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Changing energy geographies: The political effects of a small-scale electrification project

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ABSTRACT

This article contributes theoretically and empirically to our understanding about how a transition to 'modern and sustainable energy for all' may reconfigure the life of citizens who live 'outside the grid' in rural communities in sub-Saharan Africa. My inquiry is inspired by the question posed by James Ferguson and Tania Murray Li: what do development schemes do? I analyse a renewable energy pilot project in Tanzania that was implemented by an NGO, which eventually failed to continue its service delivery but still produced important effects. Conceptually, I build on and extend previous arguments about how development projects produce depoliticizing effects, have ambiguous effects, and reproduce unequal relations of power. Building on feminist and sociotechnical relational approaches to power, I identify when and where in the encounter between energy project and local community that these, and other, effects emerge. Case study data was collected by qualitative methodology, and consists of project documentation, observation, and interviews with actors involved. The study shows how particular material, social, emotional, and economic effects emerged from the encounter between the project and local society. Feedback between technical problems, financial difficulties, and social tensions created a downward spiral resulting in system failure. It had negative effects on the credibility of actors and on trust relations. I argue that asking what decentralized electrification schemes actually 'do' can provide insight relevant to energy geography, as the focus on effects reveals the sociotechnical and political relations through which electricity becomes possible and how it may reconfigure local places. The case study shows why and how a small-scale, renewable energy project only temporarily repositioned actors and places, produced ambiguous effects, and maintained unequal power relations.

1. Introduction

The growing pressure for change within energy sectors worldwide to achieve the double imperative of 'decarbonization' and universal access to "affordable, reliable, sustainable, and modern" energy services (SE4All, 2018) sees increasing resources being directed to renewable energy systems and small-scale modes of generating and distributing electricity to the public. In sub-Saharan Africa, the 'energy transition' has a different starting point compared to other world regions, as the dominant large-scale centralized model of electricity provision reaches only a minority of citizens. In this context, where especially those living in rural areas lack access to grid electricity, a growing number of international and domestic actors consider decentralized renewable energy systems necessary complements or alternatives to grid extension. The study presented here explores the consequences of one small-scale project aiming to bring 'renewable energy' to people living at the economic periphery in poor, rural Tanzania. It focuses on the encounter between a micro-grid energy project, undertaken as a pilot project by a Tanzanian non-governmental organization (NGO), and the local place and people. The aim is to explore the political effects of this particular energy project in order to understand how it—based on a certain logic and unique technological characteristics—encountered and reconfigured a particular place.

This case is, in many aspects, representative of the energy transition as it unfolds over the whole of sub-Saharan Africa, where many 'energy interventions' are carried out using funding from donors and based on the logic of development projects. My analysis is inspired by the question posed by Ferguson (1994, 2006) and Li (2005): what do development schemes *do*? I argue that shifting focus from the instrumental benefits of electricity access to how energy interventions produce political effects brings alive the socio-material and political relations through which electricity becomes a 'resource' with

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transformative potential. Electricity is 'power,' and a grid embodies a fluid potentiality—a powerful current where someone may plug in to temporarily transform their ability to do work or permanently change their capacities for knowledge.

The discussion is situated in, and departs from, the wider debate on the effects of development assistance on recipient communities, as well as the growing body of literature on how local level electrification processes reconfigure social, political, cultural, and economic relations and domains. Here in particular, energy geographers (Bridge et al., 2013) have drawn attention to how new energy geographies are emerging across multiple scales, and that we may see a shift in the relations between the 'centre' and the 'periphery.' Further, geographers increasingly discuss the particular materialities of energy systems and the political effects and geographical implications of shifting from highly centralized fossil fuel based systems to renewable energy systems and a low carbon economy (Bridge et al., 2013; Frantal et al., 2014; Kirby, 2015; Huber and McCarthy, 2017). This case contributes to this geography discussion in three ways: First, by analysing a locally embedded encounter between a new electric power system—-introduced by external actors—and people in the periphery of poor, rural Tanzania, it concretely illustrates how power—in its double meaning—is enabled and enacted through multi-level relations; Second, by applying a sociotechnical conceptualization of power, I bring out how ambiguous effects are produced from an interplay and tension between human agency and the materiality of technology, with its unique spatial and social arrangements; Third, I employ a framework of analysis that specifies *when and where* in the encounter between energy system and local place that effects emerge, which can be categorized into three types in particular.

These three effects come from three theoretical arguments made by Ferguson (1994) and Li (2005), related to the question of what development schemes 'do.' These are elaborated in the theoretical section. In brief, I label them as arguments around the way the 'logic of development'—established sets of knowledge and best practice of professional development organisations (Ferguson, 1994; Green, 2014)—exert *depoliticizing* effects; how projects are *ambiguous* in their formulation and their effects; and how development, as a sector and particular practice, *reproduces* itself and relations of power. Theoretically, I provide an extension of these arguments by considering them through a sociotechnical lens on power, and am thus able to illustrate additional ways in which these effects are produced, for example by highlighting the depoliticizing role of sociotechnical 'scripts' (Akrich, 1992) that encode exercises of power into software and hardware. Furthermore, the conceptualisation and case lend strong support to Li's argument on ambiguity, as the interplay between humans, technologies, and nature produces pressures for modification and adaptation, compromising development logic in the process and putting relations between actors involved at risk.

I provide a conceptualisation of the encounter between project and local place sensitive to how power relations shape—and are reshaped within—the process. First (Section 2.2), I integrate a feminist theorization of power, inspired by Allen (2014) and Nightingale (2006) with a sociotechnical perspective on power and technologies, building mainly on science and technology studies. Second, electrification is a dynamic and complex process that produces many differentiated effects—beyond the three mentioned above that I will focus on—at specific interfaces, relations, and for different actors. In order to analytically disentangle this complexity, I use sociotechnical concepts to distinguish interacting elements and sub-processes. This provides an analytical framework (Section 2.3) that identifies seven sub-processes of electrification where the spatially embedded encounter produces effects. This conceptual move helps me underpin the discussion of the three effects with more specific examples, and further specify Li's argument that projects are politically charged arenas where relations of power are put at risk, with attention to how unexpected environmental and technical problems—and recalcitrant users—mess up neat project plans and technical designs, resulting in tense relations between the actors involved.

This individual case study contributes to generalised knowledge by engaging with theoretical propositions—what is known as analytic generalizability (Yin, 2008)—by testing, expanding, and discussing the relevance of theoretical arguments made by other scholars (Flyvbjerg, 2006). This article's main contribution is thus to be found in this dialogue with the previous literature.[1]

1.1. Situating the case in relation to energy and development

For many citizens of Tanzania, to have grid-supplied electricity at home is a symbol of being developed, and the lack of it is associated with being backwards, poor, or lagging behind (Winther, 2008). An electrified home is among the things associated with modernity that many Tanzanians *desire*, but cannot afford. The quality and quantity of electric lights carries material and symbolic meaning (Kumar, 2015), and the power systems enabling them are involved in the making of places and spaces. Electrification is hence about both development *and* unequal access to its benefits. This remains the case, despite falling costs for solar PV and growth in markets for energy devices. Solar home systems are still accessible only for the richer minority, whereas the poorest part of the population struggles to even afford low-cost solar kits (Grimm et al., 2017). As decentralized renewable energy systems spread increasingly throughout rural areas, individuals and communities have found themselves socially and economically repositioned in relation to their neighbours and urban centres (Kumar, 2015), with the dividing line between electrified and non-electrified running through the village (Ahlborg, 2017).

The case studied here was a donor-funded NGO pilot project based in a community in rural Tanzania introducing an 'Energy Service Platform' and micro-grid to supply electricity to villagers. The imperative of this project was to extend electricity access to citizens who live 'outside the grid'—such as the people in this community—in order to catalyse 'development.' However, the NGO failed to maintain service delivery. It is a case that can be interpreted in multiple ways: as a typical donor-funded, NGO-led development project oriented around infrastructure and service provision; as a renewable energy pilot-project aimed at experimenting and testing design; or as a project for rural electrification extending access. The case has some character of all of these. The NGO framed the project as one of renewable energy for community development, and promoted the project using the mainstream discourse on environmentally friendly renewable energy as well as the importance of electricity for social and economic development.

