Ambivalences of decentralized renewable energies – Towards self-determination or reproduction of postcolonial power relations?

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Content

Ambivalences of decentralized renewable energies - Towards self-determination or reproduction of postcolonial power relations?[1]

Bettina Barthel

Abstract

The United Nations proclaimed the years between 2014 and 2024 to be the Decade of Sustainable Energy for All, and the SDG 7 emphasizes the necessity of universal energy access. Development policies increasingly see decentralised supply structures as a viable solution to achieve that goal. From a postcolonial perspective however, it is also relevant whether renewable decentralized energies enable more local control and reduce dependency relations. Technology critics in the '70s and '80s saw this potential. In the field of energy and development, various debates and understandings of decentralization converge. First the paper traces back the theoretical debates and policies of decentralisation. Secondly it examines two current case studies of German-Tanzanian partnerships of technology development, domestic biogas and solar home systems. As a result, both case studies can be described as decentralized structures with regard to some aspects, and as centralized structures with regard to others. The paper shows that decentralized renewable energies do not automatically lead to the reduction of dependency relations or a socially just implementation. It aims to sensitize against such underlying assumptions or narratives, because they can impede a more accurate and critical view on decentralized renewable energy projects.

Keywords: Decentralisation, renewable energies, development partnerships, postcolonial development research, postcolonial science and technology studies, energy anthropology

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1 The paper presents results of my PhD-research, which took place between 2011 and 2016. The text is based on the monograph: Barthel, Bettina (2019): Erneuerbare und dezentrale Energien aus postkolonialer Perspektive. Ethnografische Analysen deutsch-tansanischer Partnerschaften. Baden-Baden, Nomos. Heartfelt thanks to Hayley King for the english proofreading.

Abbreviations

BoP	Bottom of the Pyramid or Base of the Pyramid
BMZ	Federal Ministry for Economic Cooperation and Development (*Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung*)
CARMATEC	Centre for Agricultural Mechanization and Rural Technology
CEO	Chief Executive Officer
EU	European Union
GTZ	German Association of Technical Cooperation (*Deutsche Gesellschaft für Technische Zusammenarbeit*), since 2011 part of GIZ
ICT4D	Information and Communication Technologies for Development
IEA	International Energy Agency
int.	interview
ISAT	Information and Advisory Services on Appropriate Technology
KIC	EU Climate – KIC (Knowledge and Innovation Community)
NDBP	National Domestic Biogas Program
NGO	Non-Governmental Organizations
ODA	Official Development Assistance
PV	Photovoltaic system
R&D	Research and Development
REA	Tanzanian Rural Energy Agency
SDG	Sustainable Development Goals
SE4All	Sustainable Energy for All
SHS	solar home systems
SNV	Netherlands Development Organisation (*Stichting Nederlandse Vrijwilligers*)
TANESCO	Tanzania Electric Supply Company Limited
TC	Technical Cooperation (pseudonym of a non-profit association in the case study)
UN	United Nations
URT	United Republic of Tanzania
WEO	World Energy Outlook

1 Introduction

The United Nations proclaimed the Decade of Sustainable Energy for All (SE4All) between the years 2014-2024.[2] The formulated goal is universal access to sustainable, 'modern' energy services based on the problematization,

> *"that 2.6 billion people in developing countries rely on traditional biomass for cooking and heating, that 1.3 billion people are without electricity and that, even when energy services are available, millions of poor people are unable to pay for them."* (United Nations 2012: 2)

Identifying deficits in 'developing countries', the juxtaposition of 'traditional' and 'modern' energy supply and the approach of achieving 'development' via technologies indicate the discursive structure of this policy field as a development discourse. Since the adoption of the 2030 Agenda for Sustainable Development by the United Nations in September 2015, access to energy is a standalone goal in the list of Sustainable Development Goals. Since then, the narratives around the SE4All decade and this SDG 7 have converged in the energy and development nexus (see Barthel 2019, chapter 4).

