Citation for the original published paper (version of record):

Ahlborg, H. (2017). Towards a conceptualization of power in energy transitions. Environmental
Innovation and Societal Transitions, 25: 122-141. http://dx.doi.org/10.1016/j.eist.2017.01.004

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Towards a conceptualization of power in energy transitions

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A R T I C L E   I N F O

A B S T R A C T

The field of sustainability transitions has recently benefitted from efforts by multiple scholars at better conceptualizing power and politics, and integrating insights from other fields. This article argues for an understanding of power as relational, productive, contingent and situated. I conceptualize power to the aim of understanding and explaining how and where power relations become de/stabilized in energy transitions in poor rural communities. An understanding of power as a relational capacity to act is integrated with a sociotechnical and relational understanding of constitutive power, which enables us to explore the co-production of social relations, technology and nature. The resulting conceptualization is applied to a case of mini-hydropower electrification in Tanzania. I find that electrification simultaneously reinforces social inequality and enhances social mobility. I identify material, symbolic and discursive domains that work as sources of de/stabilization of social hierarchies, producing effects on the system configuration and relations of class and gender.

1. Introduction

This paper engages with the question of how to conceptualize power and politics in the field of sustainability transitions (ST). Some years back, ST scholars argued that political dimensions were not adequately reflected in the literature on sustainability transitions (Smith et al., 2010; Meadowcroft, 2011; van den Bergh et al., 2011). This stimulated discussion and efforts to address this perceived weakness. In a recent special issue addressing *The politics of sustainability transitions*, Avelino et al. (2016) suggest that ST scholars can learn from, and integrate, more elaborated conceptualizations of politics and power from other fields. There is still need to address the politics inherent in sustainability transitions and work towards more explicit, elaborated and better integrated conceptualizations of power and politics in transition studies (Scoones et al., 2015; Avelino et al., 2016).

With this paper, I wish to contribute to these joint efforts by arguing, in line with Nightingale (2006, 2011), for an understanding of power as being relational, contingent and situated.[1] In order to navigate in the rich philosophical debates on power, I build on Amy Allen's (Allen, 2014) three conceptions of power: (1) power as capacity to act (action-theoretical conception); (2) power as structural pressures (systemic conception); and (3) power as force fields (constitutive conception) that shape and co-produce subjectivities and interactions between humans, technology and nature. I argue that relational understandings of power are found among treatments of power in all three conceptions, and that conceptualizing power as

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relational, emergent and productive provides us with a theoretically consistent basis for working with the tensions between human agency and constitutive pressures, as well as dominance and empowerment.

While a thorough review of the treatment of power and politics in the ST field is outside the scope of this paper, I will use the special issue mentioned above as a point of reference. These contributions engage with various aspects of power and politics in ST, relating to: actor's roles and exercises of power (Avelino and Wittmayer, 2016); the concept of socio-political regime and a "just transition" in South Africa (Swilling et al., 2016); creative practices of niche and regime actors in the Netherlands (Hoffman and Loeber, 2016); public engagement in energy transitions in the UK (Chilvers and Longhurst, 2016); 'political technologies' and territorialisation of Spain's electricity sector (Castán Broto, 2016); problematic assumptions underlying transitions management (Kenis et al., 2016); the ambiguity of 'capture' of innovations by incumbent actors (Pel, 2016), and; the politics of visions of the future in key policy documents (Gaede and Meadowcroft, 2016).

Each of these contributions presents a different perspective on power in ST. This is no surprise since power is a broad (and contested) concept that, in order to be fruitful analytically, requires different conceptualizations depending on the empirical phenomena and analytical and political interests of the investigator (Lukes, 2005; Allen, 2014). Therefore, it can be argued that a fruitful conceptualization is one that helps us achieve our analytical and political aims. In this context, my interest is to understand and explain *how and where power relations become de/stabilized* in processes where renewable energy systems are introduced together with new organizational and institutional arrangements in local communities. The empirical case I work with is a small-scale electrification project, implemented by an international development organization, which aims at providing reliable electricity services to rural communities in Tanzania in order to enhance social and economic development of the area. My theorization of power is developed for, and through, the empirical study of this and other cases of locally-grounded energy transitions where new infrastructure, services and institutions/organizations are key features.

Avelino et al. (2016) suggest that sustainability transitions are not only processes of sociotechnical change, but also processes of sociopolitical change towards more sustainable societies. They exemplify with energy transitions in the UK, writing that it is "not only about a socio-technical transition from fossil-based fuels to renewable energy, but it is also a socio-political transition from centralized for profit energy companies, to decentralized, not-for-profit community-based and/or Third Sector-based energy cooperatives" (Avelino and Wittmayer, 2016: 638). In the Tanzanian context, it is not obvious that energy transitions involving decentralized and community-based electricity provision are necessarily "sustainable" (in either social, economic or ecological terms). Thus, I prefer to hold the question of sociopolitical change open and examine *if, how and where* relations of power – in this case most importantly class and gender relations – are reproduced and contested, and with what consequences for social inequality. The case I present here can be considered a successful example of sociotechnical change, but the sociopolitical outcomes are ambiguous – the introduction of electricity services results in growing social inequality in parallel with enhanced social mobility and expanded room for action for people involved. It seems relevant to explain the power dynamics that lead to these ambiguous outcomes as this may help us better understand the potential for sociopolitical change towards reduced poverty and a less unequal society.

To the aim of explaining de/stabilization of power relations, intertwined with the formation of a specific sociotechnical configuration of decentralized electricity supply, I engage with philosophical writings on power as well as with discussions on power among transition scholars, and present a conceptualization that integrates a relational action-theoretical understanding of power with a relational and sociotechnical framing of constitutive power – which pays attention to interactions between humans, technology and nature. I draw on key writings in feminist political ecology (FPE) and science and technology studies (STS) in order to conceptualize the active role of technology and nature in shaping electrification processes. Also, since the ST field is home to many scholars well-oriented in system thinking and sociotechnical approaches, I will use sociotechnical system concepts and visualizations in order to communicate how and where in these complex processes that power relations are (re)produced and contested. The question of how and where de/stabilization happens is then addressed empirically and theoretically in a case study of rural electrification in Tanzania.

The article is structured as follows: In the following, a short background (Section 2) is provided to situate the theoretical discussion in the context of electricity provision in rural Tanzania. In section 3, I review what I perceive as key writings on power and situate the discussions on power in the ST field in relation to these. I also present my own conceptualization of power, tailored for the study of (shifting) power relations in local-level energy transitions. Section 4 presents the methods used and the case study follows in Section 5. The ensuing conclusion (Section 6) highlights the possible value of a relational understanding of power for transitions studies.

2. Background

The linkages between energy supply and use, poverty and gender provide a good starting point for discussing power relations and local-level energy transitions in Tanzania, given that poverty alleviation is a key goal for the Tanzanian government's efforts to provide electricity services to the entire public. This section explains the linkages between electrification, gender, poverty and social inequality, and provides an overview of the current situation for public electricity provision in Tanzania.

2.1. Electricity for poverty reduction

It is explicitly stated in various policy documents that a key goal for the government is to reduce poverty in rural and urban areas by providing the population with access to modern energy services (MEM, 2003; REA and MEM, 2011). This includes not only electricity, but electricity is expected to improve services for households, businesses and social institutions, through its many applications in lighting, communication, cooling, production etc.[2] Unfortunately, the political ambitions related to rural electrification are complicated by the high percentage – around 66% – of citizens living in multidimensional poverty (UNDP, 2014). Poverty is multidimensional in the sense that it can be seen as a complex set of deprivations, reflecting lack of opportunities in key areas such as education, health, command over resources, political freedom and influence (Fukuda-Parr, 2006; Townsend, 2006).[3] To experience material poverty is also to find oneself socially excluded and subordinated in everyday situations (Wilkinson and Pickett, 2011). Poverty can be said to work as both cause and effect of current energy use in this region (UNDP, 2005; Madubansi and Shackleton, 2006) and in rural communities with high levels of poverty, the combination of multiple poverty dimensions creates significant difficulties for poorer households to afford electricity services at current cost levels.

The level of electricity access in Tanzania is low in an international perspective. In 2013 it was estimated at 18% and the divide between urban and rural areas is significant – around 45% of urban households are electrified compared to less than 6% of rural households (IED, 2014). The share of solar power systems is growing, in 2011 it was estimated to 2% of rural households (REA and MEM 2011). When electricity is not available or too expensive, people use generators and batteries to power machines and appliances, and almost 89% of households in the country rely on kerosene for lighting (NBS, 2013).

The barriers to electricity access related to economic poverty are well known (Louw et al., 2008; Bazilian et al., 2012). However, as highlighted by the World Bank and International Energy Agency (IEA and WB 2015: xv): "Analysis of the nexus between energy systems and other key areas of development—water, food, health, and gender—suggests that numerous opportunities can arise from wider cross-sector perspectives and more holistic decision-making in energy". In Tanzania and elsewhere, poverty is gendered in both economic and social terms (UNFPA, 2009) and the country ranks at place 125 out of 155 countries on the Gender Inequality Index (UNDP, 2015). Intersecting relations of gender and class[4] have shown to be widely relevant in electrification processes in East Africa, playing a critical role in excluding a large part of the population from the more significant benefits associated with electricity services (Winther, 2008; Clancy et al., 2011). Women as a group play a central role in energy-related work and suffer disproportionately from the negative aspects of current energy use – including the lack of affordable electricity – in Tanzania and many other poor countries (Bryceson and Howe, 1993; Skutsch, 1998; IEA and WB, 2015). Unfortunately, this is rarely reflected in decision-making processes or in the shaping of RE projects, which are usually 'gender-neutral'. RE projects tend to privilege men as agents of change and place them at the centre of project-related activities, which, according to existing literature, limits the effectiveness of RE projects in addressing poverty (Clancy et al., 2003; ENERGIA, 2006; IEA and WB, 2015).

