in-law, mother-in-law, brother-in-law and sister-in-law throughout the study. All of these receivers are part of her joint family group. Nita did not ask for any rent, and these receivers offered none. It also reflected in the self-reporting diary where there is not a single instance during the eleven months where Nita and Ranjan mentioned any monetary dues. It is a significant observation in light of financial trouble Nita was dealing with and desperate measures she was taking to increase her financial earnings. As in the case of Ram Manjhi at Manpur, Nita made similar arguments for not asking for any rent from these receivers:

> Ethnographer: *Do you take any rent from these receivers [pointing to names written on a self-reporting dairy entry]?* Nita: *We do not take any rent from Madhav [Nita's brother-in-law]*
> Ethnographer: *From Rachna [Nita's sister-in-law]?*
> Nita (attempting to clarify): *She is my sister-in-law, [similarly my] mother-in-law and father-in-law, how can they pay rent?*
> Ethnographer: *But do you tell them to provide rent?*
> Nita: *I do not ask. What will I tell them? From them, rent is not necessary. I do not ask them for anything.*
> Ranjan: *If you feel like it, then only give, if you do not feel like it then does not give anything*

Nita's choice (and also of Aarti and Ramesh at Manpur) to not ask for any

monetary rent from her 'socially intimate' receivers is grounded in a sociocultural milieu, where engaging in a monetary exchange with such persons is considered to be morally inappropriate. Elaborating on this issue, she and other villagers mention, '*this is how we live*.' Nita further added that by offering solar-items to her in-laws she was able to maintain her social relationships, demonstrate her goodwill and preserve their social support. She viewed these intangible entities as sufficient return for the solar-items provided. In the absence of her husband, Nita relies on her in-laws for various tasks. They play a crucial role in mediating in resolving any crisis she faces. Brewing property dispute between her husband and one of her brother-in-law had made the situation of her nuclear family precarious. For the time being, with the mediation and support from other members of her joint family group, a temporary truce has been established. The disputes within the joint family group have made her realize that she cannot take the social support and goodwill of members of her joint family group for granted[14].

Overall, in these cases of mutual energy sharing with the 'socially intimate' receivers, the givers deemed intangible returns as more valuable than any monetary (in-kind or in-cash) return. The ethnography demonstrates that people repelled quantification and measurement of the intangible returns. Similarly, they do not translate intangible returns into any monetary value. The notion of 'profit' is absent in these cases. These returns are qualitatively felt and experienced. Likewise, an idea of commensuration and translation concerning money can destroy the essence of these returns. A receiver provides an intangible return on his or her own without being asked for it. The act of asking, calculating and measuring are a risk and counter for purposes of intangible returns such as maintaining an enduring social relationship.

There are two unique methodological problems with intangible returns. First, these intangible returns are often latent and well concealed within ongoing social interactions that the givers and receivers usually do not perceive or state them as 'give and take.' For instance, a giver does not view a specific act of kindness by a receiver as a return for energy transfers. Second, in-cash and in-kind returns can also lead to some intangible benefits. For instance, Nita and Ranjan reported get-

[14]See [14] for more details on disputes within Nita's family and its influence on energy exchanges.

ting small favors and help, such as borrowing an agricultural instrument or getting a free ride to the city, from the receivers. They stated with confidence that the energy exchanges have contributed to various small and mundane favors they received in their everyday life, but they struggled to specify which one to those gestures were returns linked with energy transfers.

3.6.5. VIGNETTE: CODA TO THE STUDY

The infrastructure remained with the givers after the end of the study on 31 December 2016. The givers continued to provide the solar-items to the receivers. During the study many solar-items were damaged; nevertheless, the givers were able to repair some of these and put them back in circulation. At the time of preparation of this manuscript, i.e., in early 2018 and two years since the 'installation,' the infrastructure was still being used. However, only a small number (<10) of the solar-items have remained functional. The longevity of the infrastructure can be attributed to the value the givers attached to the infrastructure and also to the maintenance and care they had provided. The givers have repeatedly communicated their sense of satisfaction with the overall compensations provided by the receivers.

Towards the end of the study, the ethnographer asked the givers about how the choices they made were similar and different from a situation where they had to invest in the infrastructure to procure it financially. As also highlighted in Section 3.4.2, the givers firmly stated that even though they did not financially invest in the infrastructure, they 'paid' for it with their efforts. They considered the infrastructure as privately owned by them and mentioned that their choices and decisions would have been mostly the same.

However, the givers state specific subtle differences. The givers felt had they financially invested in the setup the energy exchanges would have started with lesser rental negotiations. The villagers would not have questioned the legitimacy of their decision to ask for rent. They clarified that even then the negotiations on the amount of rent would have happened. They pointed out that such negotiations are typical in the villages and are part of everyday access to goods and services from

each other. The givers stated that with the 'socially intimate' persons they would have dealt with in the similar way as observed in this study. The givers reiterated that the villagers avoid monetary and calculative exchanges with 'socially intimate.' In support of their argument, they indicated that their 'socially intimate' relations regularly share various 'machines,' such as motorcycles and mobile phones, with them without asking for any payment or monetary calculations. In case of 'socially close,' the givers stated that they still would have offered the solar-items, however, a difference would have been in the directness in asking for the rent from these receivers. For instance, at Rampur, Nita felt that had she purchased the setup she had been more forthright in asking for in-kind returns from *gotiya* ('socially close') households, yet she would have preferred in-kind returns in dealing with them. The givers added that the infrastructure had made them and the villagers aware of how energy exchanges can work in their social world. However, without this understanding, the givers and the villagers are less likely to buy the infrastructure.

3.7. Returns-continuum: a conceptual model

Based on the ethnographic findings, we propose that the three types of returns, i.e., in-cash, in-kind and intangible, can be viewed as a coexisting, overlapping, dynamic, and continuous spectrum, i.e., a returns-continuum, in the social sphere of economy. See Figure 3.12. Here, we utilize formulation of spheres of an economy by Arjo Klamer, a cultural economist, to support the proposition of returns-continuum.

Klamer proposed the notion of spheres of an economy as a way to bring together perspectives from anthropology and economics (see [98] for more details). He proposed three distinct spheres of economy, namely, market sphere, social sphere, and home sphere. The social sphere of the economy consists of everyday social interactions that are outside of the home and the market [98]. Hence, it is also considered to be a non-market space where local communities strive. Economic Anthropologist, Stephen Gudeman, describes it as 'community realm' of an economy [99]. A social sphere is where mutual energy exchanges emerge (see [14]). Our conceptualization of returns-continuum views the social sphere of energy economy to overlap with the market sphere at one end and with the home

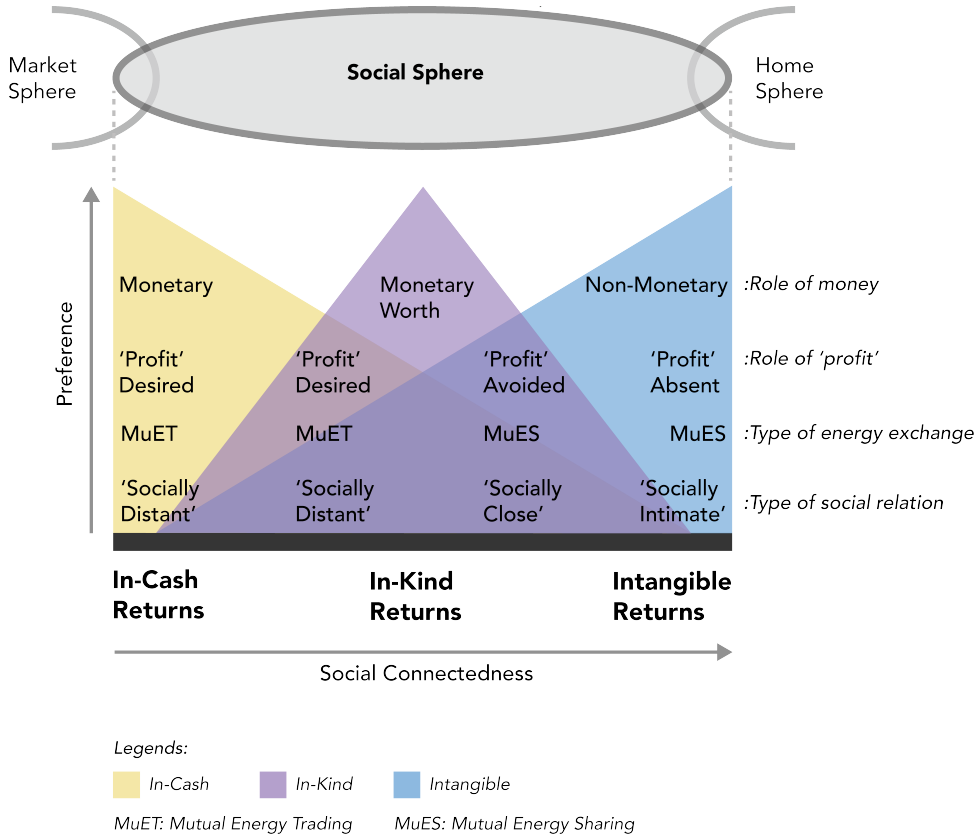


Figure 3.12: A visual representation of a returns-continuum.

sphere at the other end. The market sphere comprises of people's everyday participation in acts of buying and selling mediated by a market structure [98]. Whereas the home sphere encompasses processes of transfer and allocation of things based on a strong sense of kinship, or a feeling of social bonding and connectedness [98].

The returns-continuum proposes that at the market end of the social sphere, in-cash returns are preferred whereas towards the home sphere intangible returns are valued, and in between these two ends in-kind returns acquire prominence for people. Further, the returns-continuum suggests that people's preference for a type of return varies with the dynamics of their social relationship, i.e. 'social connectedness' between a giver and receiver. In general, the returns-continuum, conceptually suggests that structuring and procuring a return is not only an eco-

nomic event but also a complex sociocultural process.

3.7.1. Preference for in-cash return

The givers usually pursued in-cash returns when participating in mutual energy trading with the 'socially distant' receivers. In-cash returns are important for the givers as it helps them to acquire fiat money, an entity that is an important means to address various necessities of people's life. As is the case of a large number of villages in the world, these villages are not entirely self-sufficient. The villagers have to obtain a variety of necessary goods and services from the market for their survival. Therefore, a social sphere and home sphere of an economy are connected to and dependent on a market sphere for certain necessities. This reliance and need to engage with the market contribute to the value of fiat money in the village, as it is an essential means of payment for procuring goods and services from the market. It seems that fiat money is one of the necessary tools for connecting a home, community, and village economy to the market sphere of an economy.

From a utilitarian perspective, use of in-cash return seems to make an energy exchange simpler and efficient. As compared to in-kind and intangible returns, the in-cash return seems easier for the villagers to document, memorize, and calculate credit/debit balance. However, the ethnography also reports various issues with in-cash returns (Section 3.6.1) such as (a) scarcity of cash; (b) procuring these is a strenuous exercise; (c) theft and unnecessary spending risks; and (d) potential to strain social relationships. The ethnography provided rich accounts of situations where the givers refrained from pursuing in-cash returns from 'socially close' and 'socially intimate' receivers. All these issues also indicate that people do not view and invoke returns using only utilitarian economistic logic. Instead, people structure returns by employing a range of social, cultural, moral and economic notions, which explain why people prefer a particular type of return in a context while renouncing the same in another context.

3.7.2. PREFERENCE FOR IN-KIND RETURN

The returns-continuum proposes the in-kind return as conceptually between in-cash and intangible returns. The givers pursued these in-kind returns when participating in mutual energy trading with the 'socially distant' as well as in mutual energy sharing with the 'socially close' receivers. The ethnographic findings (Section 3.6.2 and 3.6.3) denote that the givers at Rampur and Manpur when they have to choose between in-cash and an in-kind return of equal monetary worth, they hold the following preference order:

In-kind return >= In-cash return

An important caveat for this preference order is that the giver needs and values the in-kind entity offered by a receiver. With the use of in-kind returns, Nita and Shiv avoided any in-cash transactions and yet managed to access a needed item (solar light) and work (irrigation) for their respective households. Similarly, in-kind returns were a useful alternative in the situation of cash scarcity and poverty, where without the use of in-kind return energy exchanges would have stopped and many households would have been deprived of the solar lighting. With creative use of in-kind return, people were able to transact using items they needed and make the return mutually beneficial. This also signifies that even though both in-kind and in-cash returns are monetary, they cater to different social and moral values. The ethnography demonstrated and gave a more nuanced understanding of how monetary logic can govern in-kind return. In total, the ethnography showcases that in-kind returns are desired in a number of contexts: (a) to address scarcity of cash (Section 3.6.2); (b) to utilize locally produced goods and services for accessing energy (Section 3.6.2); (c) as a way to avoid moral issues with in-cash returns and to enable circumvention of cash in energy exchanges (Section 3.6.3); and (d) to secure a service in near future (Section 3.6.3).

3.7.3. PREFERENCE FOR IN-TANGIBLE RETURN

The ethnography (Section 3.6.4) indicates that the givers restricted themselves to intangible returns when participating in mutual energy sharing with the 'socially

intimate' receivers. The intangible returns are built upon the notion of togetherness, friendship, love, solidarity, and different ways of bonding with others. In such cases, people seem to value their enduring social relationships more than making any monetary or material gain. The study indicates that in such a condition the givers at Rampur and Manpur seems to have the following preference order:

Non-monetary return (intangible) > *Monetary return (in-kind or in-cash)*

The giver and receiver structure an intangible return not through a rational economic framework but by using a moral, social, and cultural compass where various intangible entities are aspired for and override the search for any tangible monetary benefit. The case of Surya Singh (Section 3.6.4) also hints at a way fiat money can acquire a different sociocultural meaning within the returns-continuum and can appear as an intangible return between 'socially intimate'. In cases of in-cash and in-kind returns, if a receiver does not provide a return, then the receiver has a monetary debt, whereas in case of intangible returns a receiver does not incur any monetary debt when not providing a return. However, a receiver can destroy the relationship and the exchange by only taking and not giving back, for instance by not contributing to the sense of togetherness, failing an expectation of the giver, or by not offering support when a giver needs it.

3.7.4. Variations in the meaning of 'profit'

The ethnography indicates variations in the sociocultural logic of 'profit' as invoked in the energy exchanges with different receivers. It showcases that the local notion of 'profit' is a relative concept rather than an absolute or fixed idea. A relational stance on 'profit' was visible in the breakdown of energy exchange with Ravi Yadav (Section 3.6.3), Nita's *gotiya*, while energy exchanges with Shiv Yadav and other *gotiya* households continued. Ravi Yadav interpreted the rent to be 'profit' while other *gotiya* considered the same amount of monetary rent to be not 'profit' but a fair compensation. A 'profit' seems to be relative to the various dimensions such as the nature of social relations, socioeconomic statuses, and context of the exchange. We consider that the distinction between mutual energy trading and mutual en-

ergy sharing hinges upon this variation in the notion of the 'profit' as emphasized in the returns-continuum. The ethnography suggests that a giver and receiver mutually construct the notion of 'profit.' Hence, the valuation of 'profit' seems to be constantly negotiated within the locally emerging social, cultural and moral values of appropriateness, fairness, propriety, friendship, kinship, and family ties. These negotiations can be explicit and visible in conversations for a 'profit' desired from 'socially distant,' can be muted and avoided in case of 'socially close,' and can be absent in case of exchanges with 'socially intimate.'

3.8. Discussion and recommendation

3.8.1. Acknowledging dynamics of social relations in returns

The concept of returns-continuum describes the complexity of social relationships in peer-to-peer returns. It emphasizes that the types of returns desired by a giver differ with the nature of his or her social relationship (social connectedness) with receivers. The concept views the social connectedness between people as dynamic, which changes with the passage of time, alters with shifts in life situations, and can be reconfigured during various social events. For instance, a 'socially close' person can become 'socially distant' and vice versa. Such changes in social connectedness between a giver and receiver could lead to a shift in the type of returns that they utilize in energy exchanges. Analogously, a variation in the type of return between people can also influence their social connectedness. A trace of it was observed in case of energy exchanges with Vasu Yadav (Section 3.6.1).

The concept of returns-continuum implies that practice of structuring, administering, and provisioning of a return is a sociocultural process that has potential consequences for a social relationship between a giver and receiver. Some energy researchers suggest the use of 'peer pressure' and making local community responsible for the payment collection from other villagers (for instance, see [15, 24]). We recommend to energy researchers and practitioners that passing the entire responsibility of payment collection to a local community should be sensitively structured. A possible way forward is to take into account the social connectedness of local

community members who are tasked with payment collection from other villagers. Potential future research in this regard can be in developing methods that can support energy practitioners to gain quick insights into social connectedness of people who are entrusted with payment collection in off-grid energy setting.

3.8.2. Enabling diversity in returns

Based on the ethnographic findings, the returns-continuum underscores that the three types of returns can co-exist and overlap with each other in the social sphere of an energy economy. Hence, these returns should preferably be understood as neither disjoint nor static. The proposal of returns-continuum recognizes that all the three types of returns have different values for people in different contexts of energy exchanges. Moreover, the returns-continuum acknowledges people's ability to use different types of returns simultaneously.

As already discussed, cash (or fiat money) is not the only type of return that people value. Even though in-kind and intangible returns, from the utilitarian point of view, may seem inefficient and laden with social negotiations. However, these allow people to cater to their social relationships and demonstrate sensitivity to the socioeconomic conditions of others. In-kind and intangible returns enable givers to creatively and empathically address their social dependencies on receivers, who are not merely their 'customers' but are an essential part of their life world. Hence, in-kind and intangible returns benefit local energy exchanges by creating space for sociality to emerge through social negotiations and maneuvers in the process of identifying an appropriate return. Moreover, these returns facilitate such off-grid setups to become more embedded in the social life of people rather than being a tool of lone rational economic benefit. Therefore, the concept of returns-continuum advocates for in-kind and intangible returns as meaningful in their own right and not as mere fillers in the absence of cash.

We recommend to energy researchers and practitioners to move beyond the fiat money-centric thinking by enabling diversity in peer-to-peer returns in off-grid energy systems. We advocate for an off-grid setup where all the three types of

returns are facilitated, and people are provided with the control to structure and choose from these returns depending on the varying contexts of energy exchanges.

We consider that enabling diversity in returns can bring the following three benefits. First, it can help in making an off-grid setup to be more people-centered. This approach will allow people to adapt returns to the multiplicity of their life contexts. Moreover, it will make energy exchanges to be more responsive to the social, cultural, economic and moral values of people. Second, enabling diversity in returns can also help in addressing rural householders' limited ability to pay in cash, which is stressed as one of the major impediments to the growth of off-grid energy systems (see [17, 24, 33, 100]), as the householders can legitimately use the other types of returns in case of cash scarcity. Third, relatedly, it has the potential to improve the rental collection, which is documented in energy literature to be a pressing issue for rural electrification [15, 20, 24, 28, 43]. For instance, in the case of energy exchanges with Nandan Singh (Section 3.6.2) rental collection could happen by combining in-cash and in-kind returns. Further research is needed to study technical, financial, infrastructural, and business challenges an external agency would have to address to enable diversity in returns. For instance, in a project where an external agency (NGO, utility, state) has to collect payment from people to cover the capital cost of the energy infrastructure (for instance [22]), in-kind and intangible may not be directly useful for them.

3.8.3. Interconnecting energy exchanges with local in-kind economy

Building upon the formulation of spheres of economy by Klamer [98] and taking support from ethnographic findings, the concept of returns-continuum suggests that inter-household energy exchanges within a village to be considered as part of social sphere of energy economy, which is distinct and different from market sphere (and home sphere) of an energy economy. The ethnography demonstrated how the three types of return that populate the social sphere of energy economy vary in types of calculation performed, scales of measurements used, notions of commensuration, logics, and values.