In relation to the existing literature on energy and development, this analysis contributes a shift of focus from an instrumental analysis of benefits and outcomes to an exploratory analysis of 'effects.' To illustrate this point, development assistance impact evaluations[2] assess welfare 'impacts' on imagined 'beneficiaries,' with impacts often predefined and based on program objectives, evaluation principles, and criteria (Hummelbrunner, 2011; Winther, 2015). In contrast to such assessments, the approach taken here captures and visualizes non-linear interactions, as compared to commonly used—and criticized—linear approaches to planning, monitoring, and evaluating development projects (Williams and Imam, 2007; Dyehouse et al., 2009). My emphasis on complexity and context is similar to that of the so called 'theory of change' or 'programme theory' (Rogers, 2008; Retolaza Eguren, 2011).

[1] I have searched for, but not found, a similar sociotechnical engagement with Ferguson and Li's arguments around the 'effects' of development.

[2] As Winther writes, impact evaluations of electrification do not necessarily "pay attention to the social (and/or political) process of electrification, which in other contexts have been found to be highly significant to the outcomes and effects" (Winther 2015: 164), or to more subtle and non-quantifiable effects.

Programme theory is however a generic and very flexible approach, hence how it is applied in evaluations of electrification projects depends to a large degree on the evaluators (Rogers, 2009; White, 2009) and the approach as such provides no attention to the interplay in focus here, between power relations and sociotechnical configurations.

The scholarly literature on energy and rural development also has a strong instrumental focus, such as how to maximise impact or determining the reasons that define various electrification schemes as successes or failures. (Ilskog and Kjellström, 2008; Barnes, 2011; Bazilian et al., 2012; Palit et al., 2013; Sovacool, 2013) The risk of failure is well known as local grids have a mixed track record, and evaluations from various countries show that many small grids stop functioning before the end of their expected life time (Rahman et al., 2013; Hartvigsson, 2018). Still, new designs are piloted with optimism and new local grids are promoted, planned and built by various actors in Tanzania and neighbouring countries.[3] In this article, the focus is not 'for or against' local grids, but on the politics of such development projects. In this paper, the term 'political' is understood in a broad sense[4] and 'effects' include both material consequences and effects on social relations, values, and perceptions that emerge from the encounter between project and context. The politics of renewable energy projects have so far been given limited attention in the energy and development field, which is dominated by economic and technical analyses (Sovacool, 2014). I argue that the shift from benefits to effects is important for energy and development scholars, as it brings attention toward how all electrification schemes—including small-scale and renewable energy projects—are inherently political and become arenas for power struggles. Given that I study a case where service delivery failed, it can be considered a 'critical case,' that is, the relevance of shifting focus from instrumental benefits to political effects is tested in a case where the effects can be expected to be either none, negative, or very limited.[5]

2. Theoretical starting points

2.1. The effects of development schemes

'Development' is the domain of a variety of actors, including state agencies, international organisations, commercial corporations, and a diverse assembly of NGOs. The international development system has become a global phenomenon, with development institutions often sharing a common discourse, similar ways of defining problems, and a common pool of experts and types of expertise (Ferguson, 1994; Green, 2014). According to Green, writing on Tanzania, "development as a category of organisation and the imagination […] is a pervasive cultural trope that conveys understandings of modernization, personal achievement, desired lifestyles, and state power, as well as the possibilities of inclusion within a wider set of unequal but potentially transformative relations" (2014: 1). Schemes that are well-meaning and aim to improve people's lives and well-being—such as electrification projects—are also based on unequal relations of power. They may "work on and through the practices and desires of their target population" (Li, 2005: 383), but the development "experts" largely control how the problem is formulated, devise the intervention, and define what counts as development and how it can be achieved. According to Ferguson (1994), 'unsuccessful' projects can also have significant effects on local communities and serve the interests of dominant actors.

Here, the starting point is three theoretical arguments related to the question of what development schemes do, successful or not. The three arguments are generic propositions regarding development schemes and what happens in their encounter with local communities. Given that the energy pilot project studied here was donor funded, the encounter should be shaped by a similar logic. I present the arguments and then consider them through a sociotechnical lens.

First, as Ferguson shows, the project he studied in Lesotho expanded "the exercise of a particular sort of state power while simultaneously exerting a powerful depoliticizing effect" (Ferguson, 1994: 21). That schemes can have the effect of *depoliticizing* development by 'rendering technical' the arena of intervention has also been noted by, for example, Korf (2010). This critique can similarly be directed at the international development community and its discursive portrayal of universal electricity access as a largely conflict-free, joint effort to end poverty and achieve welfare and prosperity for all, to be realized through construction of new infrastructure (WB, 2008; SE4All, 2018). However, even if the discourse is depoliticized, this is not necessarily the case for practice on the ground.

Second, Li (2005) suggests that development projects are messy and *ambiguous*. The 'messiness' refers both to the 'logic' of the schemes themselves and their outcomes. Many development projects are "formed through an assemblage of objectives, knowledges, techniques, and practices of diverse provenance" (2005: 396). Li analyses how projects are devised and unfold; the contingent assemblages of assumptions and logic that underlie schemes; the practices and techniques of planning and implementation; and the multiple positions taken by involved actors. Development practice is ambiguous in that it is simultaneously destructive and productive in its effects on "local knowledge and practice," as locally based actors respond to schemes strategically. According to Li, projects also produce "compromise and collusion," including practices of reporting that allow dominant actors to "translate shaky numbers into solid ones or failed projects into plausible versions of success" (2005: 389).

Third, work by Ferguson and Li has improved our understanding of the development industry as a social institution which *(re)produces itself and unequal relations of power*. As Green writes, development in Tanzania connotes difference and social delineation between and within groups—an "unequal but potentially enabling relation" (Green, 2014: 10). Rather than challenging social hierarchies or the skewed resource distribution, the development sector in Tanzania provided individual career opportunities for development 'experts' and 'practitioners,' but it produces little in the way of poverty reduction (Green, 2014). Based on their respective studies, Ferguson, Li, and Green describe the success of the development industry in reproducing itself while leaving current unequal societal orders intact. However, Li's argument of ambiguity emphasizes a messy and risky process whereby power may be reproduced, but not without difficulties. This resonates with the understanding of power I will now present.

2.2. Power and a sociotechnical understanding of what electrification projects do

As Dean (2013) notes, in German, French and Italian the word 'power' has the dual meaning of 'the force of something' and 'capacity to do.' This dual meaning captures two ways of understanding power and its origin, and the tension between them brings clarity to how the three effects are produced. The first meaning suggest that power originates in human agency—what is known as *power-to*—and the situated capacities of individuals and collectives to act (Lukes, 2005). Following Allen (2014), I understand power-to as an 'action-theoretical'

[3] The actors range from large organisations such as UNIDO, to NGOs, churches, community organisations, and private enterprises (Contejean and Verin, 2017; MEM, 2017; UNIDO, 2017).

[4] I follow Nightingale, who defines politics as the "collaboration and contestations that serve to order and govern everyday affairs" (Nightingale, 2017: 13).

[5] This framework has also been used for the study of a different and comparatively successful case of decentralized electrification in Tanzania (Ahlborg and Sjöstedt, 2015; Ahlborg, 2017), but that study does not examine the three propositions that are in focus here. The analysis here is thus original, but this framework can be used as a more general sociotechnical approach to make sense of local-level energy projects bringing new infrastructure.

conception of power, which includes both power as dominance, 'power-over,' and empowerment, 'power-with' or 'power-from-within.' Power as capacity is in tension and interplay with the second kind of power, a different and more elusive one—what Allen calls 'constitutive power.' This conception shifts the focus away from human agency and intention to 'the force of things,' i.e. forces and pressures emerging from a multitude of interactions. The constitutive conception originates in Foucault's[6] work on power and describes the "fundamentally trans-individual and relational ways in which individuals and the social worlds they inhabit are themselves constituted by power relations" (Allen, 2014: para. 5). In sociotechnical literature, it is seen as pressures originating in the multiplicity of interactions in entangled webs/assemblages/forcefields of humans and non-humans.[7] Akrich's (1992) concept of 'script' is a useful starting point for understanding this form of power, and its relation to human agency. At the level of individual artefacts and more aggregated levels of system configurations or infrastructure, technologies work as 'scripts' that regulate the behaviour of users by allowing, forbidding, or discouraging certain uses, while teasing out spontaneous and strategic responses by actors who obey, reshape, and contest prescriptions of use (Latour, 1988, 1991; Akrich, 1992).