Electrification projects in Tanzania commonly reach only a small part of the population, those who can afford the required investments. Rather than initiating a process of overall societal development and higher living standards for all citizens, in a short to medium term time perspective electrification tends to widen the gap between rich and poor (Clancy et al., 2011; SEI, 1999; Winther, 2008). Historical studies show that this is a common pattern of infrastructural development. As historian Christopher Jones writes in the context of the US: "Whether it was railroads in the 19th century, transmission wires at the turn of the 20th century, or roads in the 20th century, the pattern was the same. All initially served the already powerful, and often allowed them to increase their control over markets and labour. The first deployments of infrastructure have therefore usually benefitted small groups and exacerbated social inequality." (Jones, 2016: para 4). Fair and widespread access to electricity came only after civic action and political mobilization. In many other countries, full public access was achieved as a result of years of political campaigns and lobbying, and special programs for electrifying also rural areas (Zomers, 2001).

2.2. The Tanzanian electricity sector

Tanzania's current electricity generation relies primarily on hydropower and natural gas, complemented by imported oil and cogeneration from agro-industry.[5] The country is still on the conventional development track with the government largely focussing on expanding large-scale electricity generation and extending national grid infrastructure. However, the pace of infrastructural development is below target.[6] The current generation capacity is insufficient and the national grid service is notoriously unreliable with frequent power surges and power cuts (WB, 2009; MEM, 2014). The economy is severely

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[2] Other energy carriers are equally important and necessary, especially bioenergy for heating and cooking purposes, but here I focus on electricity only.

[3] There are different approaches to defining poverty, some more related to individual capabilities whereas others include also structural sources of deprivation (Chambers, 2006).

[4] In specific contexts, these may intersect also with other bases for social exclusion, but since gender and class are the most prominent in my case, I leave other social categories of difference out of this discussion.

[5] In 2014, total installed generation capacity came from hydropower (35%), natural gas power plants (34%) and liquid fuel power plants (31%). Between 2008 and 2014, total installed power capacity increased from 1100 MW to 1583 MW (MEM, 2014).

[6] The Power System Master Plan from 2008 sets the target at 100 000 new grid connections per year. In 2009, 60 000 new connections were established, which reflects the challenges involved in reaching the targets (Bångens et al., 2013).

hampered by lack of reliable and affordable electricity services, and by poorly developed transport and communication infrastructure. Unreliable power supply is a problem in many parts of the country, and administrative, educational and health institutions, industries, well-off farms, workshops, mills etc., often rely on expensive diesel generators for power supply as well as for backup power (WB, 2008).

Against this backdrop, the government plans to invest not only in additional generation capacity from coal (2900 MW), but also in 500 MW from renewable sources such as wind, solar and geothermal by 2025 (MEM, 2014). Recent government reports also suggest that renewable energy technologies (RETs) and decentralized systems can provide less costly electricity provision in areas far from the national grid (REA and MEM, 2011; IED, 2014). However, until now, it is primarily other actors that promote and invest in renewable energy sources and decentralized systems. These are international and domestic non-profit organizations, private enterprises and developers, church organizations, individuals living in rural communities and educational organizations involved in pilot projects and technical experiments. In the Southern Highlands – the area of the electrification project studied here – the churches have been very active over the last decades in developing their own small-scale hydropower and local grids in order to supply hospitals and rural communities with electricity. Today, a number of new decentralized hydropower projects are under way (Adebayo et al., 2013; Pendezza, 2014). This description of electricity service provision in Tanzania is by no means exhaustive, but provides a contextual orientation for readers who are not familiar with the situation. For readers interested in questions of functionality and sustainability of decentralized systems in Tanzania, see e.g. (Sawe et al., 2016; Ilskog et al., 2005; Ilskog and Kjellström, 2008; Adebayo et al., 2013; Bångens et al., 2013).

A conceptualization of power that is to be useful in this context needs to capture the complex and situated interplay between the local society, the wider societal context with its power dynamics related to class and gender, and the new electric power system with its particular material and social characteristics and challenges. In order to achieve this, I engage with philosophical writings of power, especially feminist theorizations of power exercise, and discussions on power in the STS field.

3. Power and energy transitions

Decentralized electrification involves potential conflicts of interest but is also a process where the productive and creative abilities of humans can be enhanced, and where people can work together for mutual benefit. In the following, I draw on the existing literature on power and theorize how electrification processes and relations of power are mutually constituted, and how and why electrification processes are ambiguous in how they challenge and (re)produce social hierarchies of class and gender. Here, the use of brackets signifies the process whereby power relations are produced, maintained, contested and transformed at the same time. That is, the process of (re)production is dynamic also when seemingly nothing changes in the sense that social hierarchies remain largely stable (Butler, 1990; Nightingale, 2006, 2011).

In order to relate what I am doing here to the ST literature, I turn to philosophical writings on power. Following Allen, (Allen, 2014) I work with three main conceptions of power: the action-theoretical, the constitutive, and the systemic. In the following, I will focus the discussion on the two first conceptions (sub-sect. 3.1 and 3.2) as these are highly relevant for my empirical case, whereas the systemic conception contributes less to achieving my analytical interests.[7] These result in a conceptualization of power in sub-section 3.3. Finally, in 3.4, I characterize the sociotechnical system and change process that are the case study objects.

3.1. Action-theoretical power

The action-theoretical conception of power includes definitions of power that directly relate (and reserve) power to the realm of human action. In this conception we find scholars who answer the question of *what* power is by perceiving it either as a 'resource' that is unequally distributed among humans, as a personal 'attribute', or as a relational 'ability' or 'capacity' to act or refrain from action (Allen, 2008, 2014). In these definitions, power is either relational or more *thing*-like, and more or less static. All are focused on the exercise of human power, that is *how power is exercised* – called 'power-to'. In Lukes' definition, "having power is being able to make or receive any change, or to resist it (Lukes, 2005: 69). However, I argue that seeing power as a resource that one holds or which is unequally distributed in society is conceptually different from understanding it as a relational capacity to act. For example, Hoffman and Loeber puts forth an action-theoretical (agency-focused) conceptualization of power that identifies three types of power: 'dispositional power' equalling the 'power resources one has, such as money, knowledge, reputation'; relational power, i.e. the capacity to influence others, and; structural power, referring to "orders of signification, legitimisation and domination" (Hoffman and Loeber, 2016). Here, I would rather propose that actors mobilize and make use of available resources, positions, formal mandates and favourable institutional frameworks, in order to be effective and successful in their exercise of power, but these resources and entitlements are not equal to power, and they should not be conflated.

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[7] The systemic conception refers to historical and very aggregated societal phenomena such as historical origins of rule in specific societies. It is relevant in discussions of the origin of wider societal pressures, or 'structures'. Some ST scholars make use of such framings, in their use of "structural power" as a concept to describe contextual pressures at the level of "landscape" (Grin, 2010; Hoffman and Loeber, 2016).
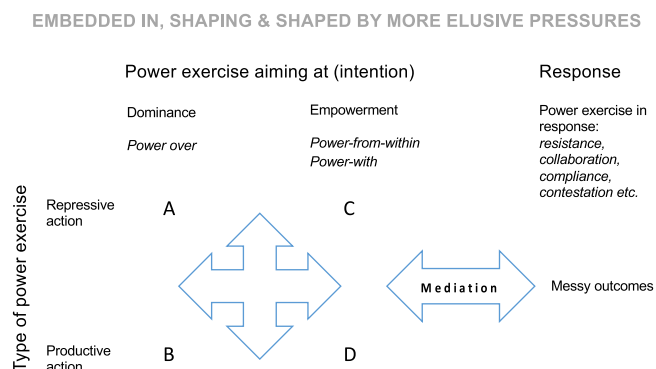
EMBEDDED IN, SHAPING & SHAPED BY MORE ELUSIVE PRESSURES

Fig. 1. Four types of action-theoretical power. Based on Lukes (2005) and Allen (2014).

A relational understanding of power exercise can be theoretically characterized according to *the way* power is exercised (repressive or productive actions), and with what *intention* (aiming at dominance or empowerment). Empowerment refers to the situated capacity of individuals and collectives to exercise power in ways that positively shape their lives and societies (Slocum et al., 1995). Fig. 1 visualizes how I understand these aspects.

Dominance and empowerment are not a binary, but represents a spectrum of ways in which, and with what intention, actors exercise power in specific situations. As Nightingale (2006, 2011) and Allen (2008) point out, domination and empowerment are interconnected and in constant tension. I should also point out that the exercise of power is not a zero-sum-game and intentions are not necessarily clear. Importantly, other actors respond to power exercise in various ways, therefore, the outcomes are mediated and may not reflect the intentions of dominant actors. The four resulting characterisations of power exercise (the letters A-D) should therefore be thought of as ideal types because human relations are messy, often ambiguous and with contradictory effects (Butler, 1990; Nightingale, 2006). This said, there are acts that clearly aim at dominance and situations in which dominance is successful. Such situations can involve a more direct (coercive) or indirect (e.g. controlling the agenda) exercises of power (Lukes, 2005).

In the ST literature, most attention has so far been given to power exercised for domination or what is called 'power-over'. Here, different typologies of power-to have been offered. For example, Avelino and Wittmayer develops a typology in order to analyse shifting power relations between actors within and between sectors. They identify three types of power relations: "(1) A has power over B, (2) A has *more/less* power than B to do x, and (3) A and B have a *different kind of* power" (2016: 633, italics in original). These can "have various manifestations, ranging from mutual dependence, one-sided dependence and independence, to cooperation, competition and coexistence" (ibid: 641). The different kinds of power that they identify are power to "reinforce existing institutions", to "develop new resources" and to "develop new institutions" (ibid: 641–642).