The study reported that the villagers' tend to prefer a localized, peer-to-peer, and in-kind exchange of goods and services within the village. Some of the reasons for this as documented in the ethnography (Section 3.6.2 and 3.6.3) are: (a) to reduce transaction costs; (b) to avoid market trading that often involves various middlemen, whom villagers wish to evade; and (c) to escape use of fiat money for procuring goods and services for their households. Moreover, the villagers demonstrated their ease, creativity, and capabilities in exchanging various in-kind entities with each other. Hence, we recommend interconnecting local village economy of in-kind things, such as of agricultural yields, dairy production, skills, labor, and other everyday things with the economy of energy exchange. This recommendation suggests moving beyond '*energy for fiat money*' model of off-grid energy economy towards '*energy for in-kind things*' economic structures. Such an approach could assist in the development of new energy exchange models that can function without the need for fiat money and utilize locally available goods and services for the provisioning of energy.

A further study with more focus on investigating the potential of local economies for such system is suggested. Correspondingly, more research is needed to design and develop novel mechanisms that facilitate payments using different types of returns, incorporate a range of quantitative and qualitative calculations, various scales of commensuration, and importantly are not limited to the market-logic by enabling people to use diverse logics of their social spheres. Similarly, we recommend development of scalable solutions to interconnect such energy economies across villages. In this regard, ongoing developments in blockchain technology could have some potential. Blockchain technology could be utilized to track and translate various types of returns into scalable and meaningful measures. However, more interdisciplinary research is needed for making blockchain technology usable and relevant for energy exchanges in such low-resource settings in the global south. Similarly, further research is required to understand how with the mediation of digital technology the dynamics of social relations between a giver and receiver engaged in peer-to-peer energy exchange changes.

3.8.4. Relevance of ethnographic approach

On the methodological front, we recommend energy researchers to include ethnographic approaches to study the use of 'rents,' 'tariff,' 'fee-for-service,' 'payments,' and 'fees' in any off-grid setting across the globe. An ethnographic research endeavor, as demonstrated in this study, has potential to bring a holistic, layered, and embedded understanding of such returns. This ethnography showcased that the village level decision-making is complex, negotiated, convoluted, emergent, and filled with competing values and logics.

In this section, we also reflect on the generalizability of findings of this study. The emic details as presented in the descriptive ethnographic vignettes may be particular to rural India. We do not claim that the preferences for the three types of returns to be universal, rather these are locally embedded and can be ethnographically studied and uncovered. Similarly, moral issues with 'profit,' and determinants of social connectedness maybe particular to rural India. However, the etic understanding as presented with the concepts of returns-continuum, and conceptual categories of returns, and the social connectedness are more general than the ethnographic particularities. Similarly, the lens of social relationships, as emphasized by returns-continuum, in understanding various aspects of returns is generally applicable.

3.8.5. Significance of findings beyond rural India

We consider these conceptual outputs of this study to be relevant for off-grid rural electrification initiatives in the global south, such as [15, 18–21, 101]. For instance, instances of social connectedness influencing returns can be seen in the following text reporting on a Mini-Grid project in Malawi:

> *'three interviewees [villagers] believed that the secretary charged different connection fees and prioritised certain households depending on their personal relationships'* ([101]:52), and *'it should also be noted that households were connected to the grid not only because they could afford the invest-*

ment costs but also because of social complications. For example, it was revealed that some villagers were connected to the grid earlier because of their personal relationship with the secretary' ([101]:51).

These empirical pieces of evidence are reflective of the underlying logic of social relations, which the returns-continuum brings to the forefront.

We also consider the concept of returns-continuum to be relevant for some emerging and envisioned contexts in the global north. The first author's ongoing user research on scenarios of energy sharing using bi-directional electric cars in a vehicle-to-grid system in a western European country indicates the relevance of in-kind and intangible returns in such contexts as well. Preliminary findings document various limitations of individual in-cash returns in such a setup and also indicate people's preference for in-kind and intangible returns when they consider energy exchange with their 'socially close' and 'socially intimate.' Once this ongoing research is completed, it will be published in a separate chapter. Another example from the global north is the Jouliette pilot [102] in The Netherlands where a local community manages a dedicated renewable energy-based smart-grid and the corresponding local energy economy. The website of the project mentions their plan to include some in-kind returns:

'*Beyond just enabling energy exchange, the community will be exploring further applications for the Jouliette, such as using it to trade for goods at the De Ceuvel Café [site of the pilot], to facilitate a local time-banking system, and to integrate other intra-community services, such as a car-sharing program*.' [103].

We suggest further research on the relevance and preference of in-kind and intangible returns in correspondence with different factors of social connectedness in off-grid and smart decentralized grids located in the global north and global south [104, 105]. Such an understanding can potentially provide useful insights for the energy practitioners and governments. Another challenging yet fruitful line of inquiry could be on how findings from off-grid setting in the global south can provide insights to off-grid pilots in the global north and vice versa.

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4

Envisioning Anthropology-through-Design

This chapter conceptualizes and describes an 'anthropology-through-design' (AtD) approach, which is a contribution to the emerging trans-disciplinary field of design anthropology. Design anthropologists acknowledge that the discussions in the field have majorly revolved around what anthropology brings to the field of design. However, what and how design can contribute to anthropology is a discussion that needs more attention. The chapter includes a description of the AtD approach at an outline-level with four key phases, namely, framing, design intervening, emic understanding, and etic understanding, and the associated steps of each of the phases. The chapter demonstrates how in the AtD approach, 'design' becomes an instrument of anthropology. Overall, the chapter serves to describe the knowledge generation in the AtD approach as a collaborative and intersubjective; reflexive and relational; and performative and dialogic process.

At the time of writing of this dissertation, this chapter is under review to a design journal: Singh, A., Strating, A. T., Herrera, N. R., van Dijk, H. W., & Keyson, D., '*Envisioning Anthropology-through-design: a design interventionist approach to generate anthropological knowledge*.' (For the sake of readability of this dissertation, some cosmetic changes have been made.)

4.1. INTRODUCTION

Design Anthropology is an emerging trans-disciplinary field at the site of convergence of anthropology and design, two distinct domains of knowledge [1, 2]. The literature on design anthropology is skewed towards discussion exploring the potential relevance, benefits, and contributions of anthropology for design [3]. Traditionally, such discussions have been limited to the methodological use of ethnography in design [2–4]. In contrast, discourse on what and how design can contribute to anthropology has been limited. Some scholars, such as [5–8] have initiated conversation on the potential of design for anthropology within the domain of design anthropology. There is a need for further attention on ways design can be conducive to anthropology especially in the context of an anthropological investigation on a sociocultural phenomenon that is 'non-dominant' in the real world. This chapter describes a 'non-dominant' phenomenon with the following characteristics. A 'non-dominant' phenomenon is a phenomenon that is either not yet occurring in the social life of people or is in its nascent form with limited performances to be observed in the real world. However, the technological, economic, and sociocultural trends indicate that the real-world occurrences of the phenomenon may become a reality or may get established in the near future. Hence, a non-dominant phenomenon may still be underspecified and in need of better anthropological conceptualization considering the potential emergence of the phenomenon in the real world.

This chapter describes and reflects on a doctoral study that aimed to build an anthropological understanding of a non-dominant phenomenon of inter-household energy exchanges. When the study was initiated, there were hardly any real-world situations where such energy exchanges could be observed, as the infrastructure for inter-household energy exchanges within neighborhoods or villages was still not available. Moreover, this phenomenon was mostly unspecified in energy literature (more details in Section 4.3.1 of this chapter). Overall, this situation raised a challenging methodological question, i.e., how to anthropologically and ethnographically study a sociocultural phenomenon, such as inter-household energy exchange, which is 'non-dominant' in the real world. Hence, this chap-

ter addresses the corresponding research question, i.e., how can anthropological knowledge about a 'non-dominant' phenomenon, such as inter-household energy exchange, be generated using a design intervention?

This chapter proposes an 'Anthropology-through-Design' (AtD) approach, which is one of the outcomes of the above mentioned doctoral project. This chapter defines 'anthropology-through-design' as a research approach to generate anthropological knowledge about a social and cultural phenomenon through the use of a design intervention in the real world. The primary purpose of the AtD approach is for the sake of generating anthropological knowledge. The object of AtD inquiry is a sociocultural phenomenon. A key engine of the AtD inquiry is the use of a 'design intervention.' Building upon conceptualization of 'design intervention' in design anthropology [9] and research through design [10], we view a 'design intervention' in context of AtD to be *an intervention that is configured based on strategic design choices and activities with the aim of enabling emergence of a sociocultural phenomenon in the real world*. The design intervention in the proposed AtD approach is grounded in the notion of providing material and conceptual space for a sociocultural phenomenon to take shape in situ or in other words to become observable for an anthropological inquiry.

This chapter describes four strategic phases of the AtD process, namely, *framing*, *design intervening*, *emic understanding*, and *etic understanding*, and the associated steps of each of the phases. See Figure 4.1 for an overview and Figure 4.2 for a detailed view of the AtD approach presented in this chapter. The proposed AtD approach takes a strategic step in relocating 'design' from being an object of anthropology, as in 'anthropology of design' [4, 7] or a beneficiary of anthropological knowledge, as in 'anthropology for design' [4, 11]- to becoming an instrument for doing anthropology. This approach is in contrast with the aims of many design anthropological work, design ethnographic studies, and research-through-design inquiry where often the knowledge generation is oriented towards a solution or improvement and realization in the real world. The AtD approach described in this chapter is one structured way, and not the only way possible, for locating 'design' for the benefit of anthropology. Overall, the chapter serves to describe the knowledge generation in the AtD approach as a collaborative and intersubjective;

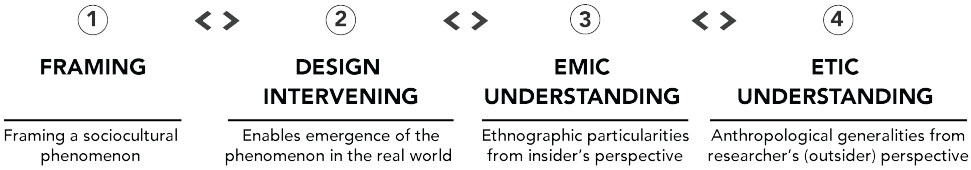

Figure 4.1: Overview of anthropology-through-design approach.

reflexive and relational; and performative and dialogic process.

Before delving into the description of the AtD process, we present the context of the project reported in this chapter. The study reported in this chapter is the doctoral research project of the first author. The project started with a vaguely defined aim of designing a system that facilitates renewable energy trading between households in the emerging context of decentralized energy systems. The future societal vision of this project is connected to the prospective scenario of energy provisioning systems where energy will be generated in a neighborhood or a village through renewable sources, such as solar PV modules, distributed and consumed, and the householders will take an active role in the local management of energy. A relevant point to mention is that in the study reported, the first author played multiple roles simultaneously, such as of design researcher, ethnographer, and data analyzer. In this chapter, we will refer to the role of the first author as that of a 'design anthropologist,' which covers all these multiple roles.

We consider this chapter as a knowledge contribution to the field of design anthropology. Hence the primary audiences of this chapter are design anthropologists; and design researchers, designers, and anthropologists who are interested in design anthropology. The remainder of this chapter is organized as follows. Section 4.2 provides a literature background covering relevant debates in design anthropology and research-through-design. Sections 4.3, 4.4, 4.5, and 4.6 respectively describe the four strategic phases of the AtD process. Finally, Section 4.7 presents a general discussion and conclusion.

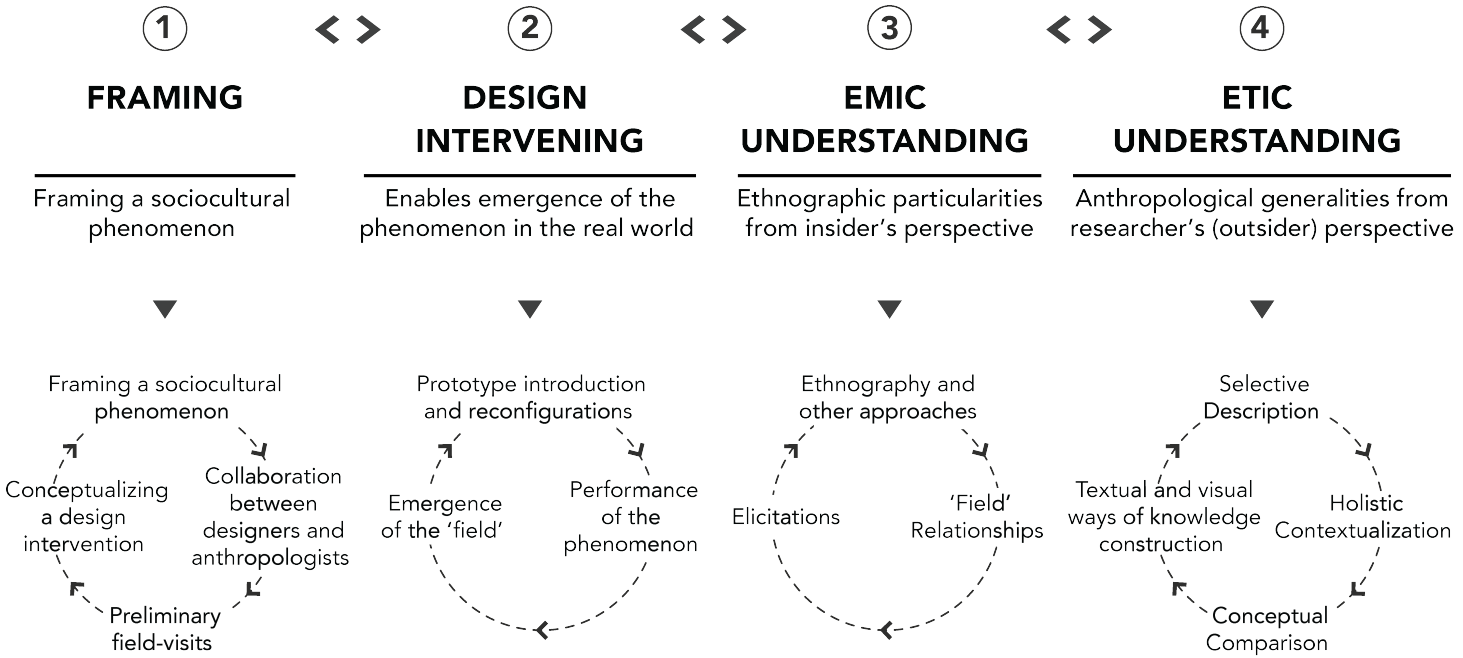

Figure 4.2: Detailed view of anthropology-through-design approach.

4.2. Literature Background

4.2.1. Anthropology, Ethnography, and Design

In a broad sense, (social and cultural) anthropology is a defined as '*an intellectually challenging, theoretically ambitious subject which tries to achieve an understanding of culture, society and humanity through detailed studies of local life, supplemented by comparison*' ([12]:7). Ethnography, which is often stated as the nucleus of anthropology, has two related yet distinct meanings. One of the meanings of the term 'ethnography' is a '*process of inquiry*' that includes methods of immersion in a social world, participant observation, and fieldwork [13, 14]. The other meaning of 'ethnography' is a 'product' of the ethnographic process that primarily includes ethnographic writings (monographs, and articles) produced to describe the observations [13, 14]. The terms 'anthropology' and 'ethnography' are often used interchangeably, however as Ingold [15] argues these are distinct and different from each other. Ethnography is a documentary and a descriptive exercise. Ethnography's main purpose is to retrospectively describe social life for 'others' [7, 15, 16]. In other words, if ethnography is a methodological approach and its descriptive output, then anthropology is an understanding of being human in a society [12, 17, 18]. The goal of anthropology is to develop '*a generous, comparative but nevertheless critical understanding of human being and knowing in the one world we all inhabit*' ([15]: 69).

In general, design or more specifically the process of 'doing design' is described as '*work done with the intention to produce a feasible solution to improve a given situation*' ([10]: 9). Traditionally, design's approach can be summarized by its orientation towards the future, the goal of developing products and services as an attempt to enable a desired state [19] by causing an implicit or explicit 'change' through its manifestation in lives of people. Similar to the use of the word 'ethnography,' 'design' as well has twin meanings of a process, as in 'designing' or 'doing design,' and also as an 'outcome' or 'product,' i.e., designed artifacts that result from design activities. Research through design (RtD) is a developing knowledge realm within the field of design. RtD is broadly defined as a '*designerly contribution to new knowledge*'

([10]: 63). RtD looks at the overlaps and differences, and tensions and coherence in 'doing design' and 'doing research' [10]. Usually, RtD uses a design artifact or a prototype as central to the process of knowledge production [10, 20, 21].

While anthropological endeavor is to understand the reproduction of societies, the design aims to transform societies [14]. Despite these differences, a common feature between anthropology and design is their empirical grounding, reliance on methods of observations, and interest in human behavior and practices for their respective purposes [4, 14]. Within these differences and similarities, a new trans-disciplinary field of design anthropology appears. Design anthropology is still in its nascent stage, drawing its approaches, perspectives, and debates from both design and anthropology, and simultaneously challenging these two fields to engage and collaborate [22].

As it is widely acknowledged, the earliest and still the dominant mode of collaboration between design and anthropology is on a methodological front that focuses on purposing ethnography as for the benefit of design [3, 4, 14]. Such an engagement appears in the literature under the label of 'design ethnography' [3, 16, 23]. Design ethnography aims to use an ethnographic approach to produce insights for design [16, 23]. It aims for a holistic understanding of people's experiences with the use of a designed artifact in a particular situation. Usually, in this regard, ethnography results in the form of contextual rich understanding of environment or space where design is or would be situated and a holistic understanding of 'potential' users. A crucial difference between design ethnography and the AtD approach is that even though both engage with ethnography, they have very different purposes for using ethnography. While design ethnography uses ethnography for the benefit of design, AtD uses ethnography combined with design for the sake of anthropological knowledge.

4.2.2. CONFIGURATIONS OF DESIGN ANTHROPOLOGY

In academic literature, confluences of design and anthropology appear in a number of configurations, such as 'anthropology of design', 'anthropology for design,' 'de-

sign for anthropology,' and 'anthropology with design.' Some differences amongst these configurations are more apparent than the others. Here, we briefly provide a summary of the key features of these configurations.

Anthropology of Design is a '*cross-cultural study of human design activities*' ([24]: 210). This configuration takes design as an object of anthropological analysis [4, 7]. The main aim is the development of anthropological theory and understanding of design activities [11]. *Anthropology for Design* is an approach of utilizing 'anthropological methods and concepts' in a design process [4]. In other words, anthropology for design situates anthropology 'in service of design' [11]. For instance, in a design process where ethnographic studies are utilized for determining design requirements [11]. Hence, many design ethnographic studies can be viewed as examples of anthropology for design.

Anthropology with Design is a '*trans-disciplinary gathering or approach that accumulates mutual exchanges [between design and anthropology] among theories, methodologies and tools*' ([22]: 127). The discourse on 'anthropology with design' is on doing anthropology together with designers and people [11]. In this configuration, the focus is on disciplinary interaction and collaboration between designers and anthropologists in a research project. *Design for Anthropology* is an approach where '*anthropologists borrow concepts and methods from design to enhance traditional ethnographic forms*' ([4]: 434). In other words, here, 'design' is utilized for the benefit of ethnography. As the description indicates, the primary practitioners of this configuration are anthropologists, and the focus is on the methodological influence of design on anthropological methodology. The anthropology-through-design proposed in this chapter builds upon the configurations of *Anthropology with Design* and *Design for Anthropology*.

The contemporary discourse in design anthropology argues for moving beyond the configurations of 'anthropology of design,' 'anthropology for design,' and 'design ethnography' as the main forms of association between design and anthropology [11, 14, 25]. Murphy and Marcus ([3]: 252) state, '*Yet as critical as the relationship between anthropology and design has become, we cannot help but notice that this relationship has historically been, by and large, one-sided, with a predominant em-*

phasis on the benefits of anthropology for design without much regard for any potential contributions of design for anthropology... In other words, in most instances the relationship between anthropology and design is asymmetrical, with anthropology almost exclusively subordinated to the needs of design'. The anthropology-through-design approach presented in this chapter is an attempt to make this relationship more symmetrical again.