The scripts help us understand the ambiguity of exercises of powers. These are socially constituted and imprinted on artefacts by human actors (e.g. encoded in software and user manuals), hence these come to embody the negotiated assemblages of intentions, assumptions, objectives and visions held by engineers, planners, technicians, funders, and so forth (Hughes, 1983; Summerton, 2004). Thus, infrastructures embody human values and power exercises, but these are—importantly—reshaped in ongoing contestation and modification. The script is rewritten as it is played out again and again (Akrich, 1992). As Feenberg points out, artefacts or infrastructures cannot be reduced to the values and intentions of engineers and designers, but take on far more complex meanings in encounters with people and other scripts (Feenberg, 1999).

The sociotechnical understanding of power I propose sees power as a relational, productive force that emerges both from human agency and as constitutive pressures. The tension and interplay between them is critical and what generates contradictory effects within the same actions (for deeper discussion, see Ahlborg and Nightingale (2018)). Here, I follow Nightingale's feminist theorization (2006), which emphasizes the ambiguity of exercises of power—the uncertain and contradictory effects—while acknowledging the strong stabilizing mechanisms that reproduce relations of dominance. In electrification projects, as well as in many other infrastructural projects or resource governance processes, complex interplay between humans, technologies and nature can result in empowerment while simultaneously creating new relations of domination (Nightingale and Ojha, 2013). Power is de and (re)stabilized continuously, not the least through sociotechnical configurations that work as places where ongoing power exercises produce tangible material and institutional forms, that in turn condition and shape actor's room to manoeuvrer. To extend Li's argument, the 'eventfulness' (Braun and Whatmore, 2010) of sociotechnical configurations contributes to open up spaces for ambiguous outcomes, in that the increase in complexity and emerging pressures reduces and de-centres control over the unfolding processes.

Ferguson and Li do not give explicit analytical attention to technologies in the processes they study, but their arguments find support in an analysis of how energy infrastructure and natural environments are active elements that shape human activities and produce specific effects. The argument on *depoliticising* has been used to describe various mechanisms whereby the (often top-down) exercise of power is rendered apolitical and less visible through its translation to a problem requiring a technical solution (Korf, 2010), or moved from a formal political arena to a 'neutral' institution, e.g. a community based organization (Lange, 2008). The process of 'rendering technical' describes how 'technocratic' society shifts decisions from political arenas and concerns for public debate to technical decisions by experts, without interference from the public (Feenberg, 1999; Korf, 2010). Akrich's concept of script offers a possibility to take the argument further. Scripts play a role in depoliticizing sociotechnical change, in the sense that infrastructures render exercises of power indirect and technical while at the same time giving them a more durable, spatially embedded, and institutionalized form.

In regard to the particular case I study, it is relevant to note that pilot projects which test and develop new technology are depoliticized in a unique sense due to assumptions held by the actors funding, planning, implementing, and evaluating them. Pilot projects aim at learning and finding configurations that 'work.' Research on sociotechnical experiments (Geels and Raven, 2006; Farrelly and Brown, 2011) suggest that there is much to learn from experiments, even when they fail. This is because experimental projects result in lessons on how to improve a technology *and* the process—that is, how to enhance innovation and learning. Consequently, when a pilot energy system stops functioning after a while, it does not necessarily undermine the legitimacy of its implementing actors, whereas the same outcome in an 'ordinary' development project would be considered a failure and waste of resources. This discourse on learning may be relevant, but may downplay the negative effects on recipient communities that do not necessarily share the same tolerance for failure.

Regarding the third proposition on how (also failed) development projects reproduce unbalanced power relations and social inequality, sociotechnical literature lends support by suggesting that technologies become enrolled in dominant actors' exercise of power and in attempts at maintaining privilege and influence (Feenberg, 2005; Smith and Stirling, 2007; Nahuis and Lente, 2008; van den Bergh et al., 2011; Stirling, 2014). More specifically, with regard to energy projects aiming at poverty reduction or 'development,' previous empirical research shows that electrification projects can initiate processes of social and economic change, also in poor rural areas (Ilskog et al., 2005; Mulder and Tembe, 2008; Winther, 2008; Alzola et al., 2009; Kankam and Boon, 2009; Kirubi et al., 2009; Ulsrud et al., 2015). However, there is no direct effect on poverty—rather, electricity access instead removes the barrier to electricity-related activities across a range of sectors, which can open up new possibilities. In contexts of significant social inequality and widespread poverty, the economic barriers remain and effects are often smaller than anticipated, where it is primarily the better-off minority that can access and make use of electricity (Madubansi and Shackleton, 2006; Peters et al., 2009; Bernard, 2012; Winther, 2015). Hence, in general, electrification in the sub-Saharan 'periphery' does not destabilize social hierarchies but reproduces social differentiation. Still, depending on how projects and technologies are shaped and how people act strategically and find ways of benefiting from externally introduced 'projects,' social mobility can increase (Green, 2014). The materiality of electricity as a unique energy carrier brings the potential to enhance human capacity in everyday life to carry out work, communicate, and engage in a wide range of activities. Therefore, electricity also carries the potential to reshape social relations and networks in a deeper sense, to transform individual and collective capacities and, over time, create shifts in multiple domains of everyday life (Winther et al., 2017; Ahlborg and Nightingale, 2018).

To summarize, my argument here is that human actors *act*, while

[6] What Allen labels the 'constitutive conception' of power includes a rich body of work inspired by Foucault's work on disciplinary power and subjection (e.g. Foucault, 1980, 1995) and what Dean describes as Foucault's economic' conception (Dean, 2013). The focus here is on the sociotechnical writings on power that, inspired by Foucault, have taken some of his insights further.

[7] As my co-author and I elaborate elsewhere (Ahlborg and Nightingale, 2018), this constitutive conception is also based on an understanding of power as relational, emergent, productive, and contingent. Therefore, it is conceptually consistent with a relational action-theoretical conception.

artefacts *do* something.[8] The implication of this position for the study of energy transitions is that political effects are produced not only through human exercises of power but also emerge from human/technology/nature interactions in their specific configurations and spaces. Hence, we need to consider the 'materiality' of technology and how the 'script' is modified over time, as well as its related spatial and social arrangements, in order to identify political effects of electrification processes.

2.3. Framework for analysing the effects of electrification

I make use of sociotechnical systems thinking to explore effects emerging from the encounter between the project and its local context. Given the complexity of the process, and my interest in examining the interplay between human agency and sociotechnical scripts, I need to identify the human and non-human elements involved and break down 'electrification' such that concrete interfaces become visible. While small-scale systems for local electricity generation and distribution are organisationally and spatially embedded in a (development and) energy sector and wider societal context (Goldthau, 2014), I delimit my analysis to the local encounter, whereas the macro-level of donors is left out of the analysis. At the local level, the process involves establishing a new sociotechnical configuration and continuously working to keep it operational in the dynamic environment.

The analytical elements of the energy system are actors, networks, institutions, artefacts, and natural resources (Hughes, 1983; Geels and Kemp, 2007). These interacting elements create the dynamic system configuration. The general purpose of the energy system is to provide the community with reliable energy services that meet demand at an affordable price (Hailu, 2012). However, public service provision serves many other purposes and political interests, and the materiality of electricity infrastructure, in combination with the challenges of governing local service provisions, creates a partly unique power dynamic that differs from that of other infrastructures (Ockwell and Byrne, 2017; Gollwitzer et al., 2018).