In a similar focus on different *forms* of power, Geels (2014) introduces power and politics in the multi-level framework through a discussion of the relations between incumbent firms and policy-makers at the regime level. By combining various distinctions into (what I perceive as) an action-theoretical framing, he identifies "four ways in which regime actors can mobilize power to resist fundamental change" (2014: 36). These are: "instrumental, discursive, material and institutional forms of power and resistance" (ibid: 28). However, no explicit theoretical justification is given for the preference for these particular forms, or how they relate.

Some attention has also been devoted to the other side of the spectrum of power-to: power as resistance and empowerment. In the wider literature on power, especially feminist theorists have highlighted the importance of "power-with" and "power-from-within" (see Allen, 2014 for an overview). In the special issue, only Avelino and Wittmayer (2016: 633) discuss empowerment, however, they chose a conceptually different, and, arguably, inconsistent, definition of empowerment coming from organizational theory that defines empowerment in emotional terms, as "intrinsic motivation", instead of defining it as power-to.

To summarize, the action-theoretical conception of power is clearly relevant in order to understand relationships between actors in electrification processes; and these processes simultaneously involve acts aiming at dominance and empowerment, and have ambiguous effects for the actors involved. Methodologically, I suggest that mapping situations in which power is exercised and doing so from the perspective of multiple actors provides important clues to how social hierarchies are challenged or (re)produced over time. When actors, through their material and symbolic practices, reiterate the same pattern over and over, social relations develop and become stabilized (Butler, 1990; Foucault, 1995). The action-theoretical perspective provides important insights regarding human agency, but for the study of electrification, it needs to be complemented by the idea of "constitutive power", which brings to the fore the co-production of human relations and infrastructures. I argue that the idea of constitutive power can be integrated in a conceptually consistent way with a relational understanding of human power.

3.2. Constitutive power

The notion of constitutive power is inspired by Foucault's work on disciplinary power and subjection[8] (Foucault, 1980, 1995). Rather than seeing power as human capacity (only), it signifies that power is spread throughout the entirety of the social body (Allen 2008). This 'constitutive conception' of power "focuses on the fundamentally *trans*-individual and relational ways" in which individuals and society come to be "constituted by power relations" (Allen 2014: para. 5). Such power is 'decentred' from the subject as it is elusive in character and cannot be traced to an actor or specific action. As I see it, the constitutive power conception[9] 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.

Constitutive power can originate in discourses,[10] institutional arrangements (e.g. legal institutions) and codified practice (e.g. administrative procedures), which produce and stabilize dominance and subordination. Foucault studied "disciplinary institutions" such as schools, prisons and hospitals and how these produced "docile bodies". He was particularly interested in *how* power was exercised by the state over the population through an "apparatus" of knowledge and techniques appropriate to its management and optimization.[11] Castán Broto builds on these ideas in relation to energy transitions. In line with other historical accounts, she notices that as symbols of modernity, the expansion of large-scale transmission and distribution networks have often been part of contested, and sometimes violent, political projects of shaping national identities and territories (Hughes, 1983; Castán Broto, 2016; Jones, 2016). Development of electricity infrastructure continues to evoke discourses of state formation and citizenship, and as ST scholars highlight, new emerging sociotechnical configurations are arenas where competing visions of the state, citizens, and the future are produced (Avelino and Wittmayer, 2016; Castán Broto, 2016; Chilvers and Longhurst, 2016).

Here, I wish to highlight three insights from the literature on constitutive power of particular relevance for transition studies. First, I find that the concept leaves more room for *contradictory and ambiguous outcomes* than most action-theoretical framings of agency—structure. Especially feminist scholars have shown how discourses, institutions and codified and embodied practices work as arenas for contestation, resistance and struggles over power (see in particular Nightingale, 2011). In feminist theory, ambiguity and contradictory outcomes in relation to power exercise are known as "the paradox of resistance" (Butler, 1990; Mahoney and Yngvesson, 1992; Gururani, 2002; Nightingale, 2006). Whereas Butler focused mainly on the social and discursive realm, Nightingale captures the materiality of subjection in her work on political ecologies, showing "how subjectivities are produced out of the multiple and intersecting exercise of power within socio-natural networks" (Nightingale, 2011: 153). She highlights how the process of internalizing, re-expressing, contesting and confirming power relations shape, and is shaped by, material environments. This is the second important insight, that *social relations and material environments are co-constituted* (Nightingale, 2006).

The understanding that power relations, places, technologies and environments are co-constituted has been profound also in STS, where scholars have highlighted the role that artefacts and complex systems play in coproducing emergent pressures. Among transition scholars, Chilvers and Longhurst (2016) build on these ideas. They take an explicit relational approach to participation by the public and civil society organizations in sustainability transitions, arguing for "close attention to the ways in which the subjects, objects, and procedural formats of public engagement are constructed through the performance of participatory collectives" (2016: 1). Their analysis of participation includes not only humans, but also non-human artefacts, and they highlight "the power of different *actants* to bring participation into being" (ibid: 7, *my emphasis*).

The concept of 'actant' comes from the STS field, where there are scholars who do not give priority to human actors in their analyses. Rather, sociotechnical systems and networks are understood as hybrid compositions of humans and non-humans, and the non-human components are understood as active elements – as actants (Akrich, 1992; Latour, 1993; Murdoch, 1997). This idea does not necessarily suggest that artefacts themselves exercise power, rather, artefacts become enrolled in exercises of power by planners, development practitioners, designers etc. Artefacts and system configurations work as "scripts", which regulate human behaviour by encouraging, allowing and forbidding certain types of uses, with social and material consequences (Akrich, 1992). The material configuration of electricity networks provides a durable regulatory arrangement, with consequences for the actors involved in supply and use. This leads me to the third insight: power is exercised by means of system configurations – a kind of *encoding or translation of the exercise of power* in hardware and software. Infrastructure embodies the intention of the designer, together with power encoded in the instructions for use. And this translation/embodiment/encoding is *a source of stabilization*, whereby human agency (that of system designers and engineers) is given a more durable form and condition spaces for action.[12] Similar to Nightingale's attention to embodied

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[8] "Subjection" signifies the processes whereby oppressed individuals often more or less fully accept and identify with subordinating norms, such as ideas around gender roles. Subjection is ambivalent and attempts to resist culturally prescribed behaviour are contradictory, because they paradoxically also confirm subordinating norms (Mahoney and Yngvesson, 1992; Allen, 1998; Nightingale, 2011).

[9] According to Allen (2014), Foucault's work contains both action-theoretical and constitutive framings of power, which indicates that there is a shared theoretical core.

[10] There is a significant overlap between the concepts of 'discourse' and 'institution'. Partly, it is a matter of disciplinary preference. Power produces both, and discourses can be seen as taking the shape of institutions, regulating human behaviour and being more or less codified (Li, 2005).

[11] This specific form of power exercised by governments with the population as its target is known as "governmentality" (Dean, 1999: 24–30).

[12] In the STS literature this phenomena is discussed in terms of "closure". Closure is "the process by which facts or artefacts in a provisional state characterized by controversy are molded into a stable state characterized by consensus" (Misa, 1992: 109).
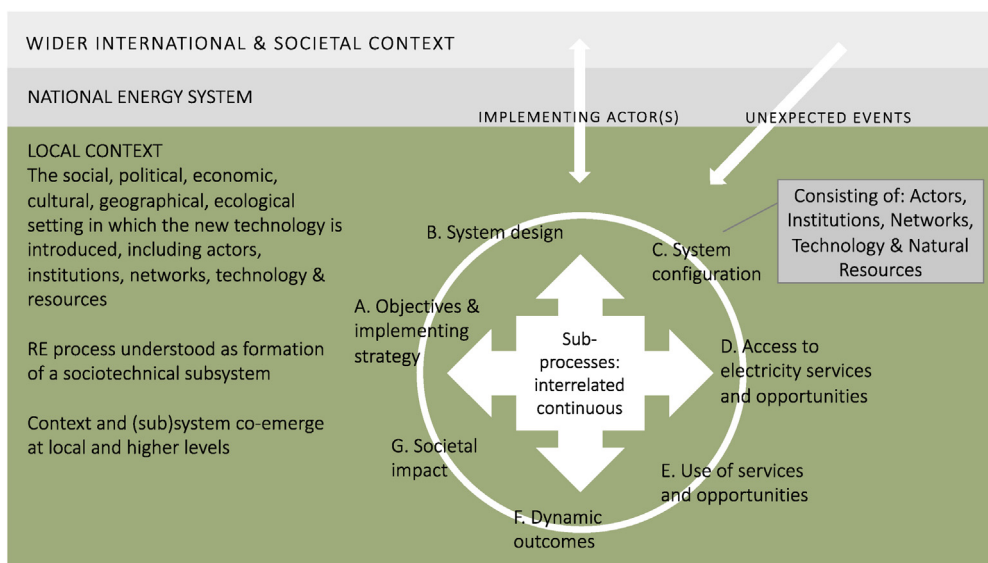
Fig. 2. Characterization of the formation process as embedded in the local context and wider societal contexts.

practices of the everyday life, I perceive the infrastructures, discourses, institutions and established practices related to electricity provision as one of the 'places' where it is of crucial importance to theorize how human agency and constitutive power entwine and transform each other – and produce social and material effects (see also Nightingale, 2011; Chilvers and Longhurst, 2016).