Many scholars recommend exploring the potential of design to contribute to a revision and renewal of the process of anthropological knowledge generation for further development of design anthropology(see [4, 6, 7, 14, 22]). Smith and Otto [5] recommend developing 'interventionist design anthropology,' i.e., unique approaches that simultaneously work by emergence and intervention. Relatedly, Halse and Boffi [9] argue that a design intervention can be viewed as a 'form of inquiry.' AtD process described in this chapter aligns with these views and sees knowledge generation as intertwined with the emergence of an intervention in a phenomenon centered on the use of a design intervention. Rabinow, Marcus, and colleagues [6] suggest design and architectural design studio as a relevant metaphor for developing different anthropological research techniques and practices for understanding the contemporary world. Relatedly, Kjaersgaard and Otto [8] suggest a mutually enriching collaboration between design and anthropology. They state, '*design as a way of doing anthropology, and anthropology as a way of doing design. In our view design and anthropology do not simply reflect but actively engage with each other's practices and perspectives*' ([8]: 188). Gatt and Ingold [7] project 'anthropology by means of design' as distinct from and an alternative to 'anthropology by means of ethnography.' They view 'anthropology by means of ethnography' as a descriptive practice, whereas they describe 'anthropology by means of design' as a practice of correspondence, i.e., anthropologists and designers collaboratively responding to the dynamics of the world we all inhabit [7]. Overall, these authors are attempting to extend and redefine design anthropology 'as a distinct style of doing anthropology' ([14]: 10). These views shape the conceptual backdrop of the AtD approach. AtD approach extends many of the ideas presented by these authors.

The AtD approach proposed in this chapter whole-heartedly agrees with the scholars on endorsing the potential of design to become an instrument for anthro-

pology. However, the AtD approach attempts to address a number of knowledge gaps in the field of design anthropology. First, despite these valuable discussions, design anthropology, in general, lacks a structured methodological approach on how design can become an instrument for anthropology. The AtD approach proposes a structured approach in this regard. Second, usually in the existing empirical studies on the role of design in doing anthropology, and also indicated in configurations of Anthropology with Design and Design for Anthropology, designers and anthropologists are two distinct experts bringing in their disciplinary training and focus into a research inquiry. In contrast, the AtD approach brings forth a role of a 'design anthropologist,' i.e., a practitioner of design anthropology who is either a designer (or design researcher) with an anthropological sensitivity or vice versa. In the case described in this chapter, a design researcher takes a primary role in anthropological knowledge generation. Third, in contrast to the innovative suggestion by Gatt and Ingold [7] to viewing design as an alternative to ethnography in the process of anthropological knowledge production, AtD approach suggests closer and concurrent manifestation of both.

4.3. Phase 1: Framing

This section reports on the 'framing' phase in an AtD process. See Figure 4.2. The primary aim of this phase is to frame a 'non-dominant' sociocultural phenomenon and familiarizing with the anthropological discourses of the selected phenomenon for an AtD study. Four key elements of this phase are: (a) Framing a sociocultural phenomenon, (b) collaboration between designers and anthropologists, (c) preliminary field visits, and (d) conceptualizing a design intervention. The significance of each element may vary based on the specific context of a project. We do not suggest any particular order for pursuing these elements. In the context of a project, a design researcher can start from any of these, or can simultaneously pursue them, however, engagement with these elements should preferably be seen as an iterative exercise where findings from one influence the other elements.

Before providing more details about the four key elements in this phase, it important to provide some information about the educational background of the 'de-

sign anthropologist.' The first author has education and professional background in design and engineering, which included training in design ethnography. Before the start of this Ph.D. research, the first author began self-educating himself in ethnographic approaches and anthropological theory. This self-education has included attending seminars on anthropology, discussions with trained anthropologists, and conducting design ethnographic field-studies. He has utilized ethnographic approaches to investigate diverse themes, such as community communication in urban slums [26–30], designing mobile-voice based language learning games for rural primary schools [31], and circulation and distribution of music videos using MicroSD cards in rural settings [32, 33]. As part of the doctoral education, for the last three years, the first author has been involved in anthropology related courses as well as engaged in detailed discussions, feedback, and supervision by an economic anthropologist from the University of Amsterdam.

4.3.1. FRAMING A SOCIOCULTURAL PHENOMENON

As specified earlier, the object of AtD study is a sociocultural phenomenon, and the primary purpose of AtD is to generate anthropological knowledge about the phenomenon. Hence, even before any design intervention is planned, it is critical for a design researcher to select a sociocultural phenomenon and familiarize him/herself with anthropological discourses of the selected phenomenon. An identification of the phenomenon requires inputs from all the elements of the 'framing' phase. Furthermore, familiarization with anthropological discourses about the phenomenon includes becoming aware of various theoretical stances and debates in anthropology. Such a sensitization will support in the framing of the research questions, awareness of knowledge gap, choice of field-site, and selection of particular methods for research investigation. Most importantly, this step keeps the focus of the AtD process and subsequent design intervention on its potential to generate anthropological knowledge. A subtle yet crucial distinction from the usual approaches followed in the field of design is to start a project by sustained thinking of a phenomenon to investigate rather than starting with a framing of a 'problem' to address and its potential 'solution' to be designed.

In the doctoral project reported in this chapter, the design anthropologist started by reviewing the literature on energy exchanges emerging from the domain of energy research. There are two main knowledge gaps that shaped this research project. First, energy exchanges are predominantly discussed from a rational techno-economic perspective. This perspective assumes householders to be rational economic actors who are motivated by the value of maximization of profit. Further, this view limits the concept of inter-household energy exchange to the notion of 'energy trading,' which is characterized as anonymous and impersonal buying and selling of energy mediated by neoclassical market principles [34]. However, the existing knowledge on energy exchanges lacks discussion on how various sociocultural factors and values shape energy exchanges between households. Furthermore, the design anthropologist questioned and imagined various types of personal, monetary as well as non-monetary energy exchanges to be possible in a real-world setting. The design anthropologist recognized that to generate (scientific) knowledge about such energy exchanges a longitudinal in-situ field study is required.

Second, the design anthropologist engaged with anthropological literature on 'exchange' and realized that the anthropologists have created wealth of conceptual and ethnographic texts on various types of exchanges, such as, trading, sharing, gifting, allocation, and barter that go beyond the rational choice perspective (see, [35–42]). However, not much has been written about the anthropology of energy exchange. Further, the existing energy literature lacks conceptualization of different types of energy exchanges that could be possible when householders are allowed to manage energy distribution for their neighborhoods or villages. Moreover, anthropological concepts and debates on various types of exchanges seemed to have a potential for understanding energy exchanges. The engagement with works of various anthropologists such as Mauss [36], Polanyi [42, 43], Sahlins [40], Gudeman [41, 44, 45], Hunt [38, 46], and Widlok [39, 47] started forming the anthropological theoretical backdrop for this research. Overall, sensitization with the anthropological discourse on exchanges empowered the design anthropologist to take a critical stance at the dominance of 'energy trading' view of inter-household energy exchanges. The research project started focusing on building a conceptual

understanding of the phenomenon of inter-household energy exchange from an anthropological perspective.

4.3.2. COLLABORATION BETWEEN DESIGNERS AND ANTHROPOLOGISTS

AtD is a proposal that requires and is enriched by collaboration between design researchers and anthropologists. The exact nature of the collaboration may vary with the specificities of a project, but such collaboration should ideally be conceived right from the start till the end of an AtD process. A collaboration with anthropologists in this 'framing' phase can help design researchers in various ways, such as interpretation and appreciation of anthropological discourse of the phenomenon, making design researchers to be aware of their ethnocentric beliefs , and increasing their awareness of various latent sociocultural assumptions embedded in a design process, goal, and direction of the project. A design researcher engaging with an anthropological discourse may find it to be filled with diverse and abstract viewpoints resting on various theoretical strands. Without an active engagement of a trained anthropologist, it is likely that the design researcher may feel overwhelmed with the rich and extensive anthropological literature on the chosen sociocultural phenomenon. Therefore, this collaboration is suggested as a crucial component of the proposed AtD approach.

In the project reported in this chapter, the collaboration between the first author and the economic anthropologist was in the relation of a doctoral student and research supervisor. The economic anthropologist holds a doctorate in social and cultural anthropology with a specialization in economic anthropology. In the reported project, this collaboration helped the design anthropologist to clarify the theoretical and conceptual underpinnings of various anthropological views of exchanges. Overall, we suggest that apart from the above-mentioned themes, the collaboration of a design researcher with an anthropologist as part of AtD process should focus on: (a) developing possible research directions and questions, and (b) developing an understanding of anthropological discourse and perspective of the phenomenon.

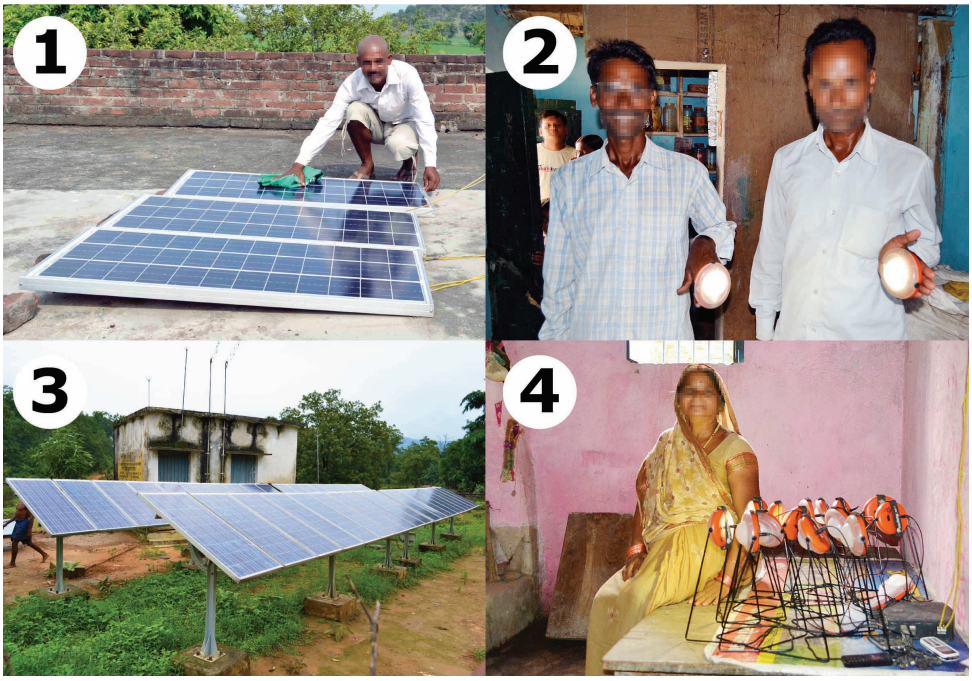

Figure 4.3: Some photographs from preliminary field-visits. Note the labels: '1': A male energy entrepreneur; '2': Villagers demonstrating use of solar-lamps; '3': A standalone mini-grid; '4': A female energy entrepreneur.

4.3.3. PRELIMINARY FIELD-VISITS

AtD approach recommends making preliminary field-visits that include interaction with potential research participants and various practitioners, and visits to potential research sites. Such a step is primarily useful for (a) getting reflection and clarity on possible research directions and questions on the phenomenon, (b) sensitizing with the practical 'real-world' situation, (c) identifying various possibilities, constraints and requirements for a design intervention, (d) forming field contacts, and (e) locating potential field-sites for a design intervention. This step is a useful direction for getting practical and early feedback from the possible research participants and site, which is vital for the planning of a design intervention as part of the AtD process.

The design anthropologist contacted Rural Spark team, an energy business startup, which was piloting energy-renting business in villages of Gaya district of

India. Various discussions led to an agreement for collaboration to conduct preliminary field-visits. See Figure 4.3. The design anthropologist visited six villages where Rural Spark's rental services were piloted. These visits included unstructured interviews and participant observations of users of Rural Spark's rental service. A couple of months later, the design anthropologist was also involved as an informal and external advisor to a field study conducted by Rural Spark where new battery prototypes were introduced in villages of Gaya. This study aimed to understand villagers' use of the battery prototypes for improvement of the product service offering by Rural Spark. Following these collaborations, a short design project was co-structured by the design anthropologist and Rural Spark team for students enrolled in the Industrial Design master's program. As part of the design project, students conducted a short field-visit to evaluate Rural Spark's products and redesigning some material components of Rural Spark's energy kit as an outcome of their design process. The design anthropologist was involved in this project as a mentor, helping students with ethnographic data collection techniques, data analysis, and translating findings into design concepts. The findings of these studies were communicated to Rural Spark team in the form of workshops, presentations, discussions, sketches, and student reports. During both the battery prototype study and the student project, the design anthropologist was involved in discussing and brainstorming various design ideas, concepts, sketches, and prototypes. Learning from these engagements contributed to the framing of a design intervention (see Table 4.1) and helped the design anthropologist to clarify and develop a research strategy used in the next phase of the AtD process (see Table 4.2).

4.3.4. CONCEPTUALIZING A DESIGN INTERVENTION

'Conceptualization of a design intervention' is an essential step in an AtD approach. The primary purpose of a design intervention in an AtD process is to facilitate the research, and it plays a central role in the anthropological knowledge generation about the selected sociocultural phenomenon. The conceptualization of the design intervention centers on two elements. First, identifying and designing a prototype (or artifacts) that enables the selected phenomenon to emerge in the real-

Table 4.1: Key decisions for identification of the prototype

Dimension	Description	Consequences
Financial	The prototype should be cheap (cost < 2000€) to fit within the project budget	Various prototypes to enable inter-household energy exchanges that required extensive material components such as connecting households with electrical cables be abandoned. A prototype that enabled a manual exchange of energy by use of storage devices was selected
Role of prototype coupled with a reason for energy exchange	The prototype should have some utility for people, i.e., it addresses some of their needs, which they fulfill by exchange of energy	In the un-electrified villages in Gaya, people valued solar lighting and mobile phone charging. Hence, the prototype was directed towards these needs
Portability	The prototype should be portable to enhance a manual exchange of energy	Portable power-banks, solar lanterns and LED lamps were selected
Robustness	The prototype should be robust to sustain rugged use by the villagers in harsh physical conditions for a long duration	The design anthropologist decided to use an assemblage of off-the-shelf products that were made for the environment. Various ideas for including lab-made electronics were abandoned not to compromise robustness; such as using Arduino boards to account for times villagers charge power-banks
Mundane Aesthetics	The prototype should not look flashy or unique. Based on previous field-visits, the design anthropologist felt that people might try to keep an energy product to themselves if it is perceived as attractive and expensive. This may also result in theft	In selecting components of the prototype, the design anthropologist deliberately chose items that were mundane looking. The prototype should be of instrumental use rather than a demonstration of creativity
Ease of Use	Local villagers should be familiar with the use of the components of the prototype. Using the prototype should have a minimal learning curve	The design anthropologists selected various items that had simple on-off buttons and charging options

Table 4.2: Key decisions for research strategy of the prototype

Theme	Decision
Research Site	Gaya district was a relevant site for the research as it had many un-electrified villages
Duration of the study	The initial aim was to have the prototype function for at least three months
Criteria for selecting a field-site	Some of the key criteria were: (a) un-electrified village, (b) heterogeneous population belonging to different castes, (c) need for solar-lights, (d) people's familiarity with solar technology, (e) Ease in physically accessing the villages, (f) feasibility of conducting field-research, and (g) interest of the villagers to participate in the research
Mode of energy exchange	Energy Kiosk model where a volunteering household in a village would become an energy-giver for the village was selected. Various other structural alternatives, such as commons approach or making multiple households as energy-givers were considered
Criteria for selecting an energy-giver	Some of the key criteria were: (a) degree of interaction and communication a potential energy-giver has with other caste groups in the village, (b) their literacy levels, (c) proficiency and comfort in using the prototype, and (d) their interest and desire to be energy-giver
Ownership of the prototype	We decided to provide ownership of the prototype without asking for any financial investment from the volunteering households. (See [48] for discussion and consequences of this choice)
Number of exchangeable items	We decided that the number of exchangeable items should be large enough to allow for inter-household energy exchanges to happen. The design anthropologist assumed that if the number of such items is small (<5) then a household may prefer to use these for there household needs rather than exchanging these with others
Demand>Supply	We decided to select villages where the demand for the solar-lighting will be higher than the supply. Such a situation will require an energy-giver to select and make choices about whom to provide energy. Hence, it makes the research inquiry on their choices discernable. Moreover, this situation is a better representation of off-grid villages in rural India
Methods	We decided to use traditional ethnographic methods, with various other techniques such as 'ethnographic network mapping, self-reporting dairy, and hand-drawn exchange mapping exercises (See [34, 48] for more details)

world. A prototype can do this by supporting people to perform the selected phenomenon in their real world context and by doing so the prototype can make the phenomenon observable for a research investigation. Hence, a prototype in an AtD process should aim to make the selected phenomenon performable for people in their real-world context. It is essential to note that the exact nature of a prototype and artifact to be used in any particular AtD process will vary with the nature of the sociocultural phenomenon to be investigated and context of the study.

A prototype is an '*embodied, materialised concept design*' ([10]: 46). (See Table 4.1 for the elements the prototype used in the reported study embodies and materializes). In the reported study, the prototype used is a small-scale off-grid energy distribution infrastructure for solar lighting. The prototype consisted of an assemblage of existing commercially available products such as solar panels, energy routers, LED bulbs, solar lanterns, power-banks, and various types of cables (see Figure 4.4). The prototype is a result of various design decisions (see Table 4.1) and design activities, such as evaluation of Rural Spark's existing prototypes, field-visits, and concept designing a power-bank casing and functioning of the prototype with Rural Spark's team.

The second element in the conceptualization of the design intervention is to develop a research strategy centered on the use of the prototype (or artifacts) in the real-world setting. It consists of identification of research questions, methods, procedure, and instruments as well as various tactical dimensions of situating the prototype for generating knowledge about the sociocultural phenomenon. (See Table 4.2 for some of the elements of the research strategy used in the reported study). In the reported study, various brainstorming discussions happened within the research team. These discussions led to a research strategy consisting of research questions, research methods, and practicalities. The main aim of the research was identified as to define and describe the phenomenon of inter-household energy exchange from an anthropological perspective. A broad overarching research question selected was: how are energy exchanges between households, in a decentralized energy system where householders can decide with whom to exchange energy, related to the social, cultural, and economic life of the householders? In conclusion, Table 4.1 and Table 4.2 define the specific frames the design interven-

Figure 4.4: Off-Grid Energy Distribution Infrastructure. Note the labels: '1': Charging Station; '2': Solar Panel; '3': Solar Lantern; '4': Energy Router; '5': Cables; '6': 3D printed casing of the power-banks; '7': a power-bank in use; '8': a LED Bulb connected with a power-bank.

tion utilized for the anthropological knowledge generation on the phenomenon of inter-household energy exchanges.

4.4. PHASE 2: DESIGN INTERVENING

This sections reports on 'design intervening' phase in an AtD process. A key component of this phase is an introduction of the designed prototype (or artifacts) at an identified research site. Overall, in an AtD process, a prototype serves the primary

role of being a research instrument for generating anthropological knowledge. The ability of the prototype to be a useful research instrument is conjoined with its success in enabling the selected sociocultural phenomenon to emerge in the real world. In the process of enabling the social phenomenon, the prototype becomes a means for the performance of the phenomenon (section 4.4.2), which in turn leads to the construction of a 'field' (section 4.4.3).

4.4.1. PROTOTYPE INTRODUCTION AND RECONFIGURATIONS

The way a prototype is introduced and configured in the real world is a strategic step. The process of introduction in itself has the potential to bring valuable insights about the phenomenon. In the reported study, after visiting many off-grid villages in Gaya district, Rampur and Manpur were selected as research sites as these two villages fulfilled the pre-identified criteria specified in Table 4.2. See Figure 4.5. The prototype was installed at two volunteering households (referred to as 'energy-giver' or simply 'giver' in this research) at Rampur and Manpur respectively. In total, thirty-three solar-items, i.e., fourteen LED bulbs with power banks and nineteen solar lanterns were available for use and exchange in both the villages (see Figure 4.4). The total cost of the prototype was 40,000 Indian Rupees (INR) (around 523€).

The prototype introduction brought the design anthropologist in contact with various villagers. As part of the prototype introduction, the design anthropologist conducted informal sessions demonstrating and discussing how various functions of the prototype can be performed. Similarly, the installation happened in full public view, and many villagers came to see the installation process. The design anthropologist let the energy-givers to plan and install the prototype. This self-organization brought some useful insights on how various things, like skills, are shared in the village. Moreover, many people started interacting with the design anthropologist. The presence of the prototype formed a facilitating backdrop for these interactions between the design anthropologist and the villagers.