To locate where effects emerge in the process, I identify seven sub-processes of electrification. These are not theoretically abstract processes, but rather, they reflect the practice of implementing such a project. The sub-processes are interrelated and continuous: (A) shaping of project objectives and implementation strategy; (B) system design; (C) translation of design into system configuration on the ground; (D) electricity access; (E) use of services and opportunities; (F) dynamic outcomes, and; (G) emerging wider societal impact. This last sub-process signifies, for example, how, over time, a decentralized electricity system becomes spatially embedded, the electric power system as well as the local economy become increasingly integrated and may grow, with the effect that the community is repositioned materially and socially in relation to other market places and the wider economy.

Table 1 provides a specification of respective sub-process, with an explanation of the analytical focus. The point of specifying them is to provide a clearer and more detailed conceptualization that works as a methodological guide for data collection. Our three effects—as well as other types of effects—can emerge in multiple sub-processes, and human agency and more elusive pressures are potentially in tension in them all. Given this complexity, I provide table 1 to clarify how one can analytically distinguish phases of the encounter.

Together, the three sub-processes A, B, and C constitute the core of many development projects. They involve translating predefined objectives, strategies, and plans into a system configuration. The configuration reflects limitations, negotiations, and compromises in the encounter between a scheme and the local setting. Sub-processes A–C are critical in producing depoliticizing effects and conditioning access such that it produces unequal material benefits. But as Li (2005) highlights, the projects are often messy compromises of conflicting logics. Sub-processes D–G are, unfortunately, commonly overlooked in development project and impact evaluations (which tend to follow a linear logic and thus pay less attention to what happens after the infrastructure is in place and service delivery begins). This is, in my view, very problematic, as feedback dynamics take some time to develop, and both deteriorating and positive cycles are often unforeseen. Many effects take time to emerge, and what was initially depoliticized may be *re*-politicized as difficulties put strain on relations.

To close, this section's theoretical contribution is twofold. First, in relationship to the analyses by Ferguson and Li, the conceptualisation of power and analytical framework draws attention to the way technical infrastructures and social relations are co-constituted and take part in (de)politicizing development, producing ambiguous and differentiated outcomes and (re)producing social hierarchies. Second, in relation to the more instrumentally focused evaluations of energy projects, I draw attention to a wider set of effects that capture non-linear relations, placing power relations at the centre of my analysis. However, the identification of seven sub-processes, and the ambition to understand all of them, comes at a cost. Each one of these are analysed in less depth as compared to what would be possible with, for example, a more concentrated focus on the process of gaining access. The advantage of the approach chosen here is that the specification of sub-processes brings into view *where* effects and feedbacks emerge and how they shape the unfolding process.

3. Case study: Introduction of a pilot project micro-grid in Northern Tanzania

3.1. Introduction to the case

In Tanzania, the estimated level of electrification in 2013 was 45% among urban households and less than 6% of rural households (IED, 2014). People without grid access rely on small-scale off-grid electric systems—primarily diesel generators. Small generators are used for a variety of purposes, such as powering milling machines, television, music, and electric machinery in workshops. As the current use of diesel generators, and their reliance on imported fuels, are considered problematic for technical, economic, and environmental reasons, there is need for alternative solutions that can provide better services at lower cost.

Such alternative solutions were the goal of the pilot project in Leguruki village. It was planned and implemented by the Tanzanian NGO TaTEDO (Tanzania Traditional Energy Development and Environment Organization). International donors provided the funding for a package of three parallel pilot projects in three different villages. The project aimed to transfer an energy systems model developed in West Africa (UNDP, 2004) and adopt it to the Tanzanian context. The model introduced was the "multifunctional platform" or "Energy Service Platform" (ESP), which in Leguruki consisted of a diesel-powered 16 horsepower air-cooled engine mounted on a chassis, together with an alternator of 11 kW for supplying electricity to a micro-grid, a combined grinding and pounding machine, and an oil press for pressing *jatropha* seeds into oil, to be used for running the machine on *biodiesel*. The ESPs are expected to be a better alternative than diesel generators because they offer a package of multiple services.

Leguruki village is located on the slopes of Mt. Meru, in the Arumeru District in the Arusha Region. The local authorities estimated a population of 5135 people at the time of the study (April 2011). People mainly grew coffee, maize, bananas, beans, and kept livestock. There was a market in the village every week and buses provided daily transport to nearby towns and villages. The village was chosen for the project after village leaders contacted the NGO regarding possibilities to add value to jatropha, which people cultivated. Local leaders also showed willingness to implement community projects, and the village

[8] There are sociotechnical scholars who suggest that non-humans have agency and exercise power, and a range of positions exist, see e.g. (Akrich, 1992; Law, 2002; Braun and Whatmore, 2010).

Table 1
Description of the electrification process and focus of analysis for respective sub-processes. Version adapted from Ahlborg (2017).

Sub-process	Analytical focus
A. Objectives & implementation strategy	The way the implementing and executive actor(s) work(s) and exercise(s) power in relation to other (local) actors is of great importance for the processes' direction. Different kinds of actors—NGOs, enterprises, churches, and government—work according to different logics and constraints, e.g. well-established practices and expertise on how to do 'development,' reflecting quite messy discourses and assumptions (Li, 2005; Green, 2014). Analysis is focused on underlying logic, objectives and strategies, the kinds of relationships established, and decision-making procedures.
B. System design	Sociotechnical system design is about what kind of system is planned and by whom. Together with system configuration, it is conceptualized as a dynamic and iterative process where actors negotiate and exercise decision-making power on what system to put in place. Depending on power balance and local embedding of actors involved, the system design is more or less tailored to local conditions and needs. Pilot projects are particular in that they experiment with design in order to find configurations that work well
C. System configuration	Place-specific characteristics (geographic, ecological, social, etc.) condition the translation from design to configuration. The system configuration is understood as the kind of system that is actually put in place on the ground, composed of actors, networks, artefacts, institutions, and natural resources. It is a physical and organisational manifestation of the system as it develops over time and space. Its characteristics result in conditioned electricity services, that is, the configuration works as a script (Akrich, 1992) that regulates user behaviour by making service available at, e.g., a certain cost, for specific hours and places, or by contractual agreement
D. Electricity access	Access to electricity is defined as the capacity to utilize services or capitalize on opportunities related to the provision of electricity. Access involves specific exercises of power in order to gain access and maintain it, and the risk of losing access. There are also actors who control the access of others (see also Ribot and Peluso, 2003). The analysis involves: (1) *factors* (individual, contextual, and external) that impact positively and negatively on individuals' and collectives' capacities to gain access; (2) *strategies* used (often in combination) by individuals and collectives to gain, maintain and control access by: (a) mobilizing assets and (b) drawing on relations, discourses, and institutions. This sub-process is critical for reproducing existing hierarchies
E. Use of services and opportunities	Individuals and collectives who are capable of utilizing electricity services and related opportunities can use electricity for a range of different purposes. The literature on energy and development tends to distinguish between productive use, household use, and use for public services. But these categories overlap as many non-commercial uses and purposes have economic dimensions to them (Cabraal et al., 2005). The household should not be used as the smallest unit of analysis, as there are intra-household differences and relations to consider (Agarwal, 1997; Winther, 2008). Dynamic practices in many domains of daily life open up new spaces for empowerment—dominance and destabilisation of roles and norms
F. Dynamic outcomes	Outcomes are dynamic and can be positive, negative, or ambiguous. They are analysed at individual, group, and system levels. It is crucial to capture divergent perceptions and how these change over time and are acknowledged, such as actors' expectations, desires, interests and needs in relation to the electrification process—from the level of specific 'benefits' to how well the system is perceived to be working (Pinch and Bijker, 1984; Mehlwana, 1997). Positive or negative feedbacks tend to emerge here
G. Societal impact	Analytically, electricity access leads to societal impact when outcomes for individuals and groups translate into impact on the community at large, i.e. when a broader societal change can be convincingly said to occur and is linked to the sociotechnical system formation. Electricity use may lead to a reconfiguration of daily life in time and space, changes to local livelihoods and, in the longer term, to quality of life. It may lead to lasting repositioning of a community's "place-in-the-world" (Ferguson, 2006)

lacked connection to the national grid but was accessible by road, and there were economic activities that could benefit from electricity.