In order to characterize the process whereby power exercise is encoded into electricity infrastructure, I conceptualize decentralized electrification as a process of formation of a new sociotechnical system at the local level. This 'system' is embedded in the national energy sector as well as a wider societal context. I identify system elements and examine the system configuration (Jacobsson and Bergek, 2011; van den Bergh et al., 2011) (see Fig. 2, sub-section 3.4 for a visualization of this conceptualization). The elements are actors interrelating in networks, institutions at multiple levels, a locally constructed technical system of generation and distribution, and natural resources required for electricity generation in the system (cf. Hughes, 1983). Provision of continuous and reliable electricity supply demands coordination and interaction between numerous components and actors at multiple levels (Wolsink, 2012). Local actors who are not involved in the project or using the electricity services are considered part of the local context. There are three relevant categories of interactions (within the system and between system and context) to consider: (1) relationships and networks between actors, (2) interactions between human and non-human elements, and (3) interactions between non-human elements (e.g. between technical components and ecosystem). Importantly, the configuration is dynamic, as local conditions, wilful users and changing circumstances tend to modify, reinterpret and contest the prescribed 'proper' use of technologies and reconfigure the system (Bijker and Law, 1992). Also when power is embedded in infrastructure it evokes responses and counteraction. This indicates that *mediation* also is at the core of human—non-human interactions. In other words, the 'script' is rewritten as it is played out (Akrich, 1992), again and again in the ongoing encounters between humans and things.

3.3. A sociotechnical understanding of power in electrification processes

After this account of the most important building blocks and sources of inspiration, I summarize my conceptualization of power. I understand human power as continuous and ambiguous exercises of power, performed in relation to other humans, artefacts and the natural world. Power relations are produced through situated and embodied practices that form patterns and produce material and social effects. The analytical question that interests me is where and how power is exercised, de/stabilized and with what effects, rather than whether actors 'have' power or not.

I acknowledge both power emerging from human agency and power as 'pressures' that arise out of a multiplicity of interactions between human and non-human elements. Both of these are relational, emergent and productive, but the second kind of power can be distinguished by its more elusive character, or by its material encoding: in that it takes the shape of discursive, institutional, material or social pressures often without any clear human sender. These pressures usually emerge at a different time scale than exercises of power embedded in specific actions of individuals. They are characterized by being beyond individual control, and/or emerging from mediated human-technology interactions.

Together, these relational framings of action-theoretical power and constitutive power assist me in identifying the role of power in electrification (the *what? who? why?* and *how?* questions of power). Further, they provide the tools for studying power dynamics across multiple organizational levels and spatial and temporal scales. I use the analytical distinction

strategically rather than ontologically as I perceive them as being intertwined and in tension in complex and dynamic webs and networks consisting of humans and non-humans. I will now take one more conceptual step and become more specific in how and *where* human power exercise and constitutive power interplay in decentralized electrification processes.

3.4. Characterising the process of system formation

In order to identify if rural electrification processes involve destabilization of social hierarchies related to class and gender, I propose that there is need to better understand what electrification schemes 'do', that is, what processes they involve and what effects they have on local society. To this end, I describe how formation takes place. The following explanation (subsect. 3.4) of how I move from a more generic to an empirically tailored approach is primarily for the benefit of other scholars of local-level energy transitions. However, this attempt at locating sources of de/stabilization responds to the call made by Avelino et al. (2016).

Based on the empirical data of this and other cases (Ahlborg, 2015; Ahlborg and Sjöstedt, 2015), I identify seven sub-processes – starting with the implementing organization setting its objectives and strategy for the local electricity supply and distribution system. The identification of sub-processes is very helpful in order to identify when and where de/stabilization occurs. The sub-processes are depicted as the circle in Fig. 2. This figure helps visualize the interfaces between electric power system and local context.

As the arrows in the circle in Fig. 2 indicate, the seven sub-processes are interrelated and continuous. In system-theoretical terms, we would say that changes in one sub-process cause changes in other parts of the system, such as when increased use of services change both outcomes and system configuration (sub-pr. $E \rightarrow F$ and $E \rightarrow C$). Over time, as a decentralized electricity system becomes embedded in, and an integrated part of, the local context, both change, and so do their interactions with higher levels.

Complementing this visualization, Table 1 provides a short description of respective sub-process, with an explanation of the analytical focus. As the description of the formation process in Table 1 indicates, actors play very important roles in driving sociotechnical change and relations of power are present in all sub-processes.

Mediation occurs in each sub-process (Table 1), such as: in the translation of objectives, implementing strategies and planned design into a system configuration on the ground; in other actors' responses to the implementing actor's priorities and norms, and; in the reconfiguration of daily life that occurs when individuals and groups experience differentiated outcomes. The system configuration as it develops over time reflects the interplay between human agency and constitutive power, and the encounter between electric power system and context as a process of negotiation and compromise. The following case study will exemplify how the unique characteristics of electric power systems produce certain effects on social relations. The introduction of reliable electricity services can in fact cause shifts in multiple domains of daily life, and open up new spaces to contestation.

Case study methods

The studied case is a process of decentralized electrification of the village of Mawengi, Ludewa district in Tanzania. The case was selected because national-level stakeholders considered it a successful development project and for its high degree of local participation.

The analysis is based on empirical work conducted in 2012–2015. After an initial one-week visit in 2012, an in-depth qualitative case study was carried out during three months in 2013. Follow-up visits took place in April 2014 and November 2015. Data consists of three sets of semi-structured interviews: 1) 90 interviews about the project (21 with project staff, 62 with villagers, and 7 interviews and meetings with local and district government); 2) 14 interviews on land rights, savings behaviour and use of electricity in households; and 3) 38 interviews, plus visits and group discussions, with rural entrepreneurs in the project area and in the nearby town of Njombe on the related topic of constraints and opportunities in the local economy. The interviews cover different aspects of the process and reflect the diverse perspectives of actors involved. Most material was coded using coding software, and all interviews were checked for concordance and divergence.[13]

I conduct a relational and process-oriented analysis. I pay attention to how electrification shapes, and is shaped by, material and social relations between individuals and different groups in society. In the centre of this analysis are relations of power and how they become co-constituted in local energy transitions – no matter if these fail or succeed. More specifically, the analysis undertaken specifically for this paper focused on: (1) Understanding the relationships between actors involved and how they exercised power throughout the process, manifested in events, decisions and actions. (2) The role of non-human actants (technology and natural conditions) in shaping the process and producing pressures that influenced the interplay between electric power system and context. (3) Identifying sources of stabilization and destabilization of social hierarchies respectively, that is, analysing what in the encounter between system and context that caused particular effects on relations of class and gender. Hence, the electrification process was approached from, on the one hand, different actors' point of view and, on the other, from the non-human dimensions of both electric power system and local setting.

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[13] That is, I examine my material to find whether there are points of disagreement and contradiction, or whether respondents have similar views, concerns and explanations. This helps assess the credibility of inference (Nightingale, 2009).

Table 1
Description of the formation process and focus of analysis for respective sub-process.

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 RE process' direction. Different kinds of actors – NGOs, enterprises, churches, and government – work according to different logics and constraints. Analysis includes 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. 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 what actors are driving the process the system design can be expected to differ in the degree to which it is tailored to local conditions and needs.
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, composed on actors, networks, artefacts, institutions and natural resources. It is a physical and organizational manifestation of the system as it develops over time. Its characteristics result in *conditioned* electricity services. That is, the configuration regulates user behaviour (as a 'script') by making service available at, for example, certain cost, for specific hours and places, by contractual agreement (Akrich, 1992).
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. 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, (b) drawing on relations, discourses and institutions (see also Ribot and Peluso, 2003).
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 analysis includes user practices, priorities and how uses change over time. 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).
F. Dynamic outcomes	Outcomes are dynamic and can be positive, negative or ambiguous. They are analysed at the levels of individual, group and system. It is crucial to capture divergent perceptions and how these change over time, such as: actors' expectations, desires, interests and needs in relation to the electrification process – from the level of specific 'benefits' to perceived system 'functionality' (Mehlwana, 1997; Ornetzeder and Rohracher, 2006). Analysis of system functionality helps identify competing discourses, differing perspectives and conflicting interests and the degree to which competing claims are acknowledged and considered legitimate (Pinch and Bijker, 1984).
G. Societal impact	Analytically, RE 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. Electrification may lead to repositioning of communities "place-in-the-world" (Ferguson, 2006). The changing context creates incentives and pressures for reconfiguration and adaptation of the energy system.

5. The Mawengi hydropower scheme

This section starts with a descriptive account that tells the short story of project implementation and events as they took place chronologically, as to provide the reader with a base for understanding the power dynamics. Thereafter, I analyse the interplay between relations of power and the sociotechnical system and explain how and why this interplay produced specific effects on class and gender relations.

5.1. The formation process in Mawengi

The hydropower system of 300 kW was built by an Italian NGO named ACRA (Cooperazione Rurale in Africa e America Latina) in partnership with the local church, funded by international and national donors. Before the programme, people in the area relied on diesel generators and batteries for powering electric appliances. The economy of the area is primarily agricultural based, with some activities in forestry and fisheries. Table 2 describes the economic situation in more detail.

ACRA initiated the programme in 2005, by conducting a feasibility study and applying for funding. The organization was successful and Phase I started (year 2006–2010) focussing on construction of the plant and micro-grid. Notably, the NGO decided to establish a local utility to legally own the system. Service delivery to the first customers started in June 2010, providing reliable electricity supply at relatively low cost and services that were much appreciated by users.

However, ACRA and the local utility faced significant problems. First, the grid construction was behind schedule and more time and resources were needed to meet project objectives: to connect the planned number of customers and generate enough income for the utility. Second, communities in the catchment area upstream did not have electricity and lacked incentive to protect the river, which presented a potential threat to the technical functioning of the hydropower station.

Table 2
Socioeconomic profile of the project area. Adapted from (Ahlborg and Sjöstedt, 2015).

Farming is the main livelihood strategy and maize and beans are the most important crops in the area. Some households also grow wheat, coffee, various types of vegetables and fruit. Most households (72% in 2012) keep livestock for self-consumption. Nearly all families (99%) grow maize for self-consumption and the rest is sold. During the months after harvest, people pay school fees and make investments. Money is set aside to buy agricultural inputs for the following planting season. Extra money is invested in domestic animals, land or tree planting.