The solar-items introduced in the two villages encountered went through cy-

Figure 4.5: Some photographs of the research sites. '1': Rural area of Gaya district; '2': Rampur; '3': Manpur; and '4': a snapshot of rural life at Manpur.

cles of functioning and non-functioning states of breakdown, repair, and re-introduction in the field. Various elements of the prototype introduced broke down during the study, and hence some re-design and repair sessions were held where the villagers found creative solutions to mend broken elements of the prototype using locally available materials. See Figure 4.6. Some of these items were locally restored, hacked, reassembled, and put back into circulation by the villagers. However, many items were damaged beyond use, lost, and stolen. In this case, the AtD process gained by close engagement of people in care, ownership, and management of the prototype. Of the total of 66 solar-items available for energy exchange in both the villages combined at the start of the study, only 36 solar-items (54%) were functional after the eleven months, i.e., at the end of the study. See Figure 4.7. Hence, the AtD process considers a design intervention not merely an event of prototype introduction but as a 'process of becoming' [49] that remains in constant flux.

Figure 4.6: Reconfiguration of various elements of the prototype. Note the labels. '1': Soldering of a broken energy-router; '2': energy-giver repairing a solar-lantern at Manpur; '3': a family member of energy-giver at Rampur redesigning the casing of power-banks using locally available materials; and '4': redesigned cases of power-banks Rampur.

4.4.2. PERFORMANCE OF THE PHENOMENON

As the prototype starts becoming an infrastructure, the performances of the phenomenon emerge in the real world. These performances are relevant objects for a design anthropologist's observation, probing and analysis. These performances are framed by specific design choices made in the 'preparation' phase. For instance, the prototype introduced at Rampur and Manpur enabled the phenomenon of inter-household energy exchanges by means of transactions of 'solar-items,' i.e., solar lanterns, LED bulbs and power banks, between households in the villages. Soon

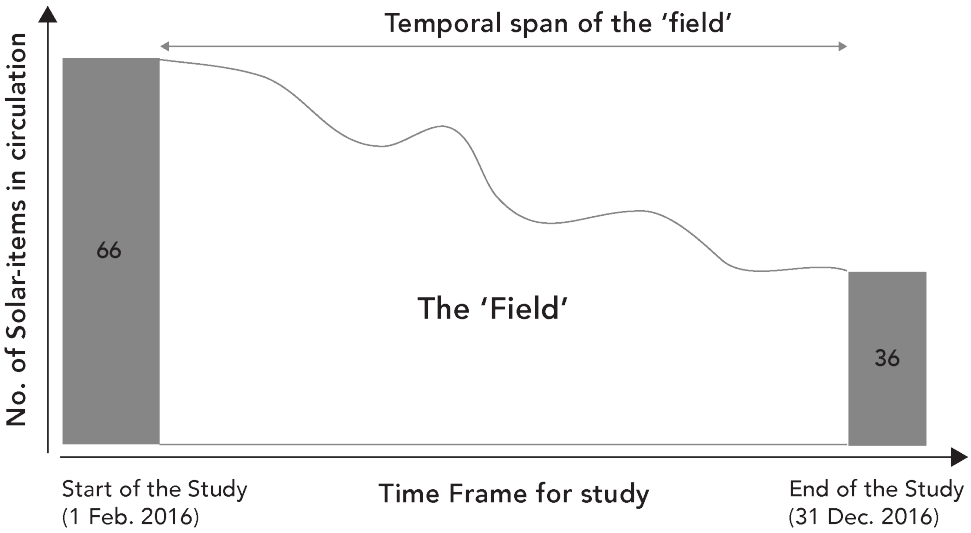

Figure 4.7: A temporal span of the 'field.' Note that the bars in the figure are based on the exact numbers of the solar-items. However, the meandering line joining the two bars is not based on exact numbers but illustrates variation in solar-items in circulation due to reconfiguration.

after the installation of the prototype in the two villages, the solar-items became part of energy exchange practices. Here, we provide a summary of the typical performance of exchange of solar-items (for details, see [34, 48]). The energy-givers and energy-receivers created with each other rules for energy exchanges. They initiated, arbitrated, and reconfigured energy exchange structures, mechanisms, and strategies. The energy givers determined every aspect of the energy exchanges in consultation with their nuclear family members and the design anthropologist refrained from any involvement in structuring the energy exchanges. Similarly, when the energy givers encountered a problem or unforeseen situation such as abuse of solar-item, or non-payment by some energy receivers, they devised various strategies to deal with these. Overall, in this way, the phenomenon of inter-household energy exchange emerged in both the villages with the use of the 'prototype.'

4.4.3. EMERGENCE OF THE 'FIELD'

The emergence of the phenomenon in the real world also constructs the 'field' for investigating the phenomenon. The AtD approach views a 'field' as a collection of

performances in the real world capacitated by the prototype introduced. The 'field' is a physical as well as conceptual space for conducting the 'field-work' that is primary data collection activity. The 'field' provides a window to design researchers to observe performances of the phenomenon. The 'field' is coupled with the working dynamics of the prototypes, and it is dynamic, emergent, and undergoes various reconfigurations. For instance, in the reported study, with the decrease in the number of solar-items due to the breakdowns (section 4.4.1), the numbers of energy exchanges happening in the 'field' were also reduced. Hence, various energy exchanges could not continue further. Such a reduction in the energy exchanges also reduced the empirical possibilities of the phenomenon. Overall, such an emphasis on the idiom of 'performance' in the AtD approach references the *performative* nature of the 'field,' i.e., an entity that results from social actions [49].

4.5. Phase 3: Emic understanding

This phase in the AtD process aims to develop an 'emic' understanding of the phenomenon. An 'emic' understanding, also described as 'insider's perspective' in anthropology, caters to comprehending the phenomenon concerning people's conceptions, vocabulary, categories, and models [12, 50, 51]. The emic viewpoint is sometimes also referred by, '*life as experienced and described by the members of a society*' ([17]: 40). It acknowledges co-existence of people's multiple realities, perceptions, and logics and aims to discern a phenomenon from the viewpoints of the performers of the phenomenon. This step supports design researchers to sensitize themselves with the diverse ways a phenomenon manifests in people's life. Moreover, it helps design researchers to appreciate how people relate to the phenomenon, meanings they associate with it, and why they behave in the way they do. The three key elements of this phase are: 'ethnography and other approaches,' 'elicitations,' and 'field relationships.' This phase foregrounds the crucial role of the prototype in an AtD process, i.e., *prototype as a research instrument*.

4.5.1. ETHNOGRAPHY AND OTHER APPROACHES

As the selected phenomenon emerges in the real world, the investigation of the phenomenon can begin. We envision a combination of ethnography with various other approaches to reap the benefit in building an emic understanding of the phenomenon. AtD attempts to build an emic understanding of the phenomenon in an iterative, emergent and explorative process where empirical observations from the 'field' shape the research direction. AtD process, to develop a fruitful emic understanding, requires design researchers to observe performances of the phenomenon and to document and understand local meanings of terms, labels, concepts, and categories people use in describing the performances of the phenomenon. Such an approach has the potential to reveal peoples' logics, classification, and conceptualization of the phenomenon.

The AtD approach encourages design researchers to creatively engage in the field and experiment with various methods based on the specific context of research. In the reported study, traditional methods in ethnography, i.e., participant observation, interviews, and field-notes, were combined with specific techniques of ethnographic network mapping, participatory rural appraisal, self-reporting diary methods, hand-drawn exchange mapping and use of digital media for self-reporting and triangulation of findings. See Figure 4.8. A useful exercise in using these methods can be co-designing of research tools with the participants. The main aim of such a co-designing activity is to make a research tool fit in the local context. For instance, in the study, the self-reporting diary was iteratively designed with the energy-givers taking into account various elements, such as, language proficiency; interest, skills and experience with documentation; locally available writing materials; locally defined labels and categories; and kind of information they considered significant for keeping account of an energy exchange. As the field-study went ahead, the design of the self-reporting diary was further adapted to particular contexts of both the villages. Eventually, the self-reporting diary became central to the practice of the energy exchanges, and it also became a useful data-gathering tool. The energy-givers used it for record keeping and calculations of monetary dues. The design anthropologist crosschecked the diary entries with the

Figure 4.8: Various research methods used in the study. Note the labels. '1': interviews and discussions; '2': Hand-drawn exchange mapping (see Appendix-B); '3': Self-reporting diary; '4': digital media for self-reporting.

energy-receivers by use of various methods. Hence, in the process of co-design of self-reporting diary, it became a 'boundary object' with different meaning and relevance in the social world of energy-givers and the design anthropologist (for more on boundary objects and design methods, see [26–28]).

The AtD approach suggests adapting the research tools based on the opportunity presented by the 'field' while being sensitive to the 'field' situation. At Rampur, Ranjan, son of the energy-giver who had formed good social-bond with the design anthropologist mentioned his desire to have a smart phone. In December 2016, *Reliance Jio*, a telecom service provider, launched a low-cost mobile data services across India. With the consent of the energy-giver, the design anthropologist gifted

a *Reliance Jio* smartphone to Ranjan. Since December 2016, the design anthropologist has maintained regular communication with Ranjan and other family members of energy-givers though the mobile phone. The energy-giver and her nuclear family have started utilizing Whatsapp, a messaging application, to share digital videos and photos of use of solar-items and entries made in self-reporting diary that they considered relevant for the design anthropologist. See Figure 4.8. Such digital communication has also helped the research process as the design anthropologist used it to clarify emergent themes.

4.5.2. 'FIELD' RELATIONSHIPS

An important aspect that facilitates the 'emic' understanding of the phenomenon is the 'field' relationships. The AtD process considers the 'field' to emerge in the web of relationships amongst design anthropologist ('outsider'), local people ('insiders'), and the design intervention (the prototype and research tools). See Figure 4.9. The local people can participate in an AtD process in various roles, such as of user (of the prototype), research participant, interlocutor, collaborator, co-designer (of the design intervention), and co-researcher. The quality of these relationships influences the 'field' research. For instance, trust and rapport between the design anthropologist and the villagers helped in documenting and developing a 'rich' emic understanding of various social, cultural, moral, and ethical issues with energy exchanges. As a result of such a relationship, villagers shared intricate and personal details that would have remained inaccessible to the design anthropologist otherwise. Similarly, the energy-givers formed a strong bond with the prototype that reflected in the care and use of the infrastructure.

The design anthropologist had initially planned the study for three months. However, the nature of the 'field' relationships allowed the design anthropologist to continue the 'field' study for 11 months and hence, benefiting the reported study. At times engagement in the mundane activities of sharing knowledge with people helps in forming a trusting relationship. For instance, during a visit to Manpur, the energy-giver and her husband mentioned their interest in buying a small digital video camera to start a rental service for their village. The design anthropologist

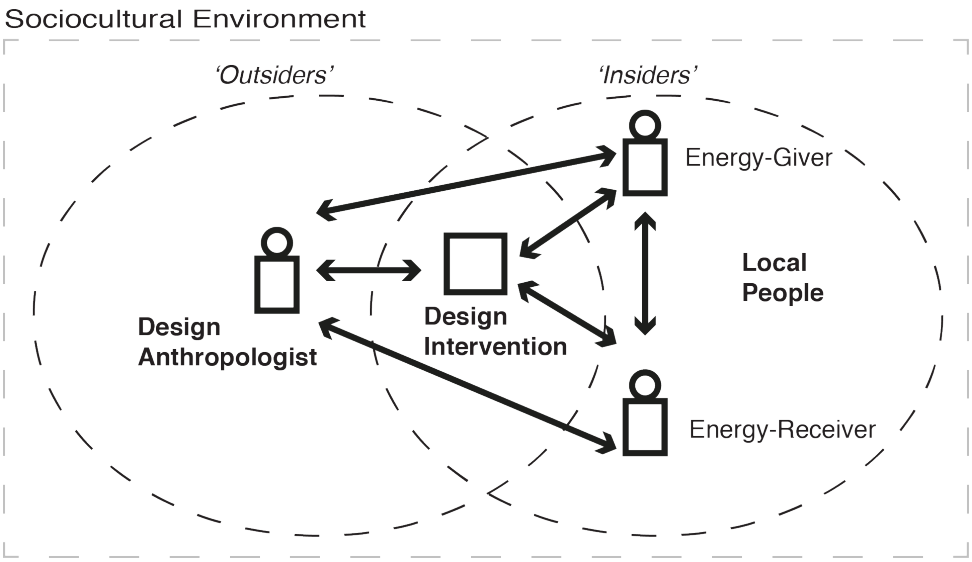

Figure 4.9: Some examples of 'field' relationships.

started sharing his views and knowledge about digital photography and videography. Eventually, the energy-giver bought a digital video camera and started a rental service to video document weddings and various other social functions. An unplanned yet beneficial outcome of this was that the design anthropologist was invited to attend various cultural and religious functions and could observe distinct use of solar-items and solar PV panels. In this way, the 'field' research in AtD process is also a matter of 'correspondence' [7], i.e., a dialogic process that grows with communication amongst 'insiders,' 'outsiders,' and the design intervention.

4.5.3. ELICITATIONS

The AtD process considers five types of elicitations to be useful for the emic understanding of the phenomenon. These elicitations are active ways to engage the local population in providing their reflection on the phenomenon. These elicitations are enabled by the use of various methods, such as discussions, visual methods, probing techniques, and interviews. We do not specify the exact ways to use elicitations in a particular investigation as it depends on the particular context of research and the phenomenon to study. As described below, these elicitations can be made part

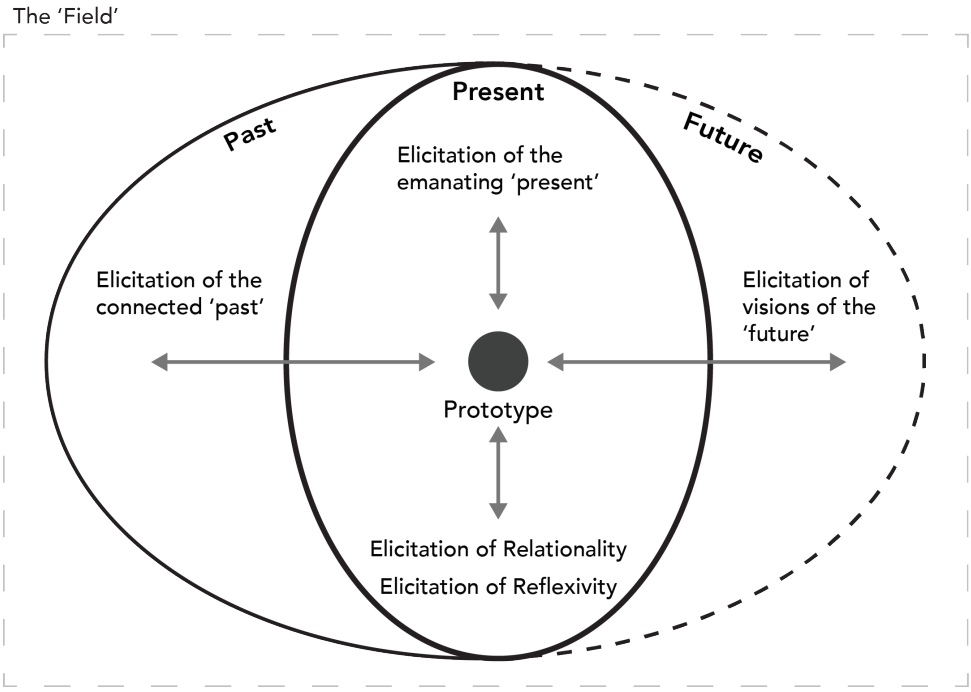

Figure 4.10: Five types of elicitations.

of the ethnographic inquiry. These elicitations are mediated, structured, and facilitated by the prototype introduced. See Figure 4.10.

The five types of elicitations are: 1. *Elicitation of the emanating 'present'*: This elicitation aims to bring forth research participants' interpretations of the emerging performance of the social phenomenon by engaging them in a dialogue. The intention is to draw out from the participants their categorization of the phenomenon, meanings attached to various performances, language used for describing the phenomenon. Hence, the elicitation facilitates a design researcher to understand the emerging performance of the phenomenon from the perspective of research participants and within the local context. For instance, in the reported study, the people spoke of local categories denoting exchanges, such as *adla-badli* (swapping), *mohabatti* (love), and *bhada* (rental). This elicitation foregrounded the significance of various dimensions people utilize to structure energy exchanges, such as the nature of social relations, the role of money, 'profit,' and context of exchange in this

particular context.

2. *Elicitation of the connected 'past'*: This elicitation aims to collaboratively develop an understanding on how the emerging performance of the phenomenon in the 'present' is linked to the 'past,' i.e., a historical context of what is empirically observed. An improved understanding of the historic context of the phenomenon instills a better appreciation of how various past practices, values, and notions are reinvigorated in and are at conflict with the performances of the phenomenon in the 'present.' As part of this elicitation, the research participants are encouraged to compare what is observed in the social world with the 'past.' For instance, the villagers at Rampur and Manpur were engaged in the discussions about how inter-household exchanges of various things have changed over the decades. The villagers provided distinct views of how various types of monetary exchanges (over non-monetary exchanges) have become more common over the years. The discussions revealed the shifting role of money in everyday life, and they provided various examples of how an agricultural technology introduced in the village has impacted social relationships within the village. Such insights helped the design anthropologist to develop a historical perspective on energy exchanges and to include the focus on what types of energy exchanges the prototype disables.

3. *Elicitation of visions of the 'future'*: This elicitation aims to engage people to imagine and discuss future scenarios, aspirations, possibilities, and alternative ways of the growth of the social phenomenon. This elicitation helps in understanding the prospective emerging paths of the phenomenon. The research participants are encouraged through various thought exercises to envision and verbalize their views on how they see the phenomenon taking shape, how the performance in the 'present' can vary with changes in the way the prototype has been introduced. For instance, the villagers at Rampur and Manpur provided a valuable perspective on how energy exchanges would have happened if the entire village communally owned the energy infrastructure or if the installation was made at a household belonging to the lowest caste in the village. The ensuing discussions helped the design anthropologist to become aware of scenarios of energy exchanges under other configurations of energy infrastructure.

4. *Elicitation of Relationality*: The AtD approach assumes that a performance of a phenomenon emerges within a nexus of related social practices (see [52] for relational stance on social practices). Hence, the focus of elicitation of relationality is to facilitate an understanding of how the emerging phenomenon is similar or different from other related practices. In this regard, the research participants are engaged in a dialogue to compare the emerging practices of the phenomenon with other related practices. For instance, the design anthropologist probed how emerging energy exchanges are different and similar from exchanges of various other goods and services in the villages. This comparison helped in better understanding of materiality of energy.

5. *Elicitation of Reflexivity*: The AtD approach, in agreement with reflexive strands in anthropology, acknowledges significance of reflexivity, i.e., considers the performance of the phenomenon and the understanding of it to be shaped by the presence of a design researcher and the specific ways a design intervention has been introduced (for reflexivity in anthropology, see [53–55]). This elicitation attempts to engage research participants in discussing the roles of the design intervention and the design researcher in the way the phenomenon has emerged. Hence, this elicitation attempts to foster a reflexive understanding. In the reported study, this elicitation brought useful insights about how people would have exchanged solar-items if energy-givers had bought the whole setup from the market.

4.6. PHASE 4: ETIC UNDERSTANDING

This phase is aimed at moving from ethnographic particularities and specificities to anthropological generalities. The emic findings are analyzed, compared and translated into more general, abstract, scientific, universal categories and frameworks, i.e. developing an 'etic' (external) perspective [12, 50, 51]. An etic viewpoint is occasionally also described as '*analytical description or explanations of the researcher*' ([17]: 40). The balance between emic and etic understanding in an anthropological endeavor is a matter of debate [12]. Overall, the anthropological knowledge that an AtD approach attempts to generate consists of both an emic and etic understanding of the phenomenon. Although in the description of an AtD process, we describe

the phase of etic understanding as sequentially following the phase of emic understanding, in reality the process of 'etic' understanding starts with the emergence of the 'field' itself. Both these phases are closely connected and a design researcher may oscillate working on these two phases while engaging with the 'field'. For instance, when a design researcher returns from the field and writes reflection notes or sketches key findings to connect with research questions at hand, he or she is already attempting to broaden from the particular 'emic' observations in the 'field' to a more general 'etic' themes.