3.2. Case study methods

The study was carried out based on a qualitative research approach. The scope of analysis is limited to the encounter at the local level and the process whereby the infrastructure was introduced and service provided. The Leguruki site was identified as a potential case through discussions with actors in Tanzania. TaTEDO is an organisation with a good reputation and long experience in rural energy development, and it welcomed external research.

At the time of the study, the generator had been down and not running for over a year, and the platform as such was standing still, gathering dust in a small house in the village centre. Data was collected over four weeks using semi-structured interviews, project documentation, informal discussions, and observation to map the electrification process. Nine days were spent in the village over two weeks, and with my interpreter I lived with a family in the village. The material includes ten interviews with NGO staff involved in the project, and 43 interviews (lasting 20 min to one hour) with people in the village (27 men and 19 women, 46 people in total). I specified, with help from the Tanzanian interpreter who is very familiar with the social and cultural context, the categories of people to talk to: interviews were held with people connected at home and/or business, people working in connected churches, and people without connection (including three non-connected schools and one dispensary). The respondents consist of both better off and poorer families, young and old people, business people, farmers, teachers, church leaders, and multiple people from the ESP village energy team. The work was done mainly by foot, walking around the village guided by the ESP technician, who introduced us to people, explaining who we were in the local language Kimeru, and answering questions people had before they agreed to talk to us in Kiswahili. I benefited from having an interpreter with social skills and status (a young woman with employment and intermediate education) that allowed us to talk to both rich and poor, women and men. We discussed the purpose of the study, as well as methodological concerns, in depth with our local guide before initiating the work. He was not present during the interviews apart from a couple of times when older people needed translation to the local language. He understood my insistence on the importance of different perspectives and thus did not only select respondents who were to his liking or counted as friends. We used a car for a couple of days to reach people living further from the village centre. Although relatively short time was spent in the village, the volume of material gathered was large enough that we reached the point of receiving similar answers to the key set of questions, and many informal interactions with our guide and our host family assisted interpretation. The semi-structured interview format gave flexibility to follow up on answers, asking for concrete examples of events and activities. To ensure the interpretation was valid, I also discussed more sensitive topics outside the formal interview. The material provides a quite clear picture of villagers' experiences and perceptions of the outcomes of the project. I have deliberately sought to identify contrasting perspectives and points of disagreement. The scope of the study was limited to what happened between the NGO, the village, and within the community, so the perspectives of donors and the district government were thus not included. I attempted, without success, to schedule an interview with local political leaders, but they did not have time for more than a couple of short formal visits.

All interviews were recorded and transcribed, and translations were double-checked. Preliminary results were presented to and discussed with TaTEDO staff. This gave further material on the NGO's view of

difficulties, the order of events, challenges ahead, and what had been learned in the project. A similar discussion with the village respondents was not possible to carry out. The interviews were coded using coding software and analysed using content analysis, based on an analysis scheme with predefined themes (Mikkelsen, 2005) according to which codes were sorted into code families—although some new codes and themes also emerged during analysis. The initial analysis identified the system dynamics and reasons for failure to maintain services. In a second phase of analysis, I revisited the data to identify effects emerging throughout the system formation, and to consider the three theoretical propositions. In the following presentation of results, I combine the different kinds of data in order to obtain a more comprehensive description of events.

4. Case study: Results

The following case analysis is organized around the sub-processes of the formation process (see Table 1), with some analytical movements back and forth between sub-processes, reflecting the cyclical character of interactions. I discuss emerging effects (of all kinds) for every sub-process (Sections 4.1–4.4) and identify what I consider the most important effects emerging from the process as a whole (Section 4.5). The concluding discussion (Section 5) builds on this analysis to address the three theoretical propositions and if they find empirical support in this case.

4.1. The logic of the pilot project: objectives and strategies

The electrification project by TaTEDO aimed to provide non-electrified rural communities with access to electricity in order to enhance rural development. Three ESPs were introduced in parallel in Leguruki and two other villages, but differed in management and technical design. By testing different designs, the NGO intended to identify a working model for scale-up in their next program phase.[9] The system in Leguruki worked only for a short period. However, from the perspective of TaTEDO, the pilot project did not "fail," but rather was successful as it produced important lessons that led to changes in their designs for upcoming implementations—however no mechanism ensured an integration of the lessons learned back into the project in Leguruki.

Underlying the process in Leguruki was a pattern typical of development interventions in Tanzania (Green, 2014). It was characterized by unequal relations of power between the NGO and local actors. TaTEDO's legitimacy was based on its capacity to mobilize resources and knowledge that was out of reach for local actors. It was largely in control of the implementation process and material resources. In its relation to local actors, TaTEDO applied a 'participatory approach' aiming to involve and give a degree of influence to the people affected by the intervention. This was a matter of both principle and practical solution, and was considered necessary for achieving positive and lasting outcomes. However, local participation started only with implementation. Before that, the NGO wrote the project proposal and grant application, specifying the technical system design, project objectives, activities, and budget. Once implementation started, the NGO actively sought the support and assistance of local government leaders, which led to negotiation and compromise. The NGO intended to engage the community in operation and eventually hand over legal ownership of the system.

In 2007, the NGO held public meetings in the village and carried out a feasibility study and Participatory Rural Appraisal (PRA) exercise, identifying villagers who wanted to become grid customers. It also trained a local technician and his assistant on how to operate and maintain the machine. Construction of the platform and micro-grid took place in 2008, during a few weeks. The NGO also carried out a few training sessions about the cultivation of jatropha and how to establish tree nurseries.

The participatory strategy applied in Leguruki produced certain political effects. First, their alignment with local leaders meant that the NGO confirmed the authority of community leaders by positioning them as partners in the project. At the same time, the NGO partly challenged existing hierarchies by pushing for and encouraging the involvement of low-status groups: poor people, youth, and women. Second, the NGO assumed that in order to be successful it needed to create a 'sense of ownership' among local actors for the project. The idea was to make sure people invested in the project and took responsibility for its continuation, even when the project had been designed, planned, and implemented by an external actor. The effect of this particular understanding of local participation was a separation of legal ownership and control over the process (which remained in the hands of the NGO) from emotional investment in the project's continuation. This did not work as intended. Participation at the implementation stage did not suffice to make local actors feel "ownership," which was confirmed in action when village leaders requested the NGO to buy the piece of land where the platform was installed. In interviews, people repeatedly claimed that the system belonged to TaTEDO.

Third, in order to generate strong local support and engagement in the project, TaTEDO mobilized the depoliticized discourse on electricity as a symbol of modernity and progress. Somewhat contradictorily, the discourse builds on the assumption—held by TaTEDO and many other development organisations—that rural people need to be made 'aware' of the importance of electricity. One reason is that electricity is rarely one of the topmost development priorities of rural people in East Africa (see e.g. EdM, 2007). Therefore, the NGO 'sensitized' the villagers about electricity being crucial for societal development. Drawing on this discourse had the effect of producing local support, but also high expectations—some beyond what was promised by the NGO—regarding what the project would bring.

4.2. Translation from design to system configuration

The translation of planned design into an actual energy system on the ground (sub-processes B–C) involved a number of compromises and negotiations due to budget limitations, cost of materials, and settlement patterns in the area. The consequence was that the actual system was not the same as the one imagined at the beginning, and it did not meet the objectives of neither the NGO nor people locally. The planned system was sized for a grid with 120 customers and this number was at the basis of financial calculations for running the micro-grid with profit. However, in the end only 49 houses nearby the platform were connected. Another 40 households and businesses wanted grid connection, and the local schools and health centres were not connected. As a consequence, the multi-functionality that was part of the core idea of the platform was not fully achieved. In order to electrify public services and reach more customers, the NGO applied—without success—for new funding for a second phase of grid extension. Table 2 provides the details of the system services and electricity uses in 2008.