From observation and informal discussion, it appears that very few people are undernourished. Still, many households in the area have no economic buffer. In time of crisis, families sell animals, timber or land, or travel to town for temporary employment to cope with economic stress. People die from diseases and in road accidents, and many families have lost members of productive age. The neighboring region Njombe has the highest prevalence of HIV (14.8%) in Tanzania (NBS, 2013).

Regular employment opportunities are quite few, around 25% of households have a member who is employed. There is also temporary employment in the forest, farms and in construction. About half of the households are engaged in small businesses for extra income throughout the year.

Tanzania is a presidential democratic republic governed by the political party CCM – Chama Cha Mapinduzi (Revolutionary State Party) – that has dominated national politics since independence. There are multiple political administrative levels with elected and appointed representatives: from national level to region, district, ward and village.
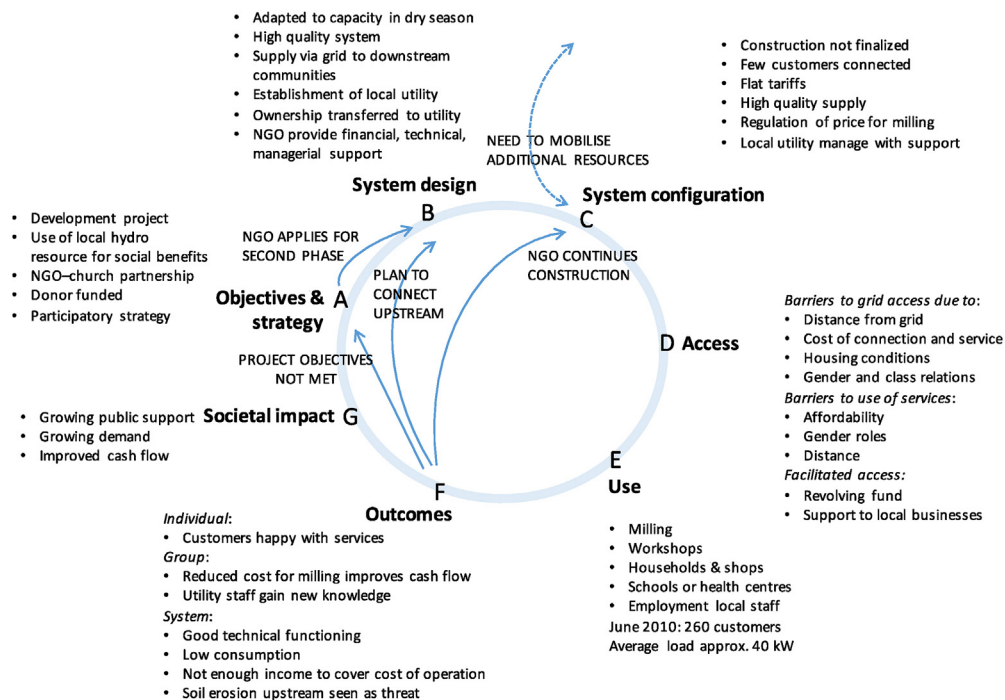

Fig. 3. System dynamics in Phase I in hydropower programme Mawengi.

Fig. 3 provides a system theoretical visualization and more detail on how the formation process unfolded in Phase I. It lists the key aspects of each sub-process and arrows indicate both positive and negative feedbacks (written in capital letters) emerging during these first four years of the project.

Since the project objectives were not met by the end of phase I, the staff applied for funding for a second phase, as to continue grid construction and connect also the upstream areas. As one of the project staff explained in 2013, "if the project had finished completely at the end of the originally funded project [phase 1], it would have been an immense failure". From his point of view, the second phase (2011–2014) allowed the staff to develop the system in multiple, crucial ways. Fig. 4 visualizes these changes, which I now describe.

The system configuration (sub-process C) changed as ACRA expanded the grid and added generation capacity, developed the regulation of the utility as such, built support networks and enhanced the capacity of the local utility to own, manage and operate the system independently. It supported the utility in connecting new customers and introducing stricter user regulations (that were enforced with the sanction of disconnection), pre-paid meters and new tariffs. Based on lessons learnt in Phase I, ACRA also developed a strategy of integrated development (sub-process A) in order to achieve synergies between electrification and activities in education, agriculture, business training etc. Together, these actions reshaped the interplay between system and context and led to a positive loop emerging between the development of infrastructure, growing numbers of customers, satisfied users who increased their use over time, and the economic capacity of the local utility (for more details see Ahlborg and Sjöstedt (2015)).
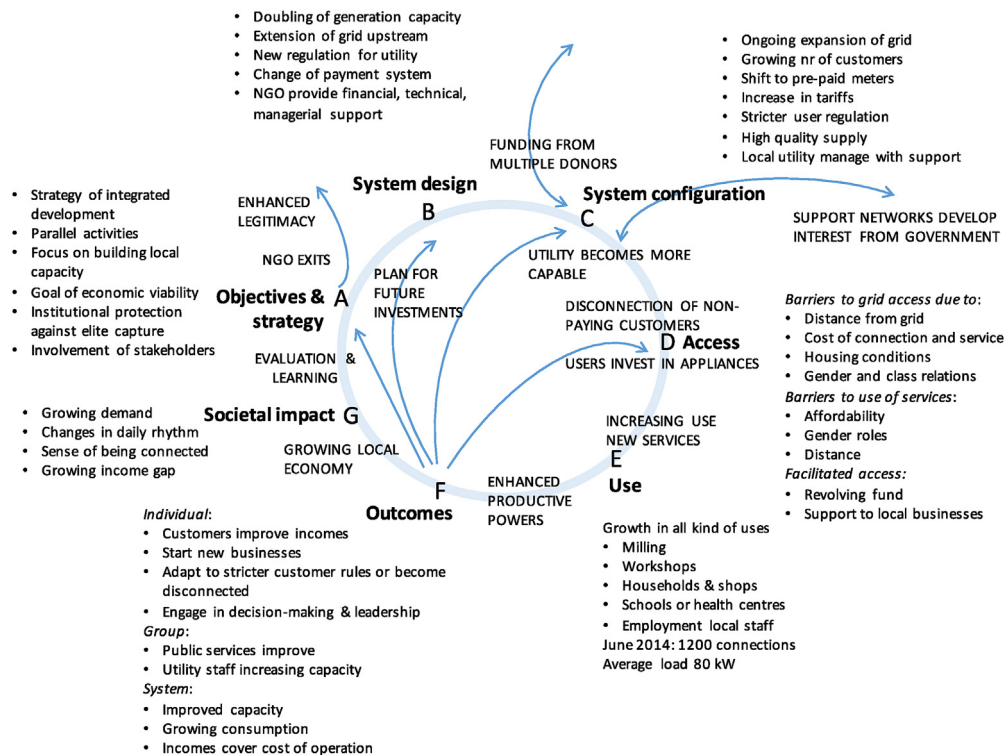
Fig. 4. System dynamics in Phase II in hydropower programme Mawengi.

In 2014, the energy system fulfilled its stated purpose of supplying services at high quality and relatively low cost to local communities. A couple of months before ACRA ended its involvement in the development programme, the grid reached 9 communities, with a total of 26 transformers. The utility had 1200 paying customers (i.e. 1200 connections, whereas the number of users was much higher), with an average estimated load of 80 kW (before prepaid meters were introduced). It provided stable and reliable services available around the clock. In comparison to other hydropower systems in the nearby area, the share of economically productive electricity uses was high and there was evidence of growth of the local economy (sub-process F → G in Fig. 4).

After this short account of the process taking place in the period 2005–2014, the relational power dynamics of this process will be analysed. The process in Mawengi involves many types of actors and their interactions have been changing over time. The following analysis is organized as the formation process, starting with sub-processes A, B and C. Using the characterization of power exercise outlined in the theoretical section, I exemplify power exercises as they manifest in actions, events and contestations. As will be illustrated, the tension between dominance and empowerment is at the heart of the process. Consequently, sources of stabilization are simultaneously sources of destabilization.

5.2. Power exercise and sources of de/stabilization – from plans to configuration

Electric systems with generation capacity to supply many users require both financial capital and particular types of knowledge and skills for construction and operation. These technical conditions influenced the relationships between actors since such financial and human resources were not available in Mawengi. The electrification process, like many other government and NGO-led development schemes, was therefore initiated based on unbalanced relations of power (Green, 2014). As highlighted by other scholars, the logic of implementing actors and the way they shape project implementations influence existing social hierarchies by setting the frame for participation, control over the agenda and distribution of benefits (cf. Nahuis and Lente, 2008). External actors tend to partner with the local elite in order to 'enter' the community, create legitimacy, gain support and avoid conflict. By that, external actors (unintentionally or purposefully) may stabilize social hierarchies of class and gender (Schroeder, 1997; Clancy et al., 2011).