This section describes four key steps to developing 'etic' understanding from the 'emic' findings. These four elements are 'selective description,' 'holistic contextualization,' 'conceptual comparison,' and 'textual and visual ways of knowledge construction.' All of these four elements are intermingled, overlapping, and concurrently engaged with each other. Here, the AtD approach connects with and builds upon the notion of '*anthropological triangle*,' an approach by which sociocultural anthropology explains and interprets social and cultural life [13, 15, 56]. An '*anthropological triangle*' consists of three nodes of ethnographic description, comparison, and contextualization [13, 15, 56]. The AtD approach associating with the fields of design research [57–60] and research-through-design [10, 21] emphasizes non-textual ways, such as visual approaches, of knowledge generation and dissemination.

4.6.1. SELECTIVE DESCRIPTION

An important first step towards generating 'etic' understanding of the phenomenon is 'selective description,' which consists of identifying key events, observations, findings from the 'field,' and preparing a textual and visual description of these. Any anthropological knowledge generated from ethnographic data requires interpretation, compression, and simplification of the data [12, 61]. The step of 'selective description' caters to this requirement. It aims for and views '*ethnography as a product*' [13], i.e., an account prepared for describing the phenomenon to others. The process of selection brings subjectivity of the design anthropologist to the fore.

Traditionally, in anthropology such an ethnographic descriptive account is also identified as '*a description that has broken away from observation*' ([15]: 88) and is created from a distance from the 'field,' i.e., once an anthropologist returns from the field. However, with the growth of digital technologies, such as smart mobile phones, and mobile internet, the disconnection from the 'field' does not need to be complete, rather the 'observation' can continue and interleave with the phases of preparation of selective description. For instance, in the reported study the design anthropologist's connection with the 'field' and the research participants continued with the help of mobile phones and Whatsapp, a messaging application. This continued connection allowed the design anthropologist to discuss and crosscheck the emergent findings with the research participants. In the reported study, the design anthropologist prepared a list of observations that provide 'rich' description of the various dimensions of the phenomenon that emerged from the 'field.' The design anthropologist conducted in-depth qualitative data analysis of the field-notes, diary entries, and interview transcripts using NVivo, qualitative data analysis software. This qualitative data analysis consisted of iterative cycles of coding, 'memoing' and creating thematic texts [62, 63]. Coding is relevant for summarizing, reducing and condensing the data [63]. 'Memoing' captures the analytical reflection, emergent categories, and themes from the data analysis [62–64]. Taking support of the data analysis, the design anthropologist selected and transformed the key events into ethnographic descriptions.

4.6.2. HOLISTIC CONTEXTUALIZATION

This step aims to translate specific ethnographic particularities as identified by 'selective description' towards a holistic and contextual understanding of a phenomenon. This step of 'holistic contextualization' brings together the anthropological endeavor for holism and contextualization in anthropological knowledge generation into the AtD process (see [12, 50, 65] for 'holism' and 'contextualization' in anthropology). It helps in connecting selected descriptions to various perspectives that go beyond the 'field' site. Here, the AtD process stresses locating the understanding of the phenomenon within the dynamics of 'change' and 'continuity.'

The essence of 'holistic contextualization' is well illustrated by Eriksen ([12]: 40) in his writing on anthropological knowledge: '*every phenomenon must be understood with a view to its dynamic relationship to other phenomena. No forms of belief, technologies, marriage systems or economic practices (to mention a few examples) have any meaning whatsoever unless they are understood in a wider context*'. Holistic contextualization suggests two strategies to address such a requirement. First, by positioning the 'selected descriptions' of the phenomenon within broader thematic frameworks, such as global, historical, demographic, developmental, social, cultural, and economic debates. The specific aspect of contextualization may vary depending on the priorities and interest of a design researcher. For instance, in the reported study the selected descriptions of the energy exchange were connected with poor status of rural electrification of the region, and connection of findings was explored with reports on energy exchanges in different regions of the world. The second strategy for holistic contextualization is by connecting the phenomenon under study with other related phenomena. For instance, in the described study, the design anthropologist compared observations of energy exchanges with other types of exchanges happening between people. This connection revealed several insights about the materiality and values of energy. Overall, this step of holistic contextualization prepares the gathered data for the 'conceptual comparison.'

4.6.3. CONCEPTUAL COMPARISON

This step aims to construct a more general, conceptual, and theoretical understanding of the phenomenon being studied by use of 'comparison.' Many anthropologists view 'comparison' as the heart of anthropology and as an innate part of anthropological knowledge construction process (for more on 'comparison' in anthropology, see [12, 13, 15, 50, 56]). Eriksen ([12]: 34) describe 'comparison' as '*a means to clarify the significance of the anthropologist's findings, through creating contrasts, revealing similarities with other societies, and to develop (or criticise) theoretical generalisations*.' He further clarifies that 'comparison' aims to comprehend both the differences as well as similarities.

In the AtD process, 'conceptual comparison' implicitly starts with the step of

'selective description' and gets foregrounded in 'holistic contextualization.' For instance, when a design researcher compares particular observations from the field with the knowledge from 'outside,' he/she is engaging with 'conceptual comparison.' It can also be in the form of comparing the ethnographic findings with what has been stated in known theories and conceptual frameworks about the selected phenomenon. For instance, in the reported study, the design anthropologists compared the findings from the two villages with dominant rational choice theoretical perspectives on energy exchanges. Similarly, the design anthropologist compared the types of energy exchanges observed in the 'field' with a range of conceptual discussion on exchanges such as sharing, trading, gifting, and barter.

The step of 'conceptual comparison' is filled with juggling between thinking of the concepts and categories from the perspective of local people and that of a design researcher (an 'outsider'), such as established universals. This step helps in what anthropologists describe as 'making the exotic familiar and the familiar exotic' in the construction of anthropological knowledge ([12]: 34). This comparison also includes cross-cultural and cross-contextual comparison, where findings from the 'field' are collated with views in other cultural settings and contexts. In case of the energy exchange study, the ethnographic findings were compared with the ongoing debate on energy exchange in African and western countries (cross-cultural comparison) and with smart energy grid context (cross-contextual comparison).

4.6.4. Textual and visual ways of knowledge construction

This step aims to utilize textual and visual approaches for anthropological knowledge construction and communication. Traditionally, anthropology emphasizes on 'text' as central to the ethnographic description. The AtD approach, taking inspiration from the field of design, considers various visual approaches, such as sketching, diagraming, mind-mapping and types of visual illustrations, as important ways for condensing, selecting, reducing, and analyzing ethnographic observations for oneself and others. This step provides space for designers in the data analysis and communication process. Another benefit of including visual means for data analysis is that the visual artifacts created in this process can become an important part

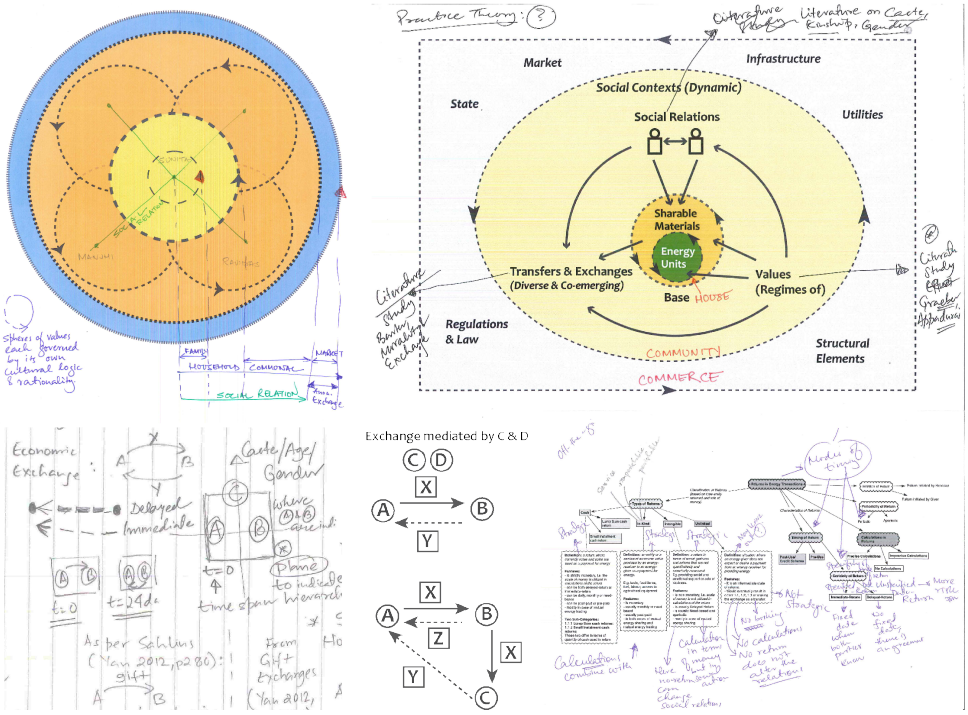

Figure 4.11: Various visuals created as part of ethnographic data analysis.

of knowledge output. In this regard, the AtD process connects with what is being described as design anthropological 'style of knowing' [66] which goes beyond textual forms of knowledge creation and communication. The inclusion of visual ways in AtD gets support from developing arguments in research through design literature where such visual materials are considered to have an assistive, summarizing, provocative, speculative, and theoretical role in design research [10].

In the reported study, the design anthropologist used various types of visual means, such as sketches, mind-maps, and diagrams, for analyzing the field observations. See Figure 4.11. These visual means were not end-points of the analysis instead they were crucial drivers of the data analysis. Another relevant example from the reported study is an interactive digital visualization prepared in the process of knowledge construction. See Figure 4.12. The process of working towards the

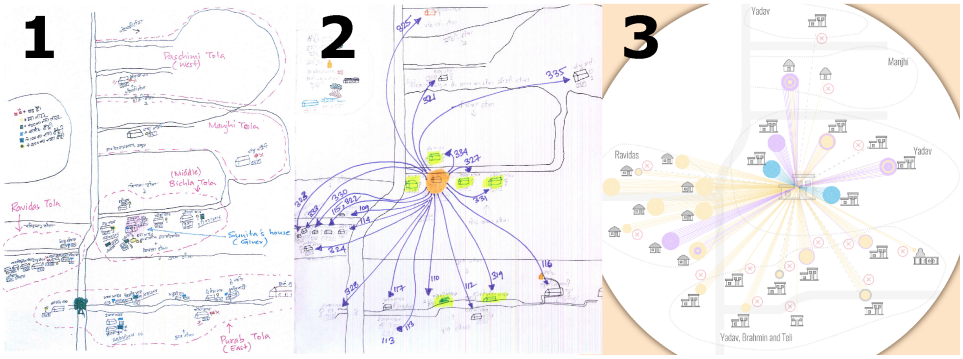

Figure 4.12: '1' and '2' are samples of visual artifacts created during the design process of the visualization. These are scans of a hand-drawn exchange maps made by the villagers with overlays of energy exchange data by the design anthropologist for analysis. '3' is the resulting screen in the information visualization. Notice how various visual elements from the sketched elements result in the final screen design. Also see Appendix-A and Appendix-B.

visualization helped the design anthropologist to select, reduce, and summarize qualitative and quantitative findings on the association between nature of social relations (between energy-giver and energy-receivers) and types of return utilized.

The visualization includes a timeline animation, filter functionality, and contextual explanations and it enabled knowledge dissemination in an interactive way to a wide audience consisting of people from business, government, and activists working in the energy sector, designers, and common public. The visualization has been part of academic presentations and has been exhibited at a large European Design Festival[1]. See Figure 4.13 and Appendix-A. Apart from visualization, the knowledge generated was communicated in the form of scientific articles published in the journal Energy Research and Social Science.

In the reported study, anthropological knowledge produced in the AtD process inspired and provided directions for further design activities. For instance, the design anthropologist provided an anthropological perspective on the limitations of fiat money as returns, and the relevance of different types of peer-to-peer returns in one of the journal articles. This article along with the visualization became a base for starting a collaborative project that aims to design a blockchain technology based payment solution for decentralized energy systems. The anthropological

[1] http://www.mindthestep.nl/energy-exchange.html

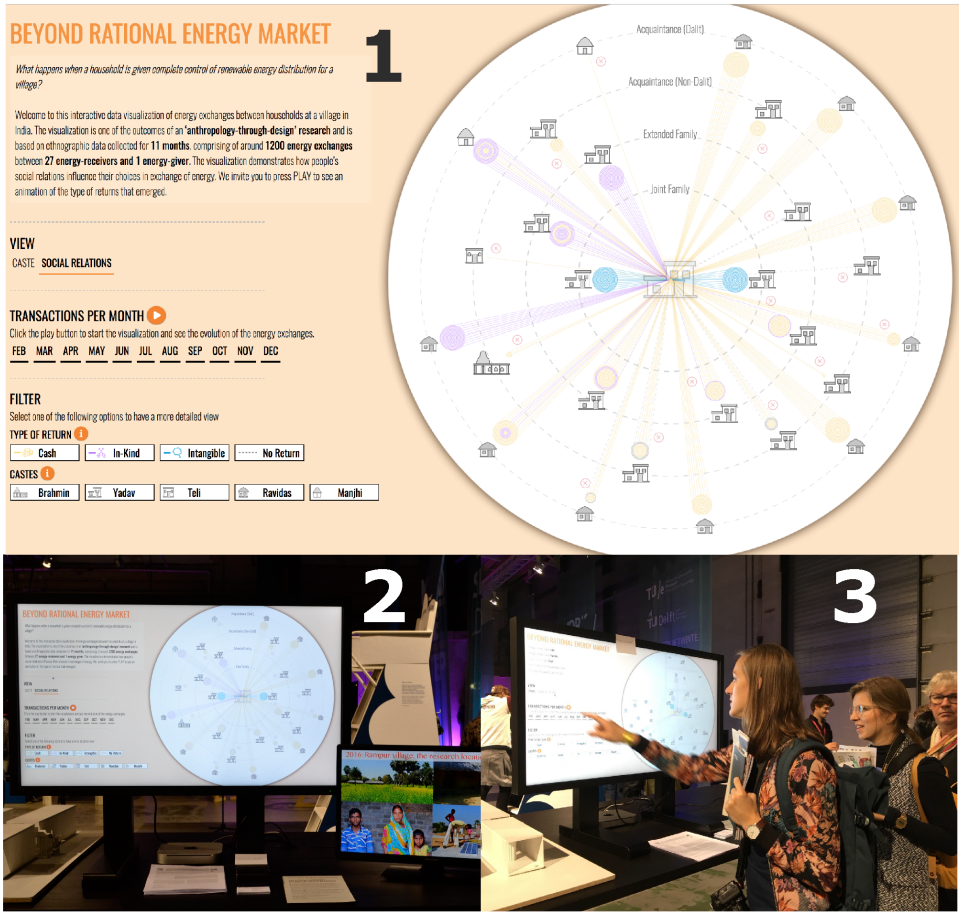

Figure 4.13: '1': *Beyond Rational Energy Market*, the interactive visualization. '2': the visualization exhibited at Dutch Design Week 2017 on a 42-inch touchscreen. '3': Some visitors of Dutch Design Week interacting with the visualization.

knowledge produced in the reported study became a boundary object as it facilitated interaction, cooperation, and collaboration between various actors such as designer, computer scientist, mathematician, anthropologist, and engineer.

4.7. DISCUSSION

4.7.1. A DESIGN ANTHROPOLOGIST'S GAZE

Traditionally, design and a designer's gaze have been oriented towards the future and in their attempt to create 'solutions.' In contrast, anthropology and anthropologist's gaze have traditionally focused on understanding the present social world and its connection with the past [25]. In addition, the AtD approach suggests a design anthropologist's gaze that in its endeavor to understand a sociocultural phenomenon meanders from the 'present' to the connected 'past,' and to the visions of the 'future.' See Figure 4.14.

The AtD approach is in agreement with the developing discourse in design anthropology which views the 'present' to be intertwined with the 'past', and the emerging 'future' [5, 25, 67]. Overall, the AtD approach facilitates this view and suggests a design intervention in the present followed by elicitations methods as a way to understand a sociocultural phenomenon, association with social trajectories of the 'past,' and entanglement with the emerging paths in the 'future.' It is worthwhile to note that simultaneous focus on present, past, and future has also been stated in the design research literature (for instance, see [68]). As mentioned in Section 4.5.3, the five types of elicitations are mediated, structured, and facilitated by a prototype introduced. The prototype provides a crucial reference and base for people to compare, reflect and discuss the five themes of the elicitations. Strategically, these elicitations introduce a speculative approach to anthropological knowledge generation. Furthermore, these elicitations underscore understanding of the emergent phenomenon to be intertwined with the past and aspirations of the future. Hence, these elicitations enable the design anthropologist's gaze or the desired temporal orientation of a design anthropological field-research. In this way, the AtD approach connects with the design anthropological interest in the imaginative and hypothetical in its move to transcend the traditional ethnography's focus on the present and the past [69]. Many scholars consider such an approach that moves beyond the linear temporal orientation of the present, the past, and the future as the hallmark of design anthropological knowledge generation giving it a

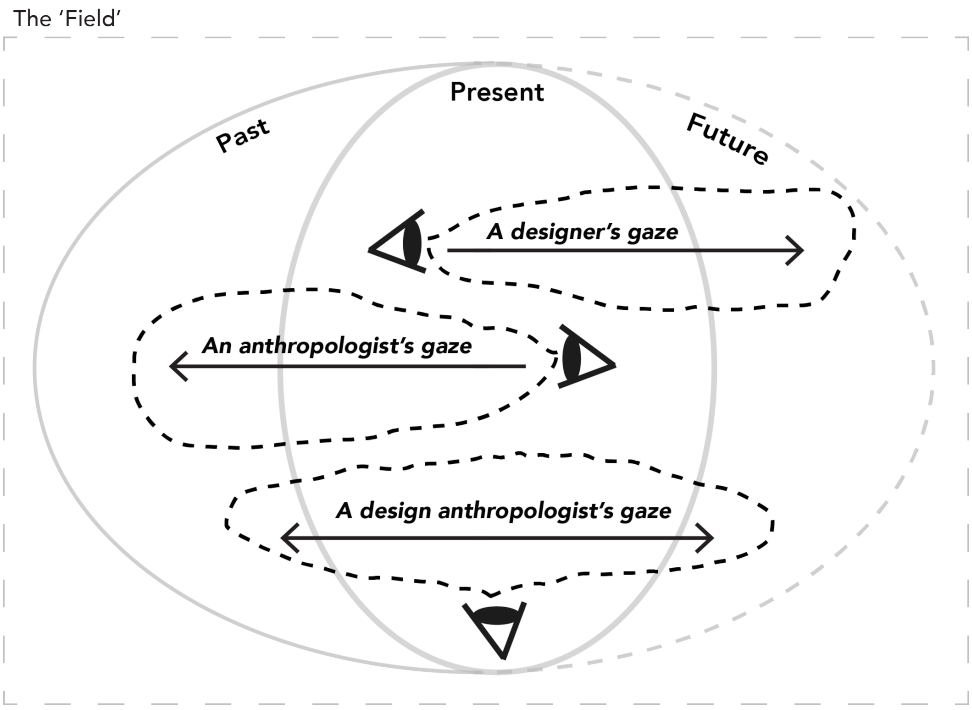

Figure 4.14: A visual representation of a designer's gaze, an anthropologist's gaze, and a design anthropologist's gaze.

unique trans-disciplinary character [5, 69].