This exemplifies the consequences of how development projects and donor logic commonly separate the design phase from implementation, but in practice the design process involves local adaptation. Hence, predefined designs have the effect of producing a 'gap' that involved actors need to somehow handle in order to make configurations work. Three examples illustrate effects of the translation from design to configuration in Leguruki. Technically, the placement of the platform and distribution grid was an exercise of power with important effects, in that the decision had consequences for who could connect and what services could be provided. There were no detailed maps available for the area nor any satellite images of sufficient resolution for someone to study

[9] The NGO received funding from the European Union for the scale-up of its ESP program. The implementation started in the second half of 2012, aiming for 50 systems in as many villages.

Table 2
System configuration and electricity use in Leguruki in 2008.

Services at the platform	Grid services
Available daytime only	*Available 3 h per night*
Pressing of jatropha: not much used as the oil press did not function very well	**Electric connection of 49 houses**: 2–7 sockets per house.
Milling services: much appreciated and considered affordable and well-functioning	*3 price groups*: (a) those connected with 2 bulbs: 4000 Tanzanian shilling (TZS) per month, (b) those with 3 bulbs: 6500 TZS per month and (c) those connected with 4–5 bulbs and a socket for radio, TV and phone: 8500–15000 TZS a month.
Battery charging: station for mobile electricity service. Never taken into use	*Uses in households and businesses*: Electric lights (mainly indoors), charging of phones, radio, TV, listening to music, playing electric instruments, cutting hair
	Street lights in village centre (much appreciated by villagers, cost shared between grid customers)

settlement patterns of potential customers and make an "expert" decision about a technically "optimal" placement of the grid. In this situation, the NGO staff relied on the local technician to advise them on the placement of the grid. Local leaders accepted the 'expert' decision by the technician. While the technician stated in the interview that technical considerations were behind his placement of the grid, in following informal discussions he admitted to considering what would be socially and politically appropriate. He prioritised a grass field where the market is held and the local government has its office over the health care centre or schools.

Managerially, TaTEDO came with the proposal that the ESP should be owned and managed by a local entrepreneur who would run the ESP as a commercial business, but for public good. However, the village leadership in Leguruki preferred a collective management model. TaTEDO agreed to this proposition and as a result a Village Energy Team (VET) was established, trained, and given responsibility for management. A verbal agreement was reached that legal ownership and responsibility for the platform was to be formalized in a contract and transferred when the village had paid 50% of the investment cost. However, the contract was never signed and the payment for the system never took place.

Financially, the ESP provided villagers with electricity connection at a cost that was comparatively lower than those offered from the national grid (users paid for internal wiring only). The arrangement of payment for services and decision on tariff levels was left to VET members and connected customers to agree on. The resulting tariffs (see Table 2) were lower compared to what the households spent on kerosene each month. However, as a result of few customers connected in the first phase, the VET had to impose a time restriction, of three hours of grid service per night, in order to balance the running cost with the level of income.

Based on the conceptual approach, we can see how translating design into a 'working' configuration produced a certain 'script' with political effects. The initial project design and budget significantly reduced the room for agency when it came to making necessary adaptations. It placed the NGO in a position where objectives could not be met, resulting in the idea of a second phase of connecting users (and need for additional fundraising). It also involved an example of what previous literature (Li, 2005; Korf, 2010) describes as 'rendering technical' a political decision (where to place the grid) based on knowledge claims, but this effect was very limited. More significantly, the introduction of electricity services required negotiations and compromise as local political leaders opposed the management model proposed by the NGO and suggested 'community ownership'—leading to the establishment of a new decision-making body (the VET). Further, the resulting configuration conditioned access to the services to specific places, specific hours of the day, and required users to mobilize resources to afford the investments. Finally, the system's spatial outline reinforced the idea of a village 'centre,' now marked also by the building housing the platform, the poles, electric lines, and outdoor lights. With the grid came a new social category in the village: electrified households.

4.3. Access to electricity constrained by class and gender

In Leguruki, the main barriers to gaining access to electricity are related to economic poverty and gender relations. These influenced, but did not determine, who could access the new services. Regarding poverty, perceptions of who is considered poor or not differs in various parts of Tanzania. In Leguruki, people are considered very poor if they cannot meet their basic needs for food, clothing, and housing. Economic poverty was considered an important barrier to access, in terms of not having enough assets—cash or appliances—to connect to the micro-grid or benefit from services like charging of mobile phones. Still, there was a perception that poor people could anyway benefit from collective services (milling and street lights). From TaTEDO's point of view, their potential grid customers are found primarily among middle and high-income people (in relative terms). There were also a few families with low incomes among the customers, including a couple of widows. Some female-headed households were among the customers, and five women interviewed had businesses and had been customers of the micro-grid. Still, the majority of ESP grid customers were men.

When it comes to gender, men dominate in most sectors of Tanzanian society and decision-making at all levels.[10] Gender matters not only when it comes to being able to connect to the grid. TaTEDO staff had the understanding that gender roles influence all stages of energy projects. According to the NGO's gender expert, there are multiple barriers limiting women's participation in and benefits from energy projects. For example, access to project-related business training favours men as it targets people (mostly men) who already have experience running businesses. In terms of participation in meetings and decision-making, TaTEDO specifically encouraged village leaders to invite women to meetings and have women members on the VET. Women came to meetings but found it difficult—due to cultural taboos—to speak in front of men or to be listened to. Other kinds of norms create more barriers for women. Technology as such is seen as a 'male thing' in the area. One of the male TaTEDO employees refers to the 'inferiority complex' holding women back when it comes to using new technology: "Women only know how to switch [the light] on and off. (…) They can stay in the dark—that happened even in my home. Why? They say we were just waiting for you. (…) Sometimes it is due to gender roles." This illustrates why it is not enough to avail the infrastructure to produce social inclusion. The women in this person's family lived in an electrified house but did not feel comfortable/capable of using the new technology. TaTEDO came to the conclusion that gender inequality is likely to be (re)produced in coming projects, unless the program targets women specifically. To counter this, the NGO initiated a gender-mainstreaming approach that would be introduced in some (not all) of the coming projects.

So far, I have analytically separated different phases and factors for sake of clarity. However, in reality these dimensions are entangled. An example from Leguruki illustrates how class, gender, and spatial location combined to create a disadvantaged position (see Shields, 2008)

[10] The country ranks at place 123 out of 149 countries on the Gender Inequality Index (UNDP, 2014).