The topic of energy access is a classic area of development cooperation and thus subject to paradigm shifts in development policy. Rebecca Ghanadan (cf. Ghanadan 2004, 2009) describes the transformation of energy supply in Africa as turning from a public good into a commodity: "In the course of the last decade, electricity service provision in Africa has been rewritten along market lines" (Ghanadan 2009: 400). The focus of the practitioner network of the UN Decade demonstrates that the private sector is seen as the main player in energy supply, even for sections of the population living in poverty:

> *"The Network's particular focus is on the removal of market barriers to the effective delivery of energy services by promoting the adoption of new technologies and innovative financial and business models, as well as the identification and dissemination of best practices and advocacy for universal energy access."*[3]

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[2] Https://press.un.org/en/2012/ga11333.doc.htm (accessed 07/30/2022)

[3] Http://www.se4all.org/about-us_practitioner-network (accessed 01/06/2016)
Http://www.se4all.org/2012_06_18_practitioner-network-releases-recommendations-achieve-universal-energy-access (accessed 12/07/2016)

One of the reasons for this policy focus might be the 'discovery' of the so-called 'base' or 'bottom of the pyramid' (BoP) as a potential market (cf. Prahalad 2005, Hammond et al. 2007) and is related to the microfinance approach. Popularized by Muhamad Yunus and the Grameen Bank, it aims to integrate people without savings or equity into the market through microcredits. They shall work themselves out of poverty by so-called productive use of energy and by becoming micro entrepreneurs (cf. Klas & Mader 2014).

The documents for the Decade SE4All follow the concept of sustainable development and thus emphasize the role of renewable energies. Renewables are said to have the potential to solve the major global problems of poverty and climate change at the same time. For several years *decentralized* energy technologies have been promoted in particular. Such technologies are characterized by the spatial coupling of energy production and consumption, which means that the energy conversion unit is used in the vicinity of the users (cf. MES 2009: 4). So-called mini-grids, or household systems, are increasingly seen as a technically scalable and long-term solution in the field of energy supply. For example, the World Bank recommends that countries with low grid coverage include a "decentralized track" (Tenenbaum et al. 2014: 1) in national electrification plans. The Energy Access Committee of the SE4All Decade focuses on decentralized, off-grid options as well (cf. Energy Access Comittee 2014: 1).

Regarding the role of renewable and decentralized energies in North-South relations, a field of tension can be identified. Development critics, mostly following James Ferguson and Arturo Escobar, problematize social problems as being conceived as "development deficits" and dealt with as technical problems (cf. Ferguson 1990, 1994: 255, Escobar 2012: 52). In this logic of the ‘technological fix’, the powerful depoliticizing tendency of development discourse manifests itself. As indicated in the beginning, this logic seems to continue in the policy field of energy and ‘development’. On the other hand, decentralized technologies and especially decentralized renewable energy technologies are understood to have a high potential for increasing self-determination, local or democratic control and technology appropriation. Such linkages often appear as implicit assumptions in introductory or concluding sentences:

> *“On the production side, renewable energy sources provide a cleaner and safer alternative and should be an important subject for future research and policy. This is especially true for developing countries, where growth in energy use will be essential for development.*

> *Renewables provide cleaner development and, since their use is decentralized, increase the possibility of local control and oversight."* (Wilhite 2005: 2)

Renewable energies are sometimes understood as being tools for resistance:

> *„The global intensity of our era (Tsing 2000) may be taken for granted by those whose supply and consumption of energy is relatively unproblematic, even as the inexorable pressures of globalization are* actively resisted through local, renewable energy projects *such as those described in this volume."* (Strauss et al. 2013: 13, emphasis added)

Such associations can also be found in concepts of self-determined or 'emancipatory' technology development and use (Boeing 2011), or in more current debates of post-development (Sachs 2006, Shiva 2008, Escobar 2012: xxiii).[4]

This paper deals with the question of how these seemingly contradictory diagnoses concerning the role of (decentralized) energy technologies in the context of global North-South relations can be understood, and what can be observed in current development partnerships in practice. It investigates if and how projects in the field of decentralized energy technologies enable the self-determined pursuit of interests and needs by users and actors in the South. Within a context of unequal and paternalistic partnership structures of the Global North and South, do they enable more local control or appropriation of the technologies and thus reduce dependency relations?