4.7.2. DESIGN ANTHROPOLOGICAL STYLE OF KNOWING

The AtD approach is in line with the view that design anthropology is developing its own 'distinct way of knowing' [14] that extends both the dominant approaches in design and anthropology. The AtD approach works within a dialectic of intervening and observing. It takes into account both knowing by observing, as in traditional ethnography, as well as imbibes knowing by intervening, causing 'change' as in design. Contrary to the dominant approach in design where an intervention typically aims for a 'change' towards a particular 'desirable state' and a 'solution,' in AtD the intervention enables the emergence of a sociocultural phenomenon. The AtD process answers invitations by many scholars to develop design anthropological approaches that simultaneously work with intervention and emergence [5, 9]. The

AtD approach suggests that the understanding, i.e., interpretations and knowledge generated, of a phenomenon to be viewed as an intersubjective and an emergent outcome of the dynamics of collaboration between a participant, design anthropologist, and design intervention (prototypes, materials, research tools). We suggest more research attention to translation from emic to etic understanding. This translation can be a site for further developing AtD and other design anthropological approaches that simultaneously (instead of sequentially) produce design and anthropological insights about a phenomenon. Overall, the AtD approach considers the knowledge generation as a collaborative and intersubjective; reflexive and relational; and performative and dialogic process.

4.7.3. ANTHROPOLOGY-THROUGH-DESIGN AND RESEARCH-THROUGH-DESIGN

AtD approach proposed in this chapter can be considered to be a specialized case of RtD. In this section, we briefly describe key similarities and differences between AtD and RtD. Research through design (RtD) is defined as a '*designerly contribution to new knowledge*' ([10]: 63) or '*a research approach that employs methods and processes from design practice as a legitimate method of inquiry*' ([70]: 310). Both RtD and AtD suggest a central role of design activities, design artifacts, and prototypes in the process of knowledge generation. Both RtD and AtD aim to generate new knowledge. However, as Stappers and Giaccardi [10] mention, the literature on RtD does not clearly specify what this knowledge is about. Often the knowledge generated in a RtD project is implicitly or explicitly intended for design. For instance, Stappers, Sleeswijk Visser, and Keller ([20]: 7) describe the knowledge generated in RtD as '*how the technology works... how the prototype is used (the phenomenon under study)*'. Moreover, one of the definitions of prototype in RtD as an '*artifact used in research that can realize the (inter)action that is studied*' ([10]: 9) provides some further clues on a typical object of RtD inquiry and associated knowledge generated, i.e. about an 'inter(action)' between a human and a prototype. In contrast, AtD's primary aim is to generate anthropological knowledge about a sociocultural phenomenon.

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5

Conclusion

5.1. REVISITING RESEARCH QUESTIONS

There were two primary goals of this dissertation. First, to develop conceptual knowledge of inter-household energy exchanges by investigating the social and cultural embeddedness of energy exchanges in a system where householders can decide with whom to exchange locally produced energy. Second, to conceptualize a research approach that utilizes 'design,' more especially a 'design intervention,' as an instrument for constructing anthropological knowledge of 'non-dominant' phenomenon such as inter-household energy exchange.

The following question addressed the first goal of the dissertation:

Q1: *How are energy exchanges between households, in a decentralized energy system where householders can decide with whom to exchange energy, related to the social, cultural, and economic life of the householders?*

Utilizing the longitudinal ethnographic data from the design intervention implemented in two rural villages in India, Chapter 2 and Chapter 3 provide a rich account of how inter-household energy exchanges and the associated peer-to-peer returns are related to the social, cultural, and economic life of the householders. In this regard, Chapter 2 emphasizes the discourse of mutuality and presents a 'circle of mutual energy exchange' as a descriptive, conceptual, and analytical unit for understanding such energy exchanges. The concept of circle of mutual energy exchange defines a mutually constituted relational and cultural boundary for energy exchanges. Focusing on peer-to-peer returns, Chapter 3 presents a conceptual model of returns-continuum that demonstrates how householders' preference for a type of return varies with the nature of their social relations with each other. Overall, the dissertation showcases that when people get to structure energy exchanges, they do so by employing a range of social, cultural, moral and economic notions.

The primary research question (Q1) is further divided into the following sub-questions:

Q1.1: *What types of energy exchanges between households emerge when householders are given control of an off-grid energy distribution infrastructure?*

Chapter 2 defines and describes 'mutual energy exchange' (MuEE) and two distinct

conceptual types of MuEEs, i.e., 'mutual energy sharing' (MuES) and 'mutual energy trading' (MuET). The chapter shows how these two types of energy exchanges are conceptually distinct, dialectically conjoined, and can be co-present in a mutual realm of an energy economy. Further, the chapter shows that within a circle of mutual energy exchange, such as a circle of mutual energy sharing, a particular type of mutual energy exchange dominates and is preferred by people. Overall, the dissertation takes a stance that both mutual energy sharing and mutual energy trading, reflecting two sides of the dialectic of an economy, are relevant and essential for the social, cultural, and economic life of people.

Q1.2: *How are social relations between energy-givers and energy-receivers at work in the energy exchanges between households?*

Chapter 2 illustrates how energy exchanges that emerged from the interventions were related to different types of social relations between givers and receivers such as kinship and family, caste, gender, co-inhabitants, patron-client, and cultivator-labor. The chapter shows how the giver's decisions were shaped by various socio-cultural structural factors such as kinship, class, caste, and gender, and within these structural factors, the giver exercised her agency. The findings in the chapter indicate the significance of (social) relational identity of a giver and a receiver in case of mutual energy sharing and mutual energy trading. In cases of mutual energy sharing, mutuality or importance of social relations is at the foreground emphasizing morality, sociability, and sociality. On the other hand, in cases of mutual energy trading, accentuates calculations, strategizing for material benefits, 'profit,' economistic and rational thinking. The chapter remarks that even in the cases of mutual energy trading prior existing social relations between the giver and a receiver such as co-dependency, work engagement, and associated trust forms a base for such energy exchanges to take place. In total, the chapter indicates that a householder can be self-interested and focus on mutuality simultaneously.

Q1.3: *What values energy-givers and energy-receivers invoke in the energy exchanges?*

Chapter 2 shows that mutual energy sharing and mutual energy trading are encapsulated in diverse moral, ethical, social and cultural values. The chapter discusses how these energy exchanges are rooted in different moralities and ethical judg-

ments, which are complex, diverse, sometimes conflicting and at other times converging. The giver and receivers in the cases of mutual energy sharing considered it immoral, unethical and culturally inappropriate to aim to earn a 'profit.' In contrast, in the reported cases of mutual energy trading, earning 'profit' from others was considered morally appropriate and ethical. In Chapter 3 indicates the distinction between mutual energy sharing and mutual energy trading to hinge upon the notion of 'profit' and suggests that valuation of 'profit' is continuously negotiated within the locally emerging social, cultural and moral values. Overall, the dissertation work shows that the values invoked in the mutual energy exchanges are plural, varied in nature, emerges in the exchange, and transcend the dominant notions of economic rationality as suggested by the rational choice approach.

Q1.4: *What types of returns energy-givers and energy-receivers invoke when they are given control of an off-grid energy distribution infrastructure?*

Chapter 3 presents a classification of peer-to-peer returns consisting of three types, i.e., in-cash, in-kind and intangible returns. The chapter discusses in-cash return as an integral part of mutual energy trading, intangible return as a constituent of mutual energy sharing, and in-kind return to being part of both mutual energy trading and mutual energy sharing. These three types of returns are co-existing, overlapping, dynamic, and forming a continuous spectrum, i.e., a returns-continuum, in the social sphere of the economy. The proposal of returns-continuum recognizes that all the three types of returns have different values for people in different contexts of energy exchanges. Moreover, the returns-continuum acknowledges people's ability to use different types of returns simultaneously.

Q1.5:*How are these returns related to the social, cultural, and economic life of people?*

The results in Chapter 3 indicate that people's preference for a type of peer-to-peer return varies with the dynamics of their social relationship, i.e. 'social connectedness' between a giver and receiver. In-cash returns are important for people as it helps them to acquire fiat money, an entity that is an important means to address various necessities of people's life. However, the ethnography also reports various issues with in-cash returns such as scarcity of cash and its potential to strain social relationships. In-kind returns are desired in various contexts such as to utilize

locally produced goods and services for accessing energy, and as a way to avoid moral issues with in-cash returns. Intangible returns are built upon the notion of togetherness, friendship, love, solidarity, and different ways of bonding with others where people seem to value their enduring social relationships more than making any monetary or material gain. The ethnography indicates that people structure peer-to-peer returns by employing a range of social, cultural, moral and economic notions. In conclusion, the chapter suggests that structuring and procuring a return is not only an economic event but also a complex sociocultural process.

The following question addresses the second goal of the dissertation: Q2: *How can anthropological knowledge about a 'non-dominant' phenomenon, such as inter-household energy exchange, be generated using a design intervention?*
In Chapter 4 an anthropology-through-design process is proposed, which is a research approach to generate anthropological knowledge about a 'non-dominant' sociocultural phenomenon through the use of a design intervention in the real world. A design intervention, which is the vital engine of the AtD process, constructs a material and conceptual space for a sociocultural phenomenon to take shape in situ for an anthropological inquiry. The chapter provides a description of AtD framework at an outline-level with four key phases, namely, framing, design intervening, emic understanding, and etic understanding, and the associated steps of each of the phases. Overall, the chapter serves to describe the knowledge generation in the AtD approach as a collaborative and intersubjective; reflexive and relational; and performative and dialogic process.

5.2. FUTURE RESEARCH

Considering the scope of this research, here I provide some general limitations of the research and associated recommendations for future research.

Investigating energy exchanges under different energy setups: This research is based on off-grid energy systems where a single household became energy-giver. However, other types of energy setups are emerging in the real world. For instance, decentralized setups that are jointly owned and managed by multiple households

or by an entire village, or an energy kiosk established as a shop managed by a local shopkeeper. Although conceptual outcomes of this research would be relevant in the context of these energy systems, specific manifestation of these may vary. Hence, it will be worthwhile to compare how various aspects of social relations, diverse values, and types of returns as part of energy exchanges in different structural setups are similar or different from what has been reported in this dissertation.

Investigating energy exchanges in different sociocultural environments: The ethnographic case on energy exchanges presented in this research is limited to rural India. Although the conceptual outputs of this research are applicable and relevant for energy systems beyond rural India, it would be valuable to compare the findings of this research with other decentralized energy systems in the global south and the global north where householders gain agency in energy exchanges and local energy management. Such investigations and comparisons have the potential to develop a generalized sociocultural theory of energy exchange that counters the rational choice approaches.

Discussing policy implications: As this research was limited to the sociocultural understanding of energy exchanges, the discussion about the policy implications of the research findings is mostly missing in the dissertation. However, there is abundant room for further work in this regard. The dissertation indicates the relevance of the following themes for policy-level considerations: initiating a more socioculturally grounded (rather than technology-determined), people-centered, and bottom-up approach for energy exchanges in decentralized energy systems. Moreover, instigating policy approaches that take a reflexive and critical perspective on rational-choice visions and the hegemony of 'market' ideal, and includes diverse forms of non-monetary and monetary payment mechanisms for energy access.

Developing a general design framework and theory for 'designing for exchanges': Although this research was limited to exchanges of energy, there is a need to develop a general framework and theory for designing for different types of exchanges in societies. Considering the emergence of various technologies such as blockchain that can enable multiple forms of exchanges in the lives of people across societies,

this seems to be an opportune moment for design research studies on this theme. In this regard, a general suggestion for any design researcher pursuing this theme is to engage with and extend wealth of knowledge economic anthropologists has produced on various types of exchanges, such as trading, sharing, gifting, allocation, and barter.

Extending anthropology-through-design approach for different sociocultural phenomena: The anthropology-through-design approach proposed in this dissertation centers around a strategic use of design interventions, which attempts to make underlying social-cultural phenomenon observable in the real world. However, there are many other sociocultural phenomena, such as various forms of sociocultural discriminations, bullying, and mob violence that are more difficult to study through a design intervention. More importantly, any deliberate attempt to facilitate the emergence of such phenomena through a design intervention for research purposes will raise grave moral and ethical issues. Further research is needed on how anthropology-through-design approach can be utilized to study various other sociocultural phenomena.

5.3. CONTRIBUTION OF THIS RESEARCH

This interdisciplinary research makes novel knowledge contribution to the fields of (a) energy studies and (b) design anthropology. Some of the original contributions of this research are as follows:

1. *Economic anthropological understanding of energy exchanges*: To the best of my knowledge, energy exchanges between households have not been investigated from an economic anthropological perspective. This research introduces, to the domain of energy studies, theoretical and conceptual perspectives from economic anthropology to understand energy exchanges. In general, this research brings attention to energy exchanges as an object of research inquiry.
2. *Conception of mutual energy exchanges*: This research introduces a conceptual and theoretical description of social and personal energy exchanges between

households in a non-market realm of an energy economy. Correspondingly, this research demonstrates the workings of this non-market realm and showcases that there is more to energy exchanges than what the dominant rational choice perspective describes.

3. *Exploration of peer-to-peer returns*: This research initiates a sociocultural classification of peer-to-peer returns that are part of energy exchanges between households in a non-market realm of an energy economy. To the best of my knowledge, such returns have not yet been explored from an anthropological perspective.

4. *Anthropology-through-design, a methodological contribution*: This research proposes a novel approach called Anthropology-through-Design (AtD), which facilitates generating anthropological knowledge about a 'non-dominant' sociocultural phenomenon through a design intervention. The proposed approach brings together perspectives from research-through-design, design anthropology, and ethnography and is a methodological contribution to the emerging field of design anthropology. The AtD approach takes a strategic step in relocating 'design' from being an object of anthropology to becoming an instrument for doing anthropology.

5.4. TWO GENERAL RECOMMENDATIONS

Finally, there are two general recommendations for design anthropology and inter-household energy exchanges.

1. *On the convergence of design and anthropology:* Beyond making a methodological contribution through ethnography in design, the field of anthropology can influence design and design research approaches in many ways. First, anthropology can provide a rich theoretical and conceptual corpus for design and design research on various sociocultural phenomena. Second, anthropology can contribute to designers' critical stance on 'solution,' 'change,' and 'desired state' they seek to create. Third, anthropology can assist design and design research process to embrace reflexivity and foreground awareness of various

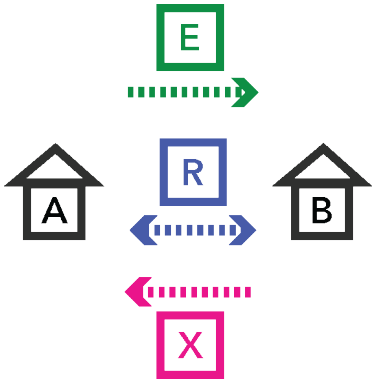

Figure 5.1: Conceptual diagram of inter-household energy exchange. Note the following labels.'R': Social Relations; 'A': energy-giver; 'B': energy-receiver; 'E': energy units; and 'X': return.

ethnocentric beliefs and latent sociocultural assumptions that shape design activities and outcomes. Fourth, anthropology can facilitate a holistic and critical understanding of how design processes and outcomes are deeply embedded in and have implications for social, cultural, political, ethical, moral, and historical contexts.

Conversely, the field of design can influence anthropological and ethnographic approaches in many ways. First, design can pioneer 'making' and causing 'change' as a part of 'knowing' process in anthropology. Second, design can assist in further developing a collaborative strand of doing anthropology. Third, design can initiate speculative approaches and facilitate anthropological research that takes 'future' as a unit of inquiry. Fourth, design can provide impetus to creative and visual ways of analyzing, visualizing and disseminating anthropological knowledge. Fifth, design, as proposed by the anthropology-through-design approach, can contribute to the conceptualization of a sociocultural phenomenon. In conclusion, a recommendation for design scholars and anthropologists is to work towards greater convergence of the fields of design and anthropology, as it seems to have potential benefits for both the fields.

2. *On inter-household energy exchanges:* The introduction chapter of this dissertation started with a conceptual representation of energy exchange (Figure 1.2) and indicated some limitations of the dominant rational choice view on en-

ergy exchanges (Section 1.2). Figure 5.1 visually summarizes the contribution and the position of this dissertation on inter-household energy exchanges as part of energy systems where householders have some agency in local energy exchanges. In contrast with Figure 1.2, Figure 5.1 has appended a crucial element, social relations ('R'). Generally, it is recommended in this dissertation for energy researchers and practitioners to view choices and decisions householders make while participating in an energy exchange to be shaped by diverse and dynamic nature of their social relations with each other ('R'). The attention to the role of social relations will also help in comprehending associated sociocultural structural factors, such as kinship, caste, class, and gender, in inter-household energy exchanges. Overall, such an approach will assist in moving beyond the dominant rational choice view of energy exchanges.

APPENDIX-A

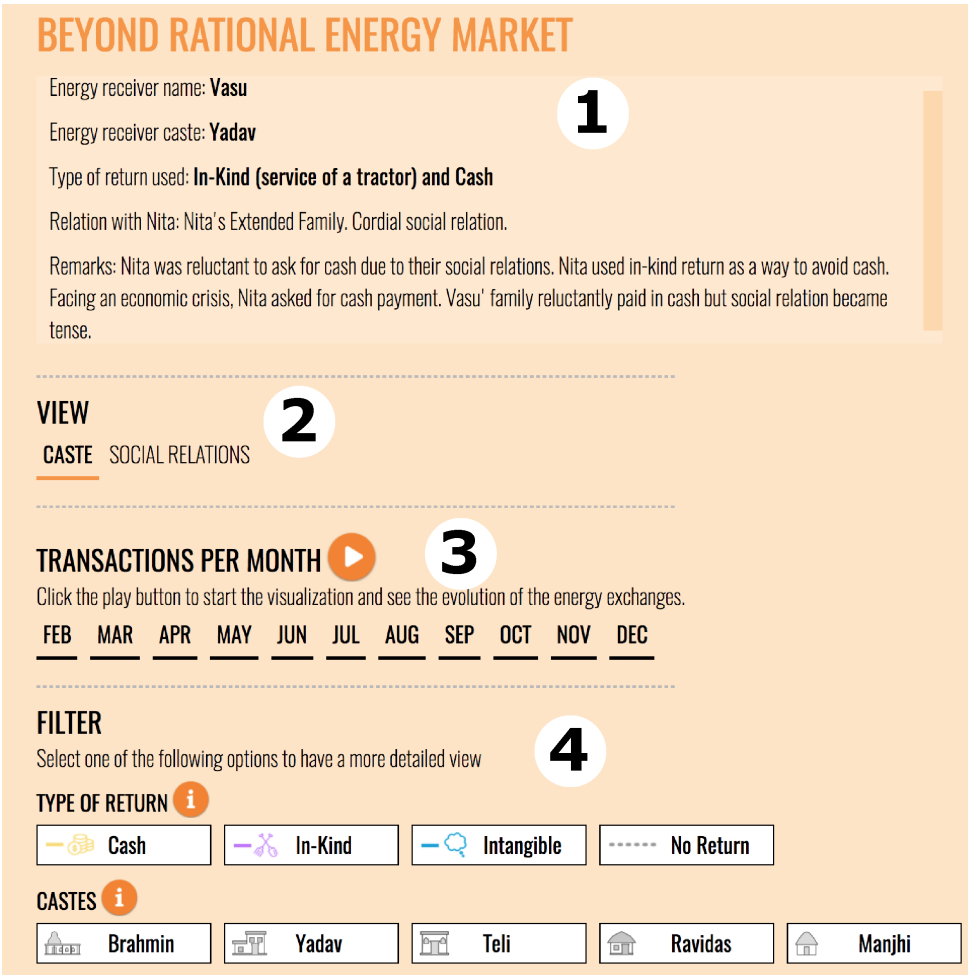

Figure A.1: Various elements of the interactive visualization. Note the following labels. '1': Descriptive Layer; '2': Views; '3': Timeline; and '4': Filters.