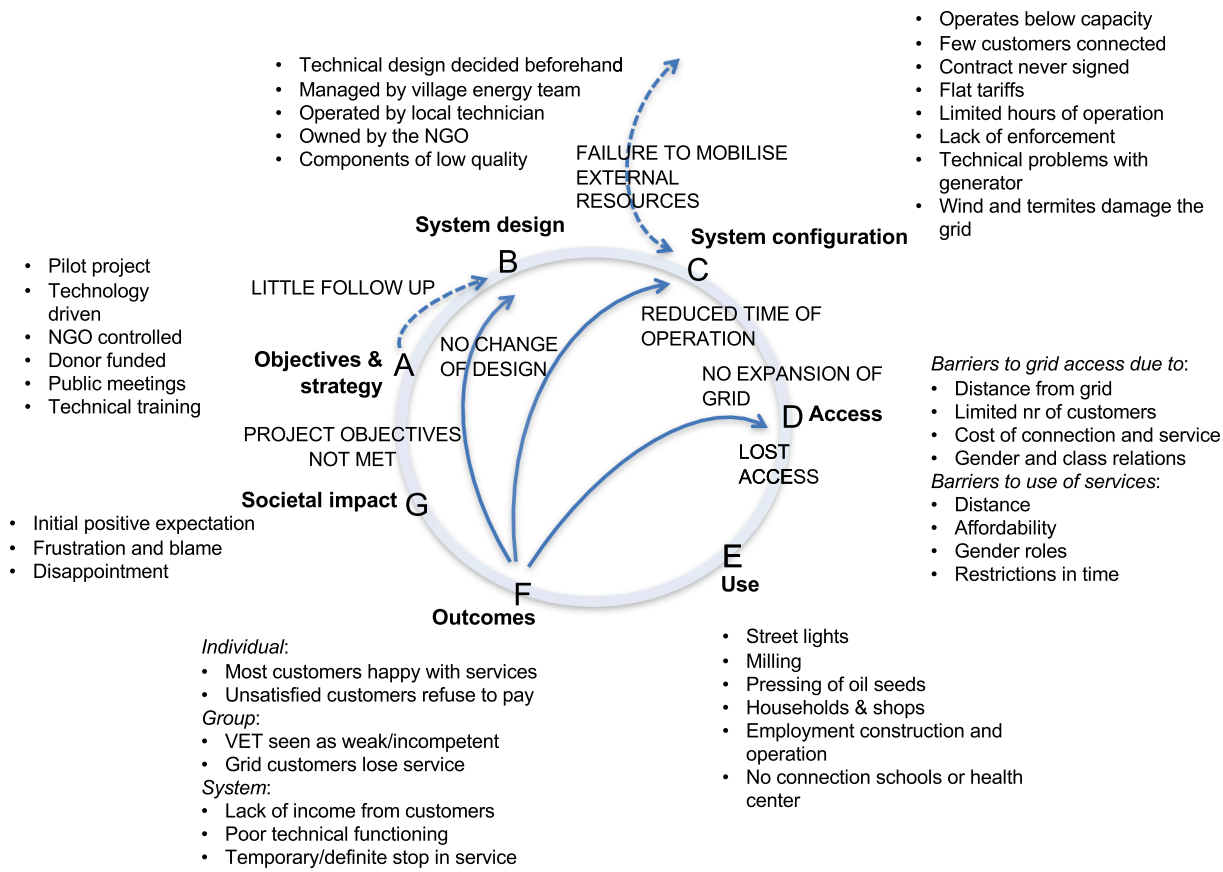

Fig. 1. System dynamics in the ESP project in Leguruki. Key characteristics of each sub-process (A–G) are listed as bullet points. Arrows and capital letters show emerging feedbacks. Dashed arrows indicate weak relationships.

and what is known as "the paradox of resistance" in feminist theory (Mahoney and Yngvesson, 1992; Nightingale, 2006). One of the women selected for the VET told the story of her involvement. Initially she was very proud to be chosen for the group. She lived within one-hour walking distance from the centre and could not connect to the grid. She felt a strong engagement and wanted to contribute as much as possible to make sure the project was sustained. But when they encountered technical problems there was not much she could do. She had little technical knowledge, low income, was not herself connected, and lacked high social status. Her hope turned into disappointment and embarrassment. When asked about women's participation in the VET, TaTEDO and the technician said the women on the VET had "not contributed much," thereby placing them in a position as incapable and—in my own interpretation—this confirmed their view on women as weak leaders. The paradox here is that being chosen as member of an organisation carries symbolic value and may enhance an individual's social status, but it may also result in the opposite if relations of class and gender work to undermine the person's position and expose her/his lack of power and influence—hence (re)producing subordination despite the intention being an act of empowerment.

These examples reflect insights from existing feminist scholarship on how unequal relations of power in the social setting influence the capacities of individuals and groups to exercise their power by responding strategically to new opportunities, such as mobilizing resources to pay for electricity connection. Unequal opportunities to participate in the process and to access electricity in turn result in a skewed distribution of benefits—reinforcing social hierarchies and income gaps. However, this general pattern is not totalizing as some individuals find ways of overcoming barriers to access, for example by borrowing money from friends and family to pay for connection.

4.4. From use to outcomes: energy uses, benefits, and system functionality

The following analysis of the sub-processes E and F describes electricity use and perceived outcomes for individuals and groups (microgrid customers, people using specific public services, women, men). It also reveals the emergence of diminishing feedbacks on the functionality of the system configuration and explains how factors combined to stop service delivery. The analytical shift from instrumental benefits to a wider range of effects brings to our attention to other consequences not noticed in the first round of analysis.

In interviews, people recalled how happy they were to have the ESP in the village. Initially, the provision of electricity worked fine, and in the connected buildings electricity was used for a variety of purposes in households and businesses. Experienced benefits included: higher incomes from business; cost reductions from replacing kerosene by electric lights; better lighting indoors and outdoors, which resulted in a better indoor environment and a sense of increased security. Also, many villagers emphasized that electric lights carry important social and emotional meaning. An old man with a leadership position said: "It feels like I have been living my life in the dark, now I want my grandchildren to live in the light." For him, knowledge and education was the key to living in "the light" and that was the importance of the project.

Other important services included the milling service (deemed to be of high quality) at the platform and the availability of mobile phone charging, access to TV and radio both in public and people's homes. Communication and entertainment had the effect of enhancing people's sense of well-being. Respondents who had TV at home said that it helped you stop "having thoughts" or "think too much until you go mad." However, male dominance of the public space and traditional gender roles limited women's access to TV to private homes, as it was considered inappropriate for "good women" to watch TV in public

spaces.

Despite the experienced benefits, the service delivery did not match expectations created at the beginning. The group of micro-grid customers had different views on a number of issues but agreed that two aspects were problematic: the cost for service and the time restriction. These in combination led some customers to refuse to pay the tariff. As a consequence, there was not enough money to buy fuel, which led to difficulties in keeping the system running. The members of the VET found it socially very challenging to enforce payments (known as the "friendship dilemma" (De la Torre-Castro, 2006)) and, as an effect, a deteriorating feedback between individual outcomes, system functionality, and configuration developed (see Fig. 1 below).

Technical problems aggravated the situation. Accounts differ regarding how long the system was actually in operation. Putting pieces of information together, it seems the system started running in August 2008 and was operated for about a year before technical problems occurred. The technology did not function as expected in the local setting with its specific natural conditions. The choice of an air-cooled engine turned out to be a mistake, as the generator did not cool properly, leading to over-heating. Additionally, the reduction in cost that the NGO had expected from use of biodiesel from jatropha failed to appear. Also, electricity poles started to fall down because of winds and termite attacks. The technician explained how recurrent problems led to temporary stops and need for repair. NGO staff went to Leguruki on three occasions to carry out small repairs. But without additional funds, the NGO lacked capacity to act and drive the project in the desired direction. Staff were frustrated that they could neither provide the assistance they knew was necessary, nor implement the planned second phase.

The discrepancy between the discourse on electricity and the way technology, natural elements, social tensions, and limited project funding interacted came to produce growing feelings of disappointment, frustration, and blame between actors involved. For example, the technician expressed frustration about the lack of follow up from TaTEDO, as well as the inability of local management to solve problems. When there were problems people approached him demanding he solve them, rather than holding the VET responsible. His positioning in between actors put emotional and social pressure on him.

The constrained position of the NGO became increasingly evident and problematic as time passed, and the NGO failed to mobilize additional resources from donors. It was unable to intervene again. The discrepancy between local needs, expectations, capacities, and the system's service delivery became too large, so local actors took the decision to stop delivery of electricity in the evenings. A few months later, in late 2010, continued technical problems resulted in the stopping of operation of the milling services. The system was then left without maintenance. Termites further damaged the grid infrastructure and people stole cables at night. What could have been a temporary stop became a system failure as thereafter not only did the engine need to be replacing, but also poles and cables, increasing the reinvestment cost.

Fig. 1 visualizes the formation process and its feedback dynamics. It shows the emergence of a downward spiral resulting in cessation of service delivery and everyone losing access. The service delivery did not last long enough to produce changes in local society (sub-process G) to a degree that it could be characterized as a repositioning of the community in society. Rather, one may see the wider impact as one of deteriorating social relations between actors involved.

4.5. 'What do projects do?' Effects produced by the project

Considering the entire process, some effects were more pronounced. Initially, the electrification project had the effect of creating positive expectations and strong support among the inhabitants of Leguruki. The project aroused desires for a better life with more possibilities and less poverty. The discursive power of electricity as a symbol of modernity is powerful, especially since the visual manifestation of electric lights at night creates a sharp contrast between villages and homes with and without electricity. There were three effects related to how the NGO mobilized this discourse. First, the experience of having electricity in the village for a year and then losing it was painful for many people. Disappointment was especially pronounced from people who had been closely involved. In interviews, the villagers expressed frustration because they didn't know what was going on and whether the system would be repaired or not. As I interviewed an old man about electricity in his home at dusk, we sat in increasing darkness until his grandchild came with a kerosene lamp. with disappointment in his voice he said, "You see, we have to sit like this in the dark" and then explained he did not expect the system to work again.