In Mawengi, the consequences of how the process was shaped were ambiguous. I will give three examples: First, ACRA was positioned from the start as the actor controlling the material resources and the implementation process. Local church leaders were active in contacting and inviting the organization to their village, and local politicians gave it the mandate to act within their area of jurisdiction/influence. In that way, the local leaders positioned themselves as formal representatives of the village, and as engaged in local development. However, this action simultaneously reinforced the premise of development aid (Li, 2005) – their need for assistance and their lack of capacity.
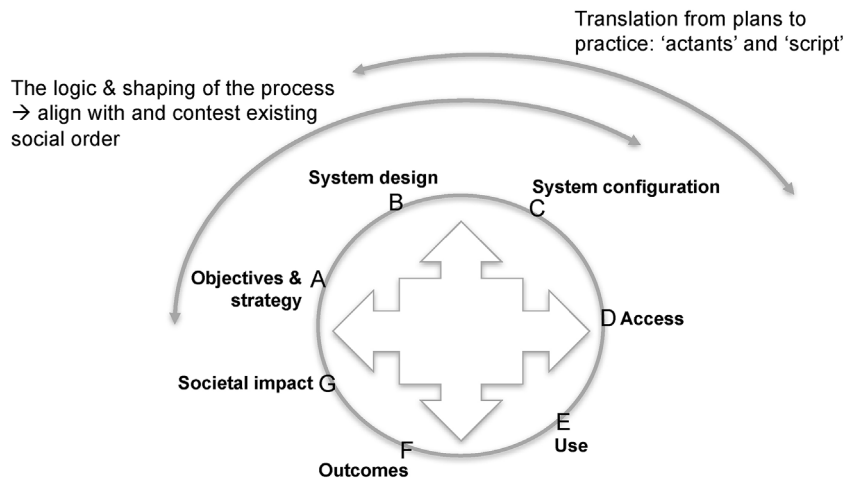
Fig. 5. Sources of de/stabilization in the formation process: (a) Logic and shaping of the process, and (b) translation to system configuration. The arrows indicate where in the formation process certain sources of de/stabilization are most clearly emerging from the interplay between electric power system and local context.

Second, the Mawengi programme was not gender mainstreamed and did not include any strategies for addressing gender issues in the implementation. No actions were taken to explicitly challenge local gender-discriminatory norms, but female NGO staff (both foreign and Tanzanian people) had prominent roles and the staff acted from an assumption of gender equality being the norm rather than the exception. Still, by allowing men's perspectives, priorities and agency to dominate the process, the NGO left social hierarchies related to gender largely uncontested.

Third, important decisions were influenced by pressures emerging from technical requirements and the local geographical, social and ecological setting. These socio-material pressures are especially prominent in the sub-process of translating technical design into a functioning system configuration. The hydropower station and distribution grid required manual, on-site operation. Thus, long-term sustainability of the system demanded the capacity of a local actor to operate and maintain the hydropower station and micro-grid, and to deliver services to local users once the NGO left. In order to achieve this, ACRA established a local utility – LUMAMA – as a legal entity with ownership of the system, and invited the local Catholic Church and District government as advisors to the utility board. Thereby, the local utility had advisors representing the two most powerful organizations in local society who could provide various types of support.

At the same time as the NGO partnered with these important organizations, it constrained the possibility for local leaders to gain control over the system. Institutionalized via the utility regulation, the NGO prevented local political and institutional leaders from holding influential positions in the utility. Thereby, the NGO opened up a new space for 'ordinary' villagers (including women), partly contesting local hierarchies, while aligning with legal institutions and political goals of actors at level of District and with national government. This created some conflicts. The sudden repositioning of some ordinary villagers as 'experts' and actors in control over the technical system and service delivery disturbed existing hierarchies and led to discontent, which the local utility staff experienced as insults and explicit mistrust from other villagers.

Fig. 5 visualizes what has just been described: the logic and shaping of the implementation process and the translation from planned design to system configuration are two important sources (or locations) of de/stabilization of power relations and social hierarchies, which require our analytical attention.

In order to capture how relations between actors changed over time, I used a methodological approach of mapping manifestations of actors' power exercise and analysing the intention and form of power exercise, the mediation that occurred and effects produced on actors' positions vis-à-vis one another (for a reminder see Fig. 1). Table 3 provides illustrative examples of power exercises in the process.

For example, interactions between the local leaders and the NGO involved both acts of dominance (establishing authority/controlling resources) and empowerment (giving mandate for action/providing economic support), in both directions. While capturing some of the 'messiness' of power relations, Table 3 also reveals the overall pattern of interactions over time, which in this case was shaped by the development logic, which exerts constitutive power by mechanisms of discourse and institutions. The logic imposed on local processes originates at higher levels where donors control the financial and time frames of working processes, and project objectives, strategy and system design are based on norms of established development practice and expert knowledge regarding how to design electric power systems (Green, 2014). The expert position of the NGO went largely uncontested, whereas interactions between local actors and the utility were characterized by more tension and mistrust.

This was indicated in interviews with villagers, where most people expressed their support for the local staff, but often simultaneously questioned their ability to manage the system. The staff was criticized for: not having "the skills" or "the

Table 3
Manifested exercises of power in the studied RE process.

Actor	Exercise of powers
Donors	• Provide funding to the NGO, thereby enabling the NGO to carry out the programme, enhancing their own legitimacy as financers of a successful development programme
NGO	• Mobilizes additional resources for adapting and developing system design and configuration: thereby reaching more customers and gaining increasing trust among the public, legitimacy in the eyes of donors, and authority in relation to local actors • Owns and manages the system initially and then transfers the ownership to the local utility • Trains local utility staff on how to operate and manage, provides resources, networks and discursive support that helps the utility negotiate with and exercise authority in relation to local and external actors
Diocese	• Invites the NGO to electrify the area, strengthening the positions of both parties, while also (re)producing the subordinate position of local actors
District government	• Holds an advisory position on the board, exerting influence and providing legitimacy to the NGO and the utility • Intervenes on behalf of the utility in conflicts with local actors, constraining the behaviour of local leaders
Local government leaders	• Assist in mobilizing citizens to do voluntary work and hold public meetings • Some refuse to pay electricity bills until they are disconnected, exerting dominance vis-à-vis utility staff
Utility staff	• Operate and manage the system and service delivery • Enter into contract agreements with customers: providing services and regulating customer behaviour • Disconnect and fine customers who do not pay: constraining dominance by local elite and exercising dominance over customers with low incomes
Utility General Assembly (GA)	• Members are elected for 3 years, they take strategic decisions regarding the system, e.g. decide the level of tariffs and approve the yearly budget • GA elects the board members every 3rd year
Utility board members	• Supervise the staff and bookkeeping, hold weekly meetings and exert strategic influence of the direction of LUMAMA • Call General Assembly meetings
Grid customers	• Draw on assets, relations and institutions to gain access • Use electricity for a range of individual and collective purposes: exercising power together as well as dominance • Engage in leadership positions in the utility, gaining influence and new knowledge • Elect their representatives up to the level of GA every 3rd year • Provide discursive support or question the competence of staff or legitimacy of disconnecting poor people
Other villagers	• Mobilize resources to use available collective services • Participate in meetings and take leadership roles • Provide discursive support • Question the legitimacy of utility actions/decisions

level of education", "they don't treat the customers nicely", "maybe they will start buying low quality of material", or lack of funds: "they cannot even afford a motorbike". This contrasted with the enthusiastic support by local people for ACRA.

The difference in level of trust was reflected upon by one of ACRA's staff who had worked in the project since its start. The level of trust is "different because when they relate themselves with ACRA, of course behind ACRA there is a donor, there is money, but the relation with LUMAMA [the local utility]. . . LUMAMA is managed by local people and [. . .] what they see behind local people managing such an association is corruption, because [. . .] corruption is at every level here in Tanzania and if there are Tanzanian people managing local associations, aah sure, they get some money, they get something."

Suspicions of corruption were not often voiced in interviews, apart from a few times, related to people paying fines for breaching the contract. The following example comes from an interview conducted by my colleague:

Customer: "The fine is ok but the leaders are using segregation. Because some people they can pay 20000 and some they can pay 10000. But all of them are disconnected."

Researcher: "Why do you think they do it differently?"

Customer: "These leaders in the office, they know; and maybe they are getting something from these people that are paying less. It must be that they are getting something. But I am not sure."

The establishment of a new organization with associated institutional frameworks is a shaky process. In 2012, the utility manager explained: "LUMAMA cannot manage by itself, not now, but when we have more costumers and can raise the money we will be able to manage by ourselves." In 2013, he had acquired more confidence and skills, while asking for further training and continued economic support. With increasing managerial capacity, well-defined institutional frameworks and improved economic situation, by 2014 the utility was in the process of becoming an actor of importance in local society. In 2015, ACRA had reduced its involvement radically and the utility was managing the electric power system independently on a daily basis. In order to better understand the changing role of the utility, we shift focus to the sub-processes of electricity access, use and outcomes (D, E and F).

5.3. Growing inequality and new room for agency

Existing power relations are a major source of stabilization throughout the entire formation process, but in particular, this manifests in specific class and gender related barriers to access and use.[14] The data confirms that in Mawengi, there is a pattern at the group level where social inequality is (re)produced. The system configuration requires individual users to mobilize a relatively large amount of resources for electricity-related investments, which is more difficult for women who in general have less access to and control over capital assets. Low incomes prevent a majority of households in the area from accessing the grid. The minority of households with grid connection enjoy economic and social gains from electricity. Thereby, the contrast between poor and better-off people becomes sharper.

For women and men with low incomes to overcome the barriers to electricity access, there may be need for changes in the system configuration, as well as in the contextual setting. Without efforts to remove such barriers, subordinated groups are significantly more likely to find themselves as losers in energy transitions.[15]

The Mawengi project was aiming to provide benefits for all people, not just the richer minority. Initially, access for people with lower incomes was facilitated through a revolving fund, but the utility could not afford it at a later stage. Despite the economic barriers to access, the introduction of electricity in Mawengi provided opportunities and changes that enlarged the space for manoeuvre also for less privileged groups. I see three main explanations for this: first, subordinated individuals and groups *acted strategically and collectively* to overcome barriers to access. Second, the introduction of electricity *enhanced and reshaped* human capacities, in interplay with existing distribution of resources and individual and collective strategies. This is a source of de/stabilization that has multiple effects and reconfigures social life in many dimensions. Third, and related to this, there were constitutive elements in this process where a *multitude of human-technology-nature interactions produced changes* outside the control of individual actors. The RE process in Mawengi provides interesting examples of such domains where systemic pressures emerge and become sources of de/stabilization. These three explanations are now elaborated upon.