Between 2011 and 2016 I conducted ethnographic research to investigate processes of technology development and implementation in two case studies of German-Tanzanian partnerships. Taking into account the criticism of state development institutions and transnational corporations, with regard to their interests, hierarchical power relations and the lack of self-determination of actors from the South, I selected two non-governmental organizations (NGOs) as the first case study, and a German start-up company that collaborates with a Tanszanian social business as second case study. Both cases look at renewable decentralized energy technologies, defined by the spatial coupling of production and consumption at the household level, where a process of technology development took place. From a techno-sociological perspective, the R&D phase is the moment with

[4] "Since solar and biomass can be found just about anywhere, the place of generation can be very close to where they are consumed, making tankers and pipelines, as well as quite some large scale power plants, obsolete. Coupled with the miniaturization of conversion technologies - micro power plants, combined heat and power, integrated photovoltaics - and the networking of many independent small producers via the power grid, this opens up historically new perspectives for a decentralized, democratic energy system." (Sachs 2006: 25f, own translation)

the greatest openness to incorporate user needs into the system design and to influence the design of the socio-technical network. Both projects began at approximately the same time, during 2009 and 2010, meaning that the actors were operating within the same political context.

Both case studies look at partnerships between Germany and Tanzania. Before Tanganyika Territory passed into British trusteeship after World War I, the region was part of German East Africa, a colonial territory of Germany. It primarily served Germany as a supplier of raw materials; however, German colonialism triggered strong resistance movements, some of which were bloodily suppressed (for example, the Maji-Maji War). Since the independence of Tanzania, both the Federal Republic of Germany and the German Democratic Republic became donors for Tanzania (cf. Büschel 2014: 58ff). The relationship can be understood a classic donor-recipient relationship in the postcolonial condition.

The case studies will be analyzed from a postcolonial perspective. The postcolonial context, the global North-South relations and the structures of power and inequality that are inscribed in those relations will be systematically considered (for example, whether paternalistic tendencies in partnership structures persist, cf. Eriksson Baaz 2005). Because of their focus on discourse, identity, difference and representation, postcolonial theories have been accused of neglecting the material concerns of people: "Development studies does not tend to listen to subalterns and postcolonial studies does not tend to concern itself with whether the subaltern is eating" (Sylvester 1999: 703). However, there are approaches that show the analytical potential of linking postcolonial theories with development studies (cf. Eriksson Baaz 2005, Kapoor 2008, McEwan 2009, Ziai 2010). With the topic of energy supply, which relates to people's material concerns, it seems suitable to follow this line and to contribute to postcolonial development research (cf. Barthel 2019: 53ff). It means, among other things, becoming aware of the inherent contradictions of postcolonial relations, to point out ambivalences, and to avoid simplistic explanatory patterns. The postcolonial perspective leads to certain questions that are relevant for analysing the case studies: It is necessary to examine how the project came about, who defines what the problem is, and who determines what is considered as a solution. How can the cooperation in the 'partnership' be understood? Regarding methodology, postcolonial development research leads to interweaving ethnographic material, discourse-analytical and theoretical elements.

In section two, I will first examine where the association of renewable energies as democratic and self-determining technologies comes from, and how the sociology of technology can aid understanding of this association. What is understood as decentralization and which strands of discourse converge in the thematic field of energy and 'development'? This theoretical section is then followed by a comparative analysis of the case studies in section three. The comparison does not reveal which project is 'better' or 'worse'; but highlights ambivalences from a postcolonial perspective. Despite the different constellations and objectives of the actors in the two partnerships, there are some commonalities to be found. The fourth section reconsiders both case studies with regards to the various dimensions of decentralization.

2 Decentral and renewable energies – democratic and self-determined technologies?

Energy and critique of technology

The onset of industrialization also marks the beginning of a critical examination of the effects of technology in society (cf. Weyer 2008). Such analysis centred on industrialization and the destructive technologies used during the two world wars. Against the background of the first atomic bombing in World War II and the subsequent atomic threat in the Cold War, it was stated that technology lost its neutrality and nuclear power became a central topic of technology criticism, in both its military and so-called peaceful usage (cf. Marcuse 1967, Schumacher 1973, Ullrich 1988, Boeing 2012). Therefore, alternative energy technologies were sought (cf. Dickson 1975).

The idea of a democratic technology developed following the theses of Ivan Illich (1973) and Lewis Mumford. In his historical work *Myth of the Machine* (1974), the latter introduced, among other things, the contrast between democratic and authoritarian technologies:

> *"My thesis, to put it bluntly, is that from late Neolithic times in the Near East, right down to our own day, two technologies have recurrently existed side by side: one authoritarian, the other democratic, the first system-centered, immensely powerful, but inherently unstable, the other man-centered, relatively weak, but resourceful and durable."* (Mumford 1964: 2)

He thus distinguished technologies according to their societal effects. In particular, solar energy advocates continued this argument and associated renewable energy with more democracy and control.