In interviews, NGO staff, as well as some of the villagers, expressed that the people in Leguruki did not fully understand the importance of electricity and that this contributed, to some extent, to the failure to keep the system running. However, this stated lack of awareness did not show in interviews. Only once did a person question the idea that electricity was important, as having electricity in the house had not met her expectations. What came out—the second effect—was rather a clear reflection of the dominant societal discourse on electricity as part of modernity. Thus, the project 'failure' did not seem to undermine the discourse on electricity as central to development. However, the way TaTEDO mobilized the discourse created exaggerated expectations. The third effect was that the mismatch between expectations and actual service delivery led to an unwillingness (resistance) to pay for services.

The failure to maintain services resulted in a deterioration of the trust relationships between actors involved. The capacities and credibility of actors involved were called into question. One of the VET members directed critique at the NGO: "I am really disappointed it is not working. If you put something you have to make sure it works. The system was very expensive and it cost a lot of time for people involved." Other villagers were also disappointed with TaTEDO, and felt the organisation had not fulfilled promises and was "too far away." Some villagers were critical of how local management had handled the situation. TaTEDO staff were regretful that they had not managed to fund necessary repairs and connect more customers. But they said the local leadership shared responsibility for outcomes. In their understanding, power dynamics internal to the village, ineffective leadership, relations between individuals, and conflicts related to money became hindrances for the economic sustainability of the project.

On the other hand, disappointment was not the only effect of the project. In 2011, many villagers still harboured hope that the system would be repaired and improved. They had not given up on the project and they were willing to make new investments. For a few people, the experience had been motivating. The clearest example was the technician who used the knowledge gained in the project to develop various businesses. As Li (2005) points out, development projects are often both productive and destructive in their local effects.

For TaTEDO, the project produced a number of lessons for their scale-up phase. In terms of technical design, it decided to prioritize high quality equipment and systems of higher capacity. In terms of managerial models, they had reached the conclusion that accommodating the local leaders' wish to manage the ESP created more problems than it solved. For them, the idea of 'community ownership' appeared less attractive, and in coming implementations they would prioritize a private ownership model under conditions stipulated by legal contract—which in itself is a political effect in the way it supports neoliberal discourses on the effectiveness of markets and the private sector (Newell and Phillips, 2016). The NGO modified its strategies for creating local support for the project and establishing good relationships between the entrepreneurs, local customers, and political leaders.

5. Discussion and conclusion

This article has engaged with the question: what do development

projects do? and asked that question in relation to decentralized electrification in Tanzania. The aim was to study the political effects (in the broad sense of the word political) of a decentralized community electrification project produced in the encounter with the local community. I examined the question of what this project *did*—that is, how and why it produced certain effects even though it failed to sustain service delivery.

As highlighted by recent writings on future energy geographies, the shift from fossil fuels to renewable energy brings possibilities to also shift from large-scale centralised power networks to distributed and small-scale power generation and distribution. For people in rural Tanzania, the experimentation in and diffusion of renewable energy-based electricity services reconfigures the existing energy supply and its use, repositioning people and communities as 'connected' or not to 'modernity.' The article has contributed to understanding the effects of this shift by investigating the encounter between an 'energy for development' project and people living in the rural 'periphery' through a sociotechnical lens showing how power relations and inequality combine with the material characteristics of infrastructure to shape projects that bring widely desired services.

The sociotechnical perspective expanded the question posed by Ferguson and Li to explicitly include effects emerging from interactions between human actors, technology, and nature. This allowed us to appreciate how a planned design was translated into a compromised version due to limited budgets, cost of equipment, spread out settlement patterns, and contestation around the management model. The system failed to deliver services because winds, termites, and air temperatures messed up its technical functioning, people refused to pay according to contract, and the NGO failed to raise additional funding. Theoretically, the case study illustrates how emergent effects are produced from spatialised interactions between humans and non-human elements, and how the encounter between project logic and local context results in compromise and modification, giving the system configuration a character of 'assemblage' (Li, 2005). The conceptualisation of relational and productive power emerging from the interplay between human agency and constitutive pressures—manifested in the dynamic 'script'—also helped clarify the ambiguity of the exercise of power and the tensions between dominance and empowerment.

The empirical analysis speaks to theory by examining three propositions found in previous literature. First, the results only partly support Ferguson's (1994) argument that the logic of development discourse and practice *depoliticizes* interventions. In this case, the discourse on the importance of electricity helped 'sell' the project to garner local support and engagement, while obscuring the limited actual benefits and differentiated outcomes. This created, as in many other projects, high expectations that paved the way for later disappointment (Massarella et al., 2018). Interestingly, the negative outcomes did not affect the discourse on the importance of electricity, which remained intact. So, perhaps, it is not so much a question of depoliticizing local development by rendering development 'technical,' but rather selling a project based on ideas around modernity speaking to people's aspirations for a better life. This mechanism is perhaps one of 'rendering emotional' a project. In line with Li (1999), I argue that rather than depoliticizing local development, the project became an arena where local politics and aspirations for a better life played out. Upwards however, in relation to donors, the failure to deliver on project objectives was discursively depoliticised through applying the labels of pilot project and 'lessons' produced.

Second, the case also supports the argument that projects have *ambiguous* effects, in that they are both productive and destructive in relation to local knowledge, relations, and practices. The tension between dominance and empowerment was revealed in the reproduction of the prejudice against women as incapable leaders, despite the intention to empower women by including them in decision-making. Further, an important effect of the failure to keep the system running (partly due to the role played by winds and termites) was a deterioration of trust and a questioning of the capacities and credibility of dominant actors—a finding that supports Li's (2005) argument that development projects also come fraught with uncertainties and risks for dominant actors. This seems to be the case even for pilot projects, despite the seemingly higher tolerance for failure. TaTEDO took a risk, exposing itself by allowing me, an external researcher, to study one of their less successful projects, and by transparently sharing their experience of the process and the difficulties they encountered.

The study of this 'failure' led me to reflect on how the constrained position of the implementing actor works against critical assumptions relating to pilot projects—namely that pilot projects are arenas for experimentation and learning from failures (Geels and Raven, 2006). The financial logic of donors, and the artificial separation of the design phase from implementation, contradicted the project's intended flexibility (Edwards and Hulme, 1996). Whereas pilot projects, such as the one in Leguruki, in principle allow for experimentation and testing of technical, financial, and managerial models, in practice the budget and time constraints often reduce the implementing actor's capacity to fully adapt the system configuration to the local setting. If there is a lack of funds for unforeseen expenses, and donors are unwilling to provide additional funds, then the risk for failed implementation increases (Edwards and Hulme, 1996; Massarella et al., 2018). To me, this raises the question: does the logic of pilot projects, in combination with the logic of development, place the costs of failure on local communities to an even larger degree than 'ordinary' development projects?

Third, the findings also support the argument that development interventions *(re)produce* social inequality and power relations (Green, 2014). It did so firstly because the shaping of the project reflected, and did not contest, the unequal relationship between the NGO and the village, as well as social differences of class and gender within the village. The NGO aligned with local leaders, but the relation became uneasy and tensions grew over time. The conclusion is that the project re-established the village as being situated in the 'periphery,' the incapacity of local actors, and their dependency on external support for 'bringing power' to their village.

Based on these findings, I conclude that it is fruitful, for multiple reasons, to ask the question of what projects *do*. Most importantly, it helps in rendering energy interventions *political,* when they are too often simply framed as neutral welfare schemes (Chatterjee, 1993; WB, 2008). This allows us to better understand how energy transitions involve a socio-material repositioning of peripheries, with differentiated consequences for people and spaces. The analytical shift from *benefits* to *effects* allows us to appreciate how electrification reconfigures the very same multi-level relations that enable power to flow through networks.

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