1) The case examplifies strategies that people apply to gain access to electricity services. Among the customers in Mawengi, there are women and men who had previously struggled to make a living, now seizing the opportunity to start up new businesses and earning enough income to afford a higher material standard. In order to mobilize necessary resources, people with small incomes borrowed money from family and friends, shared costs related to labour and materials and provided one another with access to connection points. Far from being a process where subordinated people were passive, people responded to new opportunities with strategic action that was distributed, productive and flexible.

2) Electricity is a unique and highly useful energy carrier. As a resource and as "actant", it grants humans new (or different) opportunities and has the potential to transform our capacities, i.e. it enhances specific human powers – to carry out heavy labour, generate light, communicate etc. – if combined with other resources and abilities. Thus, electricity services (e.g. electric lights, milling machines, water boilers, refrigerators at health centres, and water pumps) helped free time, reduce costs, improve health and increase productivity of land. There were immediate positive consequences of these services for the individuals – most often women – who are responsible for providing their families with food, water and kerosene. In a longer time perspective, these services can play a significant role in improving women's work situation, cash flow and economic position and, thus, be empowering.

Importantly, the hydropower system is of enough capacity and quality to accommodate larger electric loads, including machinery. For example, electric milling machines significantly reduced the cost for milling the staple maize in comparison to the previous use of diesel-powered machinery. It beneffited basically all families in the area – also low-income households – and improved the cash flow in the local economy. The introduction of various machinery in Mawengi has reshaped (and continues to reshape) the relationships between time, labour, material resources and services. For example, work at the carpentry that used to require the collaboration of many able-bodied persons could be replaced by one person to operate a machine. Emerging effects manifest in a changing social organization around work and shifts in energy use patterns.

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[14] The data shows a pattern at the group level for gender and class, but not for other categories of social difference.

[15] This touches upon important and fundamental questions of power, which fall outside the scope of this discussion, regarding the exploitation of poor people's labour, resources and environment along the supply value chains of electricity infrastructure and electric appliances.

What is also unique with electric grids, is the way they allow for control of individual users' access. The utility took repressive action against customers who did not pay for the service. For example, some local leaders felt entitled to electricity services for free and did not pay their bills. There were also customers who failed to pay their bills due to lack of cash. To handle the situation with delayed payments, the local utility disconnected customers as a means of sanction. This power exercise took on different meaning in the eyes of villagers who discursively or in action supported or contested the actions, authority and legitimacy of the utility. In interviews, respondents typically saw disconnection as legitimate when it was used against people who could pay (what I classify as a legitimate repressive act for empowerment) whereas it was seen as unfair when it hit poor villagers (an illegitimate exercise of dominance). In the words of one of the customers: "This is fair to some of the people who can afford to pay within the time of one month, but to other people it not fair because they need more time to get the money."

For the staff, disconnection proved an effective means of enforcement, but it came at a high social cost, as illustrated by the following exchange:

Manager: "In our project we don't look at people's positions, we treat all customers equally. That is why we disconnected the [local politician] because he is not paying the tariff. [. . .] So we just follow what is in the constitution and our rules, I can even be disconnected, even the parish priest can be disconnected."

Researcher: "For how long was [the leader] disconnected?"

Manager: "For almost six months now. I even reported him to [higher administrative level], he was called by the disciplinary committee and he was instructed in writing to pay the tariff."

Researcher: "Why is he not paying?"

Manager: "It is just politics. That is why for me, I see that it is better for the people to hate me just to make sure that the project continues through enforcement of law."

The manager expressed a sense of obligation towards the project's continuation, and entitlement based on the rules in the contract, to exercise authority towards misbehaving customers. His position in local society was fundamentally changed through his engagement in the project − a shift from being a local butcher to the manager with power to interrupt the flow of electricity in the wires. This also relates to the third aspect.

3) The formation process brought many new requirements, opportunities and activities to Mawengi, which led to a redistribution of resources, shifts in people's daily lives, in their (professional) identities and the use and meaning of spaces. Many of these shifts took on constitutive character, being outside the control of individual actors. Some changes were produced by a mesh of strategic action, coincidence, luck and unexpected events to produce winners and losers. One unintended consequence of electrification was a social repositioning of electrified and non-electrified places, due to the dominant discourse on electricity as a symbol of modernity and development. People who could not afford connecting to the grid stated in interviews that they felt their poverty in a more acute sense, now that the neighbour had electric lights.

The experience of a growing gap between rich and poor is not surprising, and it follows a common pattern. But what does it mean for the potential for electrification to reduce poverty and destabilise relations of class? While it is too early in this case to evaluate the long-term impact on poverty, I wish to point to a new and potentially subversive position produced in this process: the *customer/member* of the local utility. This new category of people is very important as the customers in this membership organization elect their representatives. The General Assembly (GA) members influence the priorities of the utility regarding whether the focus should be to connect high-income customers who can pay more for service, or local households who use less and pay less. This is an ongoing discussion and so far, the GA, board and utility staff have prioritised connecting as many users as possible, rather than giving priority to businesses and high-load users. Judging from the discussions in GA meetings, the members of LUMAMA have not let go of the idea of eventual access for all people in their communities. In comparison to processes of grid extension, community owned systems open up a wider political space for local mobilization around ideas of fairness and equality, which may reshape system configurations over time.

5.4. Locations of de/stabilization

To summarize, the empirical analysis identifies the following sources of de/stabilization throughout the formation process: (a) the logic of implementation and shaping of the implementation process as a 'space' where actors exercise power, and the dominant external actor align with and contest social hierarchies; (b) the translation from planned sociotechnical design to actual system configuration; (c) the existing distribution of resources, division of labour and decision-making power, which combine with dominant discourses and institutions to constrain the capacity of subordinated individuals and groups throughout the process; (d) collective and supportive actions based on trust and norms of sharing that help individuals overcome barriers to access; (e) electricity as a unique resource that can be quite effectively controlled by the utility and that enhances human capacities, changing the relations between time—labour—resources and social organization around work. In parallel the discourse shifts on the relative value of material and human resources and what knowledge is considered important; (f) associated shifts in mobility and use of spaces accompanied by a shift in the performance of place and activity-bound identities; and (g) a material and symbolic repositioning of individuals and collectives place-in-the-world.

Hence, Figs. 5–9 visualize when (in what sub-process) and where (in what domains of daily life) in the formation process that the interplay between relations of power and the sociotechnical system produced de/stabilization. The tension between dominance and empowerment has so far manifested in a (re)production of social hierarchies and growing social inequality in parallel with increased social mobility at the level of individuals (see also Green, 2014). Also, the community was socially
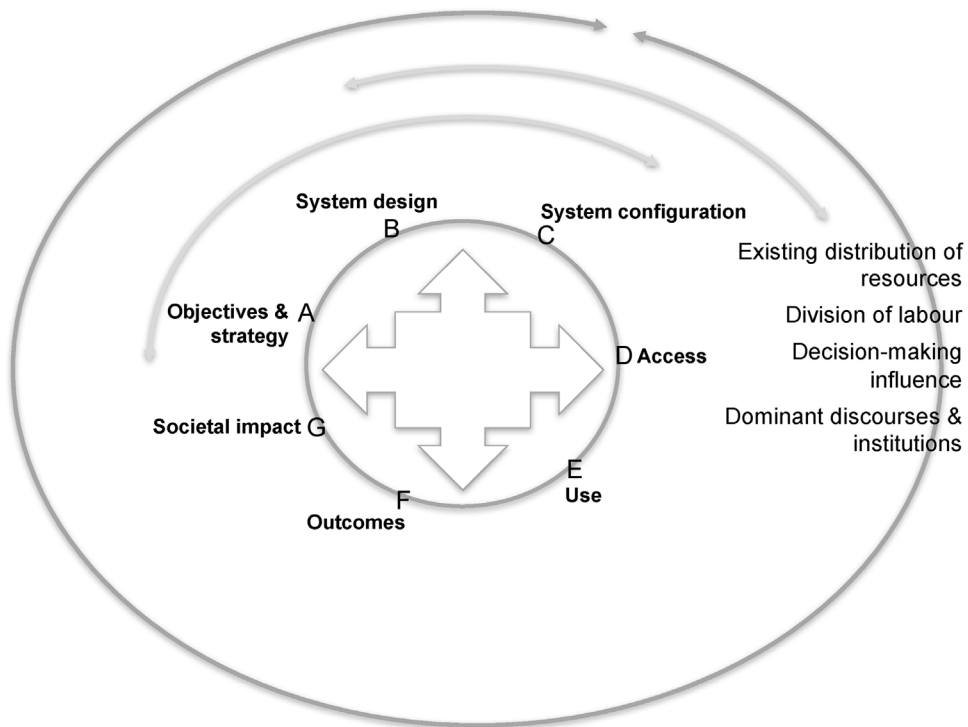
Fig. 6. Source of stabilization in the formation process: (c) Existing social relations create barriers to participation, access and use for poor people and women throughout the entire process.
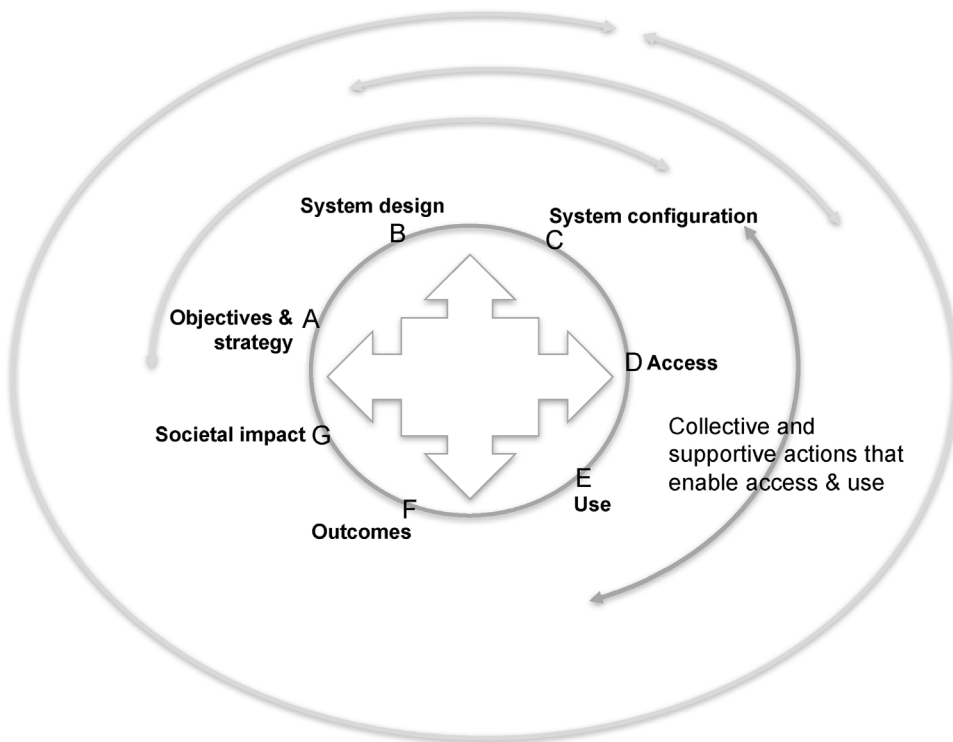