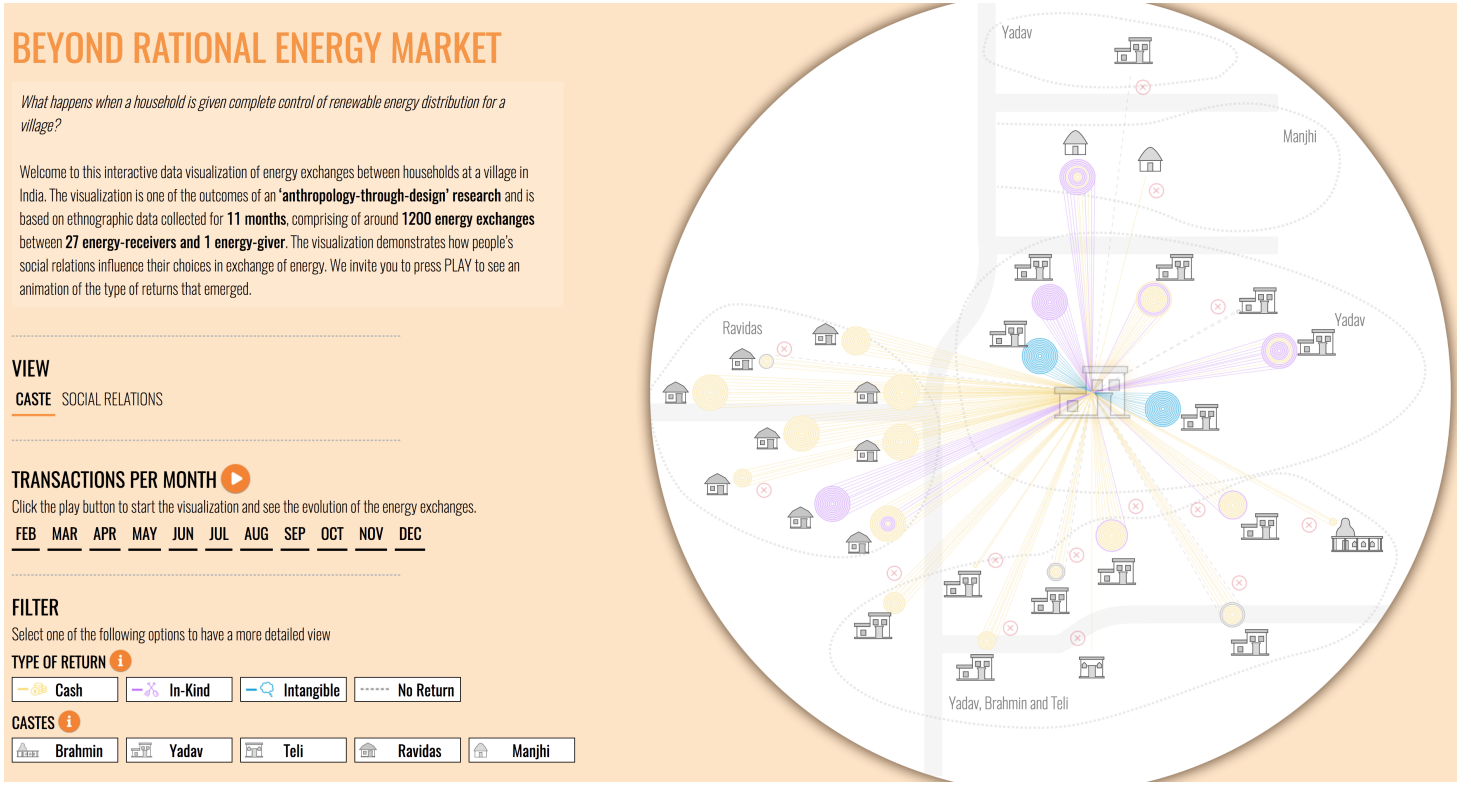

Figure A.2: 'Caste' view of '*Beyond Rational Energy Market*,' an interactive visualization.

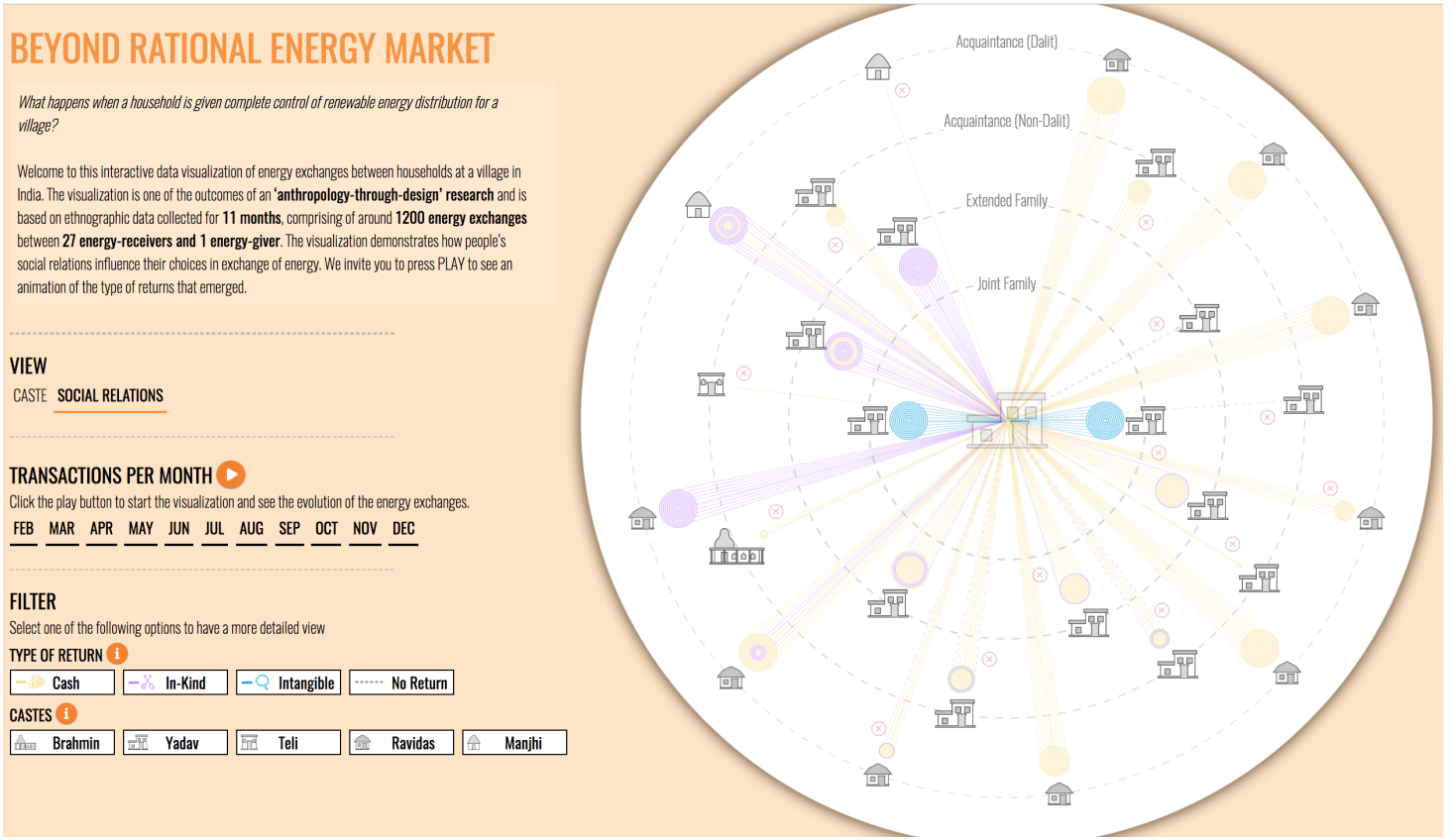

Figure A.3: 'Social Relations' view of '*Beyond Rational Energy Market*,' an interactive visualization.

APPENDIX-B

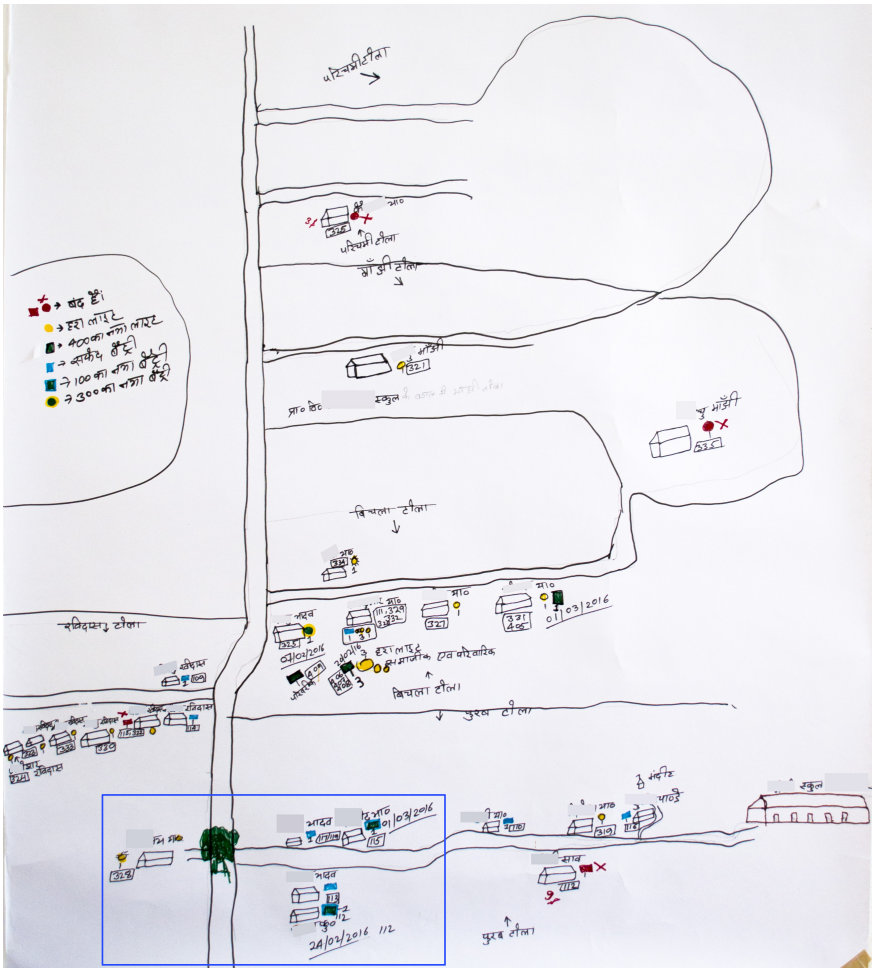

Figure B.1: Hand-drawn exchange map of Rampur. Note that the blue-lined rectangle is an annotation by the author. See Figure B.3 for the information documented inside the rectangle. (*Names of the energy-giver and energy-receivers mentioned on the map have been concealed for anonymization.*)

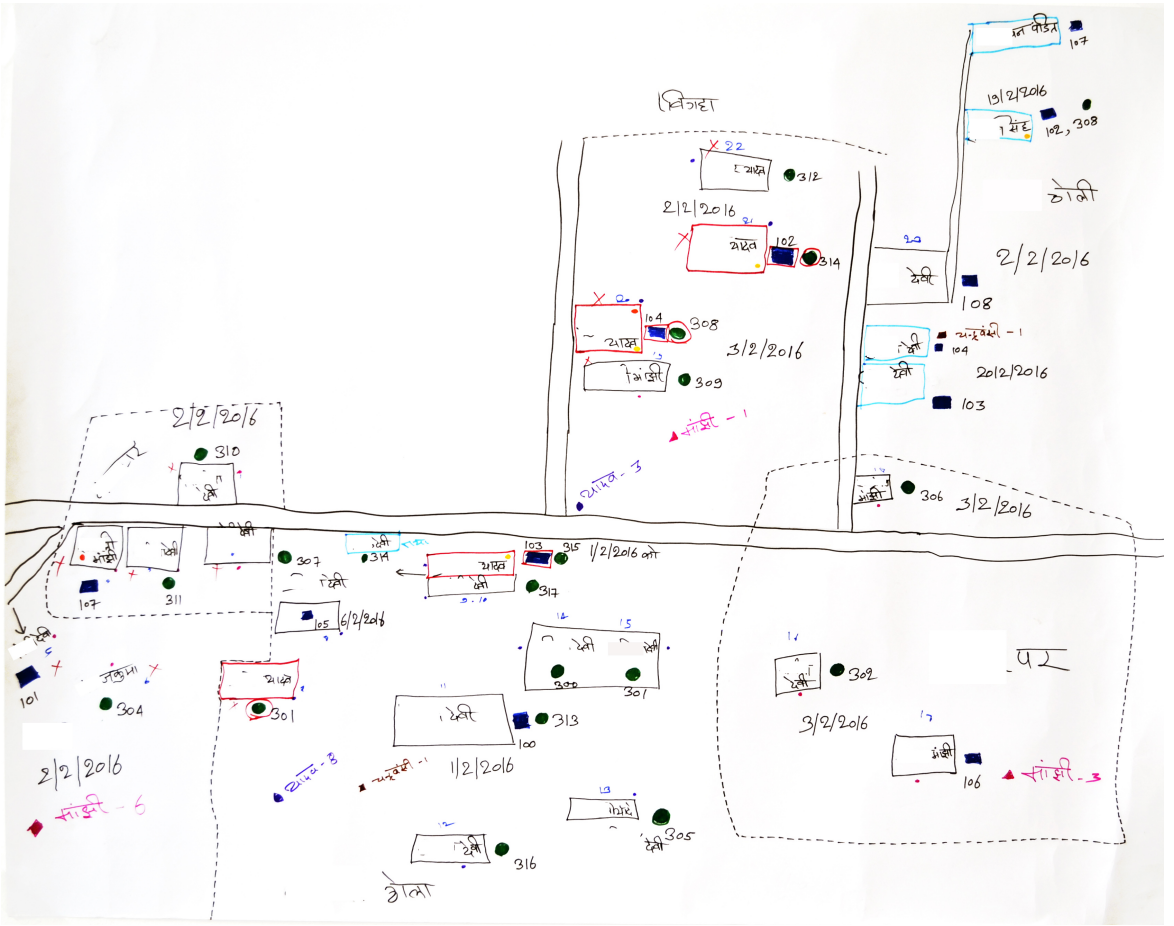

Figure B.2: Hand-drawn exchange map of Manpur. (*Names of the energy-giver and energy-receivers mentioned on the map have been concealed for anonymization.*)

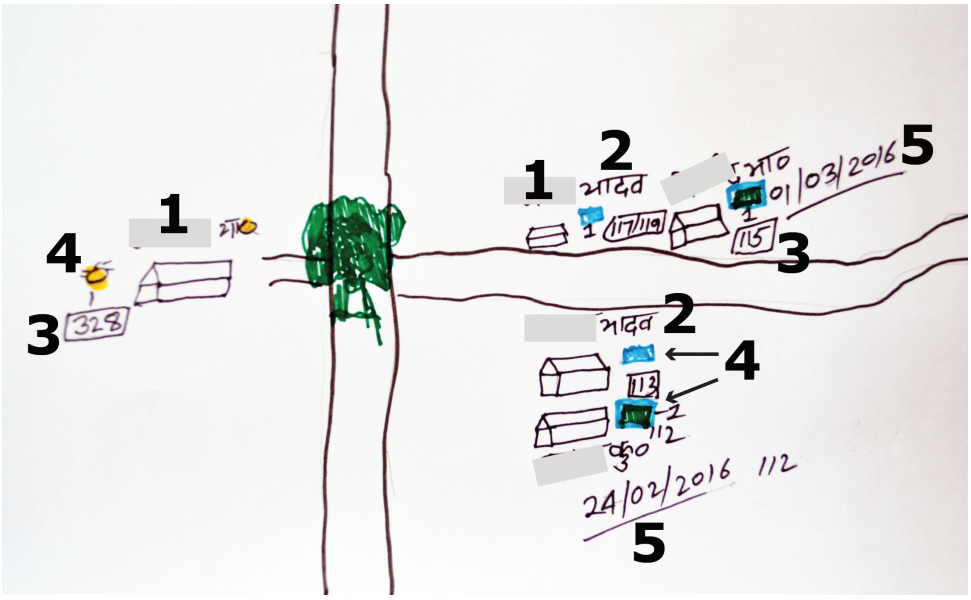

Figure B.3: A sample of information documented on the hand-drawn exchange maps. This figure is an enlarged version of the blue-lined rectangle in Figure B.1. Note the following labels. '1': Name of the energy-giver or energy-receiver; '2': Caste of the energy-giver or energy-receiver; '3': Item code of the solar-item assigned to a particular energy-receiver; '4': Icon indicating the type of solar-item; '5': Starting date of energy-exchanges with an energy-receiver. (*Names of the energy-giver and energy-receivers mentioned on the map have been concealed for anonymization.*)

SAMENVATTING

Met de groei van gedecentraliseerde, niet aan het net gekoppelde en over de hele wereld verspreide hernieuwbare energiesystemen wordt een areaal aan mogelijke uitwisselingen van energie tussen huishoudens geopend. In vergelijking met traditionele 'gecentraliseerde' energievoorzieningsystemen worden huishoudens in deze opkomende energiesystemen verondersteld zelfsturing (agency) te ontwikkelen voor de uitwisseling van energie tussen huishoudens in buurten of dorpen. Deze zelfsturing kan tot uiting komen in een actievere rol van de huishoudens, waarbij zij keuze en controle hebben over de lokale uitwisseling van energie tussen huishoudens en dus tegelijkertijd zowel consument als energieproducent zijn.

De gangbare visie op interhuishoudelijke energie-uitwisseling is vertroebeld met vele aannames. De bestaande literatuur over energie-uitwisseling gaat meestal uit van een techno-economische analyse gebaseerd op rationele keuze. Men gaat daarin dus voorbij aan de sociaal-culturele dimensies van energie-uitwisselingen, of met andere woorden de discussie ontbreek over de invloed van de sociale en culturele realiteit in het dagelijks leven van mensen op energie-uitwisselingen. Bovendien ontbreekt een theoretische en conceptuele discussie over niet-marktgebonden energie-uitwisselingen, zoals sociale en persoonlijke energie-uitwisselingen die tot stand komen zonder de bemiddelende rol van neoklassieke marktprincipes.De twee belangrijkste doelstellingen van dit proefschrift zijn:

- Het ontwikkelen van conceptuele kennis van interhuishoudelijke energie-uitwisselingen door het onderzoeken van de sociale en culturele inbedding van energie-uitwisselingen in een systeem waarin huishoudens zelfstandig kunnen beslissen met wie ze lokaal geproduceerde energie willen uitwisselen.
- Het conceptualiseren van een onderzoeksaanpak die 'design', en meer in het

bijzonder een 'designinterventie', gebruikt als instrument voor het construeren van een brede antropologische kennis van verschijnselen zoals de uitwisseling van energie tussen huishoudens.

Dit onderzoek maakt gebruik van een theoretisch perspectief uit de economische antropologie om het fenomeen van energie-uitwisseling tussen huishoudens te bestuderen. De methodologische benadering van dit onderzoek is geïnspireerd op discoursen op het gebied van design antropologie, onderzoek door design en etnografie. Als onderdeel van de methodologische aanpak werd een designinterventie ontworpen, geïmplementeerd en onderzocht in een longitudinale multimethodische studie die gedurende 11 maanden (1 februari 2016 - 31 december 2016) is uitgevoerd in twee off-grid villages op het platteland van India. De designinterventie bestond uit de installatie van een zelfstandige energiedistributie-infrastructuur waarmee de uitwisseling van zonne-energie in de dorpen mogelijk werd gemaakt. De designinterventie gaf één huishouden in een dorp de mogelijkheid een andere huishoudens binnen het dorp energie te 'geven'. De bewoners hadden de volledige controle over de geïnstalleerde energie-infrastructuur en de vrijheid om 'betaling' naar eigen inzicht te organiseren zonder enige betrokkenheid van de etnograaf. De iteratieve, en verkennende aanpak van het onderzoek hebben samen met de veldwaarnemingen de onderzoeksrichting bepaald.

De belangrijkste bijdragen van dit onderzoek worden gepresenteerd in drie hoofdstukken, *Conceiving Mutual Energy Exchanges*, *Exploring Peer-to-Peer Returns*, and *Envisioning Anthropology-through-Design*, in dit proefschrift. Als geheel draagt dit transdisciplinair onderzoek bij aan de domeinen van (a) energie en sociale wetenschappen en (b) design antropologie.

Conceiving Mutual Energy Exchanges: Hoofdstuk 2 definieert 'wederzijdse energie-uitwisseling' als een sociale en persoonlijke energietransactie tussen een energie-gever en -ontvanger, die onderling wordt vormgegeven en onderhandeld. Het woord 'wederzijds' verwijst naar het antropologische discours van 'wederkerigheid'. De etnografische gegevensanalyse brengt twee soorten wederzijdse energie-uitwisselingen aan het licht: 'wederzijdse energiedeling' en 'wederzijdse energiehandel'. Het hoofdstuk definieert een 'wederzijdse energiedeling' als een sociale

en persoonlijke energie-uitwisseling waarbij een energiegever en -ontvanger deelnemen omwille van de sociale relatie tussen hen. Wederzijdse energiehandel daarentegen is een sociale en persoonlijke energiehandel waar een energiegever en -ontvanger deelnemen met een gecalculeerde uitwisseling omwille van materieel of geldelijk gewin. Het hoofdstuk beschrijft hoe verschillende sociale relaties en diverse cultuurwaarden de energie-uitwisseling hebben beïnvloed. Het hoofdstuk laat zien dat de 'wederzijdse energiedeling' en 'wederzijdse energiehandel' geworteld zijn in verschillende moralen en ethische oordelen, die complex, divers, soms tegenstrijdig en op andere momenten convergerend zijn. Het hoofdstuk introduceert een 'cirkel van wederzijdse energie-uitwisseling' als een conceptuele, analytische en beschrijvende eenheid voor het begrijpen van dergelijke energie-uitwisselingen. Het definieert een 'cirkel van wederzijdse energie-uitwisseling' als een conceptuele omgeving voor de sociale constructie van een wederzijdse energie-uitwisseling, die wordt gemodelleerd door sociale relaties tussen energiegever en -ontvanger en wordt gevormd door diverse sociale en culturele waarden.

Exploring Peer-to-Peer Returns verkennen: In hoofdstuk 3 wordt een classificatie van betalingen beschouwd die bestaat uit drie soorten 'betalingen', namelijk in cash, in natura en immateriele betalingen. In-cash betaling is een betaling door een energieontvanger aan een energiegever voor die energie in de vorm van geldbiljetten en munten. Betaling in natura is een betaling door een energieontvanger aan een energiegever voor de geleverde energie in de vorm van een ding of werk met een overeengekomen economische waarde. Immateriële betalingen zijn niet gemeten en niet gekwantificeerde sociale gebaren en acties, zoals goodwill of sociale steun, die gemaakt worden door een energieontvanger ten gunste van de energiegever. Het hoofdstuk presenteert een sociaal-cultureel begrip van deze betalingen aan de hand van vier etnografische vignetten. Het laat zien hoe de voorkeur van mensen voor een vorm van betaling varieert met de aard van hun sociale relaties, d.w.z. hun sociale verbondenheid met elkaar. Het hoofdstuk stelt een conceptueel model van 'return-continuüm' voor, dat ervoor pleit om alle drie soorten rendementen te zien als een coëxisterend, overlappend, dynamisch en continu spectrum van betalingen. Het conceptuele model erkent dat alle drie soorten betalingen verschillende waarden hebben voor mensen in verschillende contexten van energie-

uitwisseling en erkent het vermogen van mensen om verschillende soorten betalingen gelijktijdig te gebruiken. Tot slot betoogt het hoofdstuk dat het configureren van een betaling dus niet alleen een economische daad is, maar ook een complex sociaal-cultureel proces.

Envisioning Anthropology-through-Design: Hoofdstuk 4 definieert antropologie-door-design (AtD) als een onderzoeksaanpak die tot doel heeft antropologische kennis over een sociaal en cultureel fenomeen te genereren door middel van een ontwerpinterventie in de bestaande wereld. Het doel van AtD onderzoek is om een ontluikend 'niet-dominant' sociaal-cultureel fenomeen waar te kunnen nemen in het het sociale leven van mensen. Een designinterventie de motor van de voorgestelde AtD-benadering, beoogd de noodzakelijke materiële en conceptuele ruimte te bieden om een dergelijk sociocultureel fenomeen in-situ vorm te geven en dus waarneembaar te maken voor antropologisch onderzoek. Het hoofdstuk bevat een beschrijving van het AtD-raamwerk waarin we vier fasen herkennen, namelijk framing, designinterventie, emic understanding, en etic understanding Het raamwerk laat zien hoe in de AtD-benadering 'design' een instrument van de antropologie wordt. Het hoofdstuk beschrijft de kennisgeneratie in de AtD-benadering als een proces dat gelijkertijd collaboratief en intersubjectief; reflexief en relationeel; en performatief en dialogisch is.

In het kort toont het onderzoek aan dat huishoudens, wanneer ze zelfsturing hebben over het organiseren van interhuishoudelijke energie-uitwisselingen, zij kiezen voor energie-uitwisselingen die verder gaan dan de heersende economische logica, zoals rationele keuzebenaderingen beschrijven. In plaats daarvan, gebruiken huishoudens voor energie-uitwisselingen een breed scala aan sociale, culturele, morele en economische begrippen en implementaties daarvan.

Acknowledgements

At the end of this thesis, I would like to acknowledge and extend heartfelt gratitude to everyone who has, directly and indirectly, played a role in his or her capacity and beyond to make this dissertation a possibility. You all have taught me about different dimensions of life in some way or the other.

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My next acknowledgment goes to Hylke W. van Dijk, my copromotor for his guidance and support. Hylke, you had always supported my decisions even when they deviated away from your research interests. Your openness and curiosity to learn new things are infectious, which has inspired me on so many instances. You always went an extra mile to make my doctoral journey successful and with less turbulence. One of the prominent examples is your effort to arrange an extension for 4 months after my contract ended. It came at a point when I needed it the most, and nobody else came forward.

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This project would not have been possible without the financial support by the province of Fryslân provided through the research programme of University Campus Fryslân (UCF). I feel privileged to be associated with UCF, which has been highly supportive and open to new ideas and freedom in research. I thank all the staff of UCF, you made this journey smoother with your support throughout the project.

The richness of this research was made possible through the undying support and involvement of the field-study participants and support team in India. I extend my gratitude to Niranjan, Sunita, Nisha, Rakesh, and the various other villagers who participated in this research. The depth in data collection couldn't be achieved without your consistent engagement and efforts. You all honestly engaged in the project and made it your own endeavor. Thanks for allowing me to be part of your life and accepting me as your own. I am deeply grateful to Debotosh Mahato for facilitating the field-research and volunteering in the ethnographic study as a research assistant. Debotosh, thank you for offering me space to stay in your home, for your enthusiasm, and involvement in the research.

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Various organizations have indirectly supported my ideas and invested in it. I would like to express my warm thanks to all of them for providing the resources to develop ideas I felt passionately about. Design United's 'Demonstrator Fund' made it possible to design and develop an interactive visualization based on the findings of this research. Through this visualization, I was able to present some of my key findings to a broader audience at Dutch Design Week 2017 and at various other venues. The 'Delft Global Seed Fund' allowed me to further develop some of my findings into a more extensive research proposal.

I am highly grateful to all my committee members for reviewing an earlier draft of this dissertation, and for providing me with their comments. Your feedback and constructive criticism have greatly helped in improving the quality of this dissertation. I also thank Martijntje Smits for reviewing and providing critical feedback on my research plan and report at the end of my first year as a doctoral candidate.

I feel fortunate that I have been a part of Faculty of Industrial Design Engineering (IDE) and ID-StudioLab of TU Delft as well as Serious Gaming Research Group of NHL Stenden University of Applied Sciences. My dearest colleagues at NHL –Asli, Uche, Bard, Sarah, and Sine, thank you for making my stay at NHL very memorable. Due to these beautiful memories, I have a special place for Friesland in my heart. All the wonderful intellectual discussions and funny lunch sessions still bring a smile to my face. I express my gratitude for Peter Joore. Peter, you made my stay and journey at NHL very comfortable by being always there to help and solve any problems. My stay at IDE was made special due to the support of various people. I would like to express my sincere thanks to the Secretarial office, and the administrative team-Joost, Daphne, Amanda, Monique, Denise, Charleyne. Thanks for your timely response to my difficult administrative queries and various requests. You all have been very supportive throughout my journey at IDE. Thank you my colleagues, friends, teachers, seniors, and fellow PhDs from IDE- Mafalda, Boudewijn, Marian, Patrizia, Stella, Tessa, Holly, Marierose, Bahar, Argun, Parag, Jie, Xueliang, Gaowei, Steven, Anna, Elisa, Froukje, Sacha, Annemiek, Lye, Bob, Mathieu, Ricardo, Chen, Aadjan, Marc, Nynke, Gert, Tomasz, Peter, Ianus, Haian, Marco, Arnold, Niko, Richard, Jasper, Ingrid, Roy, Rick, PJ, Haian, Maarten, Martin, Astrid, Pieter, Paul, Elvin, Valentijn, Jacky, JC, Carlos, Lianne, Jan-Willem, Wouter, Jotte, Charlotte, Lavender, Fenne, Nazli, Jantien, Ioanna, Jarry, Juan, Eefje, Penote, Reiner, Ricardo, Odetta, Wonsup, Ruben, Wei, and Rick. Thank you all. I always found it assuring in sharing each other's struggles and discussing solutions. Thank you for breaking the isolating life of doctoral study by sharing a quick chat in between work, stimulating and funny discussions about work and personal life, and get-togethers.

Froukje, thanks for helping me in finding the PhD position when I was seriously looking for it and also for various informal conversations on research through design and ethnography. JC, thanks for always being helpful and present when I needed your input about anything. You connected me to Rural Spark, and when there was a need, you helped me in formulating a JMP project and encouraged me to apply for Delft Global Seed Fund. Boudewijn, thanks for all the conversations, reading sessions, and joint project ideations. All these added significantly to my learning at the department. Thank you Patti for being a caring friend everyone needs and acquainting me about Italian culture. Holly, thanks for those stimulating discussions about anthropology, you were one of the few colleagues with whom I could satiate my desire to discuss design anthropology. Marian and Mafalda for

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I express my gratitude towards my mentors and supervisors, Lily Díaz-Kommonen and Joanna Saad-Sulonen, from Aalto University's School of Arts and Design, Finland. You generated my interest in design research and ethnography. Thank you for supporting me in my pursuit of learning new things and guiding me generously throughout my stay in Helsinki. I feel my interest in design research would not have been the same without your role in it.

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project even when I was very unsure of how to go about it. Your openness and support helped me to start this journey exploring the convergence of anthropology and design.

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My little son, Kabir, you taught me the value of simple virtues like cherishing small joys, simplification of life, and honesty of expression. I am waiting for you to grow so that I can show you photographs and tell you stories about how your father wrote this dissertation while waiting for you to arrive, and after your arrival. I will tell you how parts of this thesis were written in the maternity ward of Reiner de Graaf hospital in Delft, for example, during late night emergency checkups when you randomly decided to stop kicking your mummy's belly for a few hours. After your arrival, there were even more heroic acts, such as one-handed typing while you were comfortably asleep on my other hand. Your presence made the writing process slower, but you also made this period more meaningful and beautiful.

Last and certainly not the least, this long journey would not have been possible without my wife, Noopur, who has stood by my side through thick and thin. Noopur, no words will ever be able to do justice to all what you have done to help me to reach here. As I am writing this, my mind is filled with a plethora of images and spectrum of happy emotions. I am blessed to have you as a life partner. Finally, we have reached a significant milestone, and let us embark on another journey, but this time you be in the driving seat, and I will be the navigator.

About the author

Abhigyan Singh

Abhigyan Singh was born in Korba, India and has lived, studied, and worked in India, Finland, and The Netherlands. In 2005, Abhigyan completed his bachelor's degree in Information and Communication Technology (ICT) from Dhirubhai Ambani Institute of Information and Communication Technology (DA-IICT), India. As part of his bachelor's thesis, he designed an '*audio-haptic color teaching tool*' for visually impaired children. The project was awarded the highest grade and introduced him to the world of design. Later in 2005, he started working as a user-interface designer at Infosys in India, where he worked on various design aspects of information technology applications for multinational clients such as Bank of America, Kmart & Sears, ABN-AMRO Bank, and BNSF Railways.

In 2007, Abhigyan moved to Finland to pursue Master of Arts in New Media Design from Aalto University's School of Arts and Design. While pursuing his master's studies, Abhigyan worked as a research assistant at Crucible Studio and ARKI research groups. In 2008, he received a field research grant from European-Union funded '*Enabling community communications – platforms and applications*' for conducting a design ethnographic study in India. This research germinated his interest in ethnography and anthropology. Abhigyan's master's thesis ('*Design Opportunities and Challenges in Indian Urban Slums – Community Communication and Mobile Phones*') was awarded the highest grade and '*Department of Media-Stipend*.' The thesis was exhibited and awarded the Second Prize at CUMULUS 20th Anniversary Exhibition ('*Young Creators for Better City & Better Life*') hosted by Tongji University in combination with Shanghai World Expo 2010, Shanghai, China. Around 50 Cumulus member schools participated in the exhibition with a submission of over 400 student works. His master's research resulted in five peer-reviewed publications. During his stay in Helsinki, he also worked as a freelance photographer and videographer.

In early 2011, Abhigyan moved to the Netherlands to work as a scientific programmer and design researcher at Multimedia Information Retrieval Lab at the Faculty of Electrical Engineering, Mathematics and Computer Science (EWI), TU Delft. In 2012, he visited IBM Research India as a research intern and soon after started

working as an interaction designer at Parallel & Distributed Systems group, EWI, TU Delft.

In 2013, he started his doctoral research that investigates the social and cultural dimensions of inter-household energy exchanges in decentralized renewable energy systems at the Faculty of Industrial Design Engineering (IDE), TU Delft. The doctoral education provided a productive platform for him to traverse the convergence of design, anthropology, and energy research. To strengthen his anthropological training and understanding, he has taken courses at Department of Anthropology of the University of Amsterdam, conducted design anthropological studies, and worked with trained anthropologists. In 2017, he initiated and was co-applicant in two proposals that were awarded '*Delft Global Seed Fund*' and Design United's '*Demonstrator Grant*.' Later in that year, he exhibited some findings of his research as an interactive visualization at Mind the Step exhibition at Dutch Design Week 2017. Apart from the research work, he acted as a Promood representative (2015-16) of doctoral students at IDE and is a Student Volunteers Chair at RTD 2019 conference.

Overall, Abhigyan identifies himself as a trans-disciplinary researcher who is genuinely interested in exploring the mutual confluence of design, anthropology, energy studies, and technology. He is currently developing research proposals on these lines.

List of Publications

Journal Articles

6. Singh, A., Strating, A. T., Herrera, N. R., van Dijk, H. W., & Keyson, D., 'Envisioning Anthropology-through-design: a design interventionist approach to generate anthropological knowledge,' (under review, design journal).

5. Singh, A., Strating, A. T., Herrera, N. R., Mahato, D., Keyson, D., & van Dijk, H. W., 'Exploring peer-to-peer returns in off-grid renewable energy systems in rural India: An anthropological perspective on local energy sharing and trading,' Energy Research & Social Science 46, 194-213, (2018).

4. Singh, A., Strating, A. T., Romero Herrera, N., van Dijk, H. W., & Keyson, D., 'Towards an ethnography of electrification in rural India: Social relations and values in household energy,' Energy Research & Social Science 30, 103–115, (2017).

3. Mukherjee, R., & Singh, A., 'Reconfiguring Mobile Media Assemblages: Download Cultures and Translocal Flows of Affective Platforms,' Asiascape: Digital Asia 4 (3), 257-284, (2017).

2. Singh, A., 'Visual Artefacts as boundary objects in participatory research paradigm,' Journal of Visual Arts Practice 10:1, pp. 35-50, (2011).

1. Sayed, S., Singh, A., Saad-Sulonen, J., & Diaz, L., 'Co-construction as complex adaptive system,' The Journal of Community Informatics 6:2, (2011).

Book Chapter

1. Mukherjee, R., & Singh, A., *MicroSD-ing "Mewati Videos": Circulation and Regulation of a Subaltern-Popular Media Culture* in Neves, J., & Sarkar, B. (eds), Asian Video Cultures: In the Penumbra of the Global, Duke University Press, (2017), (*authors alphabetically ordered*).

Conference Papers

7. Singh, A., & Herrera, N. R., 'EthnoVis: An interactive visualization as a designerly product and process of mixed data analysis and communication', (*conditionally accepted*, RTD 2019 conference).

6. Singh, A., van Dijk, H. W., Wartena, B. O., Herrera, N. R., & Keyson, D., '"Electric City': Uncovering Social Dimensions and Values of Sharing Renewable Energy through Gaming", Works-In-Progress paper at the ACM Conference on Human Factors in Computing Systems (ACM CHI'15), Seoul, Republic of Korea, April 18-23, (2015).

5. Larson, M., Rajput, N., Singh, A. & Srivastava, S., 'I want to be Sachin Tendulkar! A Spoken English Cricket Game for Rural Students,' In the proceedings of the ACM Conference on Computer Supported Cooperative Work and Social Computing (ACM CSCW'13), San Antonio, USA, February 23-27, 2013 (*authors alphabetically ordered*).

4. Singh, A., 'Collaborative Videoing - A Reflexive Account,' In the proceedings of IASDR 2011, the 4th World Conference on Design Research, 31 October - 4 November, Delft, (2011).

3. Singh, A., Sayed, S. & Raike, A., 'Human Nodes - Relevance for Inclusive Design and Social Innovation at Urban Slums in India,' In the proceedings of Include 2011 Conference, Royal College of Art, London, April 18-20, (2011).

2. Singh, A., 'Design challenges for sustainable mobile community communication services for Indian Urban Slums,' In the proceedings of Sustainability in Design: Now! Conference, Bangalore, India, (2010).

1. Tuomola, M.L., Korpilahti, T., Pesonen, J., Singh, A., Villa, R., Punitha, P., Feng, Y., & Jose, J.M., 'Concept, content and the convict,' In the proceedings of ACM MultiMedia '09. Beijing, China, pp. 1063–1072, (2009).

Other Publications

4. Singh, A., van Dijk, H. W., Herrera, N. R. & Keyson, D., "Enabling 'New' Practices of Renewable Energy Sharing: A Cross-Cultural Approach," Position Paper at 'Design for Sharing in Local Communities' workshop at ACM CHI'15 Conference , Seoul, Republic of Korea, April 18, (2015).

3. Wartena, B.O. & Singh, A., 'Taqe; Energy Sharing Through Meaningful Play,' Presentation and Extended Abstract at BEHAVE Energy Conference, Saïd Business School, Oxford University, UK, Sept. 3-4, (2014).

2. Larson, M., Rajput, N., Singh, A., & Srivastava, S.,'Spoken-English Learning Cricket Game,' Video Submission at the ACM Conference on Computer Supported Cooperative Work and Social Computing (ACM CSCW'13), San Antonio, USA, February 23-27, (2013) (*authors alphabetically ordered*).

1. Singh, A. & Larson, M., 'Narrative-driven Multimedia Tagging and Retrieval: Investigating Design and Practice for Speech-based Mobile Applications,' Workshop Paper at Speech, Language and Audio in Multimedia (SLAM) workshop, InterSpeech Conference, Marseille, France, August 22-23, (2013).

With the growth of decentralized, off-grid, and distributed renewable energy systems across the globe, an arena for energy exchanges between households is opening up. As compared to traditional ‘centralized’ energy supply systems, in these emerging energy systems households are imagined to acquire agency by having choice and control over inter-household energy exchanges within neighborhoods or villages. The existing literature on such scenarios of energy exchanges is mostly rooted in a techno-economic analysis built upon visions of rational choice approaches and lacks discussion on the sociocultural dimensions of energy exchanges.

This research utilizes theoretical perspectives from economic anthropology to study the phenomenon of inter-household energy exchange. The methodological approach followed takes inspiration from discourses of design anthropology, research through design, and ethnography. This approach is instantiated in the form of a longitudinal multi-method study conducted at two off-grid villages in rural India.

This interdisciplinary research makes knowledge contribution to the fields of energy studies and design anthropology. This dissertation develops conceptual knowledge of inter-household energy exchanges by investigating the social and cultural embeddedness of energy exchanges in a system where householders can decide with whom to exchange locally produced energy. Overall, the dissertation showcases that when people get to structure energy exchanges, they do so by employing a range of social, cultural, moral and economic notions, and demonstrates that there is more to energy exchanges than what the dominant rational choice perspective describes. This work proposes a novel approach called Anthropology-through-Design (AtD), which facilitates generating anthropological knowledge about a sociocultural phenomenon through a design intervention. The AtD approach takes a strategic step in relocating 'design' from being an object of anthropology to becoming an instrument for doing anthropology.