Fig. 7. Source of destabilization in the formation process: (d) collective and supportive acts for empowerment that overcome barriers to access and use.
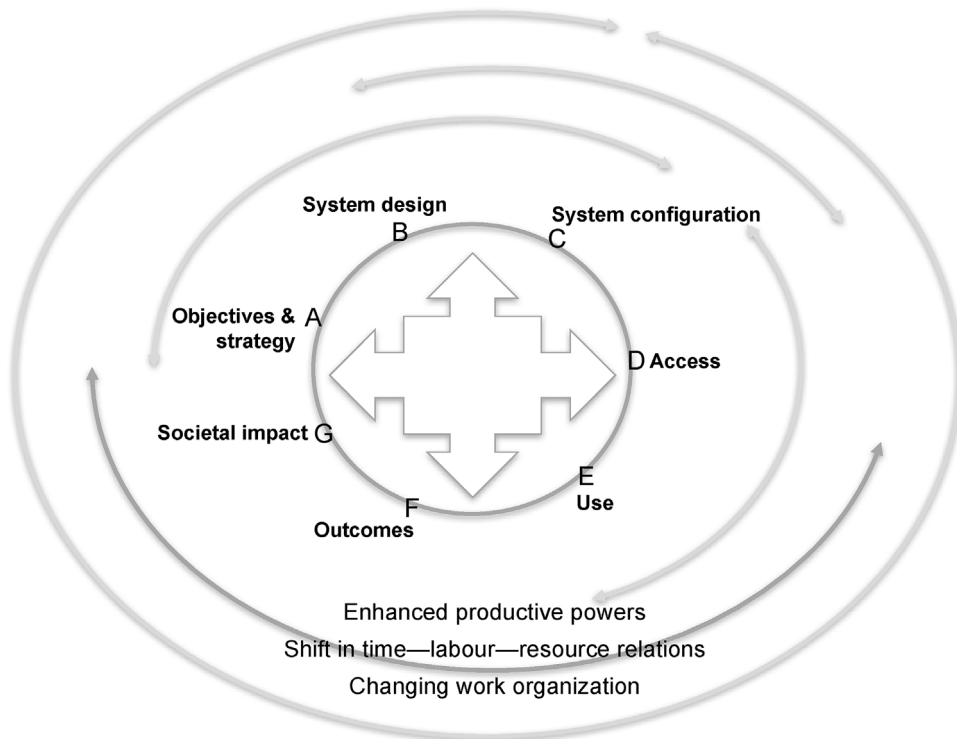
Fig. 8. Source of de/stabilization in the formation process: (e) the unique character of electricity, enhancing human capacity to act and reshaping relations between time—labour—resources.
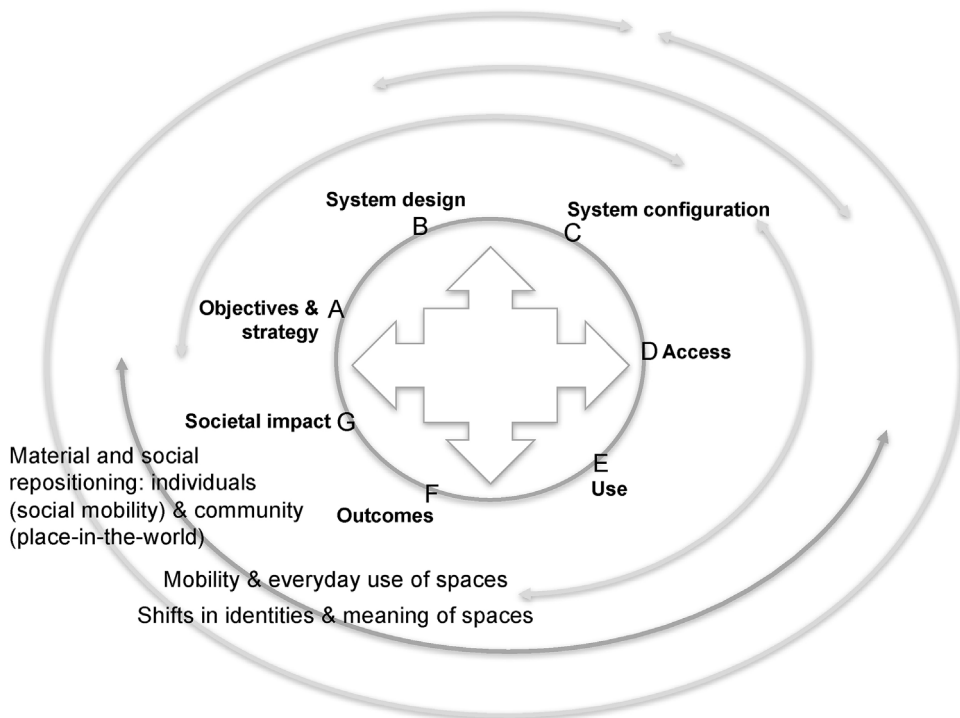
Fig. 9. Sources of de/stabilization in the formation process: (f) changing mobility, use and meaning of spaces and shifting identities, and (g) a repositioning of individuals and collectives and their place in the world.

repositioned in relation to surrounding society, and it is now 'connected' and 'part of modernity', with an increasing number of users and electricity services.

6. Conclusions

This paper has developed a conceptualization of power tailored for the study of local-level energy transitions in poor, rural communities in Tanzania, to the aim of explaining if, how and where power relations become de/stabilized in a process of sociotechnical change. The analysis has highlighted that introduction of systems for electricity generation and distribution involves agency and negotiation, exercise of dominance, experienced subordination as well as potential for empowerment. Multi-dimensional poverty creates significant constraints on the capacity of subordinated individuals to engage in the electrification process and to access and use electricity services. Therefore, the general pattern is that electrification (re)produces social inequality related to class and gender. This is a common pattern at the early stages of electrification, and experience from other contexts shows the importance of political mobilization and bottom-up pressures for wider access and more equally shared benefits to materialize (Zomers, 2001; Jones, 2016). But where can such political spaces open up?

In Mawengi, new political spaces open up simultaneously with growing inequality. This small-scale system of local generation and distribution is powerful enough to redirect processes of social and economic change and bring accompanying shifts in relations of power and various aspects of daily life. Thus, the introduction of electricity causes a destabilization of the existing social order, even when external actors collaborate with locally dominant groups and align to a large degree with their interests. This is due to purposeful acts to limit the influence of local elites, as well as a multitude of interactions, pressures, opportunities and shifts in various domains of daily life that are beyond the control of actors involved. These are identified as locations or 'domains' where destabilization occurs.

When the room for individual and collective action expands with expected and unforeseen opportunities, some individuals are able to change their positions in social hierarchies. Still the impact may be limited to a few individuals improving their situation. The analysis points to the importance of a new actor that is being produced: the 'electricity consumer/utility member'. It is a potentially subversive position that can be employed by individuals to direct the future development of the utility towards continued socioeconomic exclusion, or increasing inclusion based on an ethics of social equity.

The kind of analysis undertaken in this paper presents a very different view on electrification processes, as compared to mainstream development discourse where electrification of the public is depoliticized as a 'national interest' or a 'welfare' project (WB, 2008). Surely, electricity has unique characteristics and it is highly useful for a range of welfare services. However, renewable energy projects are politically charged arenas in which relations of power are reworked and negotiated in terms of what 'development' is produced, by whom and with what consequences for social equality, local livelihoods and ecosystems (Avelino and Wittmayer, 2016; Castán Broto, 2016).

The paper has developed a conceptualization of power as relational, contingent, situated and produced through interactions between human actors as well as with non-human elements. I have used sociotechnical system concepts and visualizations in order to describe and illustrate the system dynamics involved in the (re)production of social hierarchies. The resulting characterisation of system dynamics, in combination with the conceptualization of power in decentralized electrification processes, reveals a range of interfaces, interactions and feedbacks that have material and social effects. Importantly, the analysis did not prioritise either human agency or the role of actants beforehand, but studied their interactions, the tension between them, and found that they exert specific pressures in de/stabilizing power relations at different moments and domains. The value of explicitly addressing questions of power was that it helped clarify how, why, when and where certain change was produced in this multi-actor process.

The relevance for the ST field, I would argue, is that an understanding of power as relational at its core allows for matching the dynamic understanding of sociotechnical change with an equally dynamic understanding of power. Further explorations of relational power in processes of sociotechnical change may contribute to more in-depth understanding of where the politically subversive spaces open up.

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