> *"The increased deployment of nuclear power facilities must lead society toward authoritarianism. Indeed, safe reliance upon nuclear power as the principal source of energy may be possible only in a totalitarian state."* (Hayes 1977: 71)

> *"Although energy sources may not dictate the shape of society, they do limit its range of possibilities; and dispersed solar sources are more compatible than centralized technologies with social equity, freedom, and cultural pluralism."* (ibid. 159)

Many advocates of solar energy emphasized that it fits much better with a democratic, egalitarian structure of society than energy systems based on coal, oil, or nuclear power. They argue that solar energy contributes to technical and political decentralization.

> *"We think decentralization is an implicit component of renewable energy; this implies the decentralization of energy systems, communities and of power. Renewable energy doesn't require mammoth generation sources of disruptive transmission corridors. Our cities and towns, which have been dependent on centralized energy supplies, may be able to achieve some degree of autonomy, thereby controlling and administering their own energy needs."* (Argue et al. 1978: 16, cited from Winner 1980).

In the 1980s, West German environmental associations saw connections between technology and democracy (cf. LBU 1983). Their critique focused on large scale and risky technology (cf. Schumacher 1973, Traube 1978, Ullrich [1977] 1988, Perrow 1987). The concept of large scale technology was associated with industrial production structures, unmanageability and uncontrollability, risk, inertia, invasiveness in the environment, and putting many people in inflexible relationships with each other. Large technologies were seen as 'inhuman' (following E.F. Schumacher 1973) and disempowering, since their high level of complexity can only be understood by a minority of trained specialists. Size and complexity make technologies inscrutable and therefore more difficult to control. When controllability is no longer guaranteed a momentum emerges that leads to the perception of technology autonomy. 'Small' technologies have been regarded as alternative and *Small is beautiful* (Schumacher 1973) turned into a kind of resistance formula.

The underlying question of whether technical artifacts actually have political qualities was addressed by the anthropologist Langdon Winner in his essay *Do artifacts have politics?* (1980). He concludes that an unambiguous assignment is hardly possible; on the contrary, most technologies are very flexible in this respect. Legal and social scientist Thomas Kluge (1985) also shows argumentative weaknesses of such claimed connections[5] and sums up, "that there is no compelling connection between decentralization, decomposition of large industrial structures and changes in social structures in the sense of the ecology movement" (Kluge 1985: 14, own translation). These contributions mark the beginning of the scientific foundation of the politicized technology-critical debates and form one of the roots of the sociology of technology. One of the important contributions of the sociology of technology was to identify and deconstruct the technological determinism of the preceding debates (cf. Wyatt 2008). Technical artifacts are part of socio-technical constellations and their inherent power relations, so they are not neutral in this sense. However, due to the complexity of socio-technical systems, general statements about specific technologies or 'the technology' aren't possible. Societal effects, the inscription of hierarchies, and the emergence or transformation of dependencies must be understood in light of power-sensitive and differentiated empirical analyses.

Ideas about the relationship between renewable and decentralized energy and democracy, autonomy, and self-determination were raised the 1970s. They emerged from the convergence of critiques of nuclear power, concerns of technology becoming autonomous, the environmental movement, the oil crisis, and debates around *The Limits to Growth* (Meadows 1972). It was at this time that renewable energy was first systematically treated as an alternative to fossil fuels. Thus, when assumptions appear that associate a particular technology with a particular social order, they can be understood as following on from debates of that period.

Critique of technology meets development critique: Intermediate and appropriate technologies

Technology and knowledge have already been an integral part of the idea of 'development' as it was formed during the Enlightenment (cf. Cherlet 2014: 773).

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5 To mention them: Too superficial criticism of the natural sciences in Ullrich (cf. Kluge 1985: 17), arbitrary formations of tradition in Mumford (ibid. 16). He also shows how these weaknesses are covered by certain philosophical figures (especially by a methodological opposition of life and death going back to Spengler, but also by the static notion of an equilibrium, which conceptually not allows for social change), which lead to various aporias.

> *"Technology, it was believed, would not only amplify material progress, it would also confer upon it in a sense of direction and significance. In the vast literature on the sociology of modernization, technology was theorized as a sort of moral force that would operate by creating an ethics of innovation, yield and result."* (Escobar 2012: 36)

Accordingly, technical development was given a central role during the development era, which began after World War II. The term technical assistance (TA) was introduced in 1947-48 to describe the official aid provided by the United Nations Department of Economic Affairs. The concept of technology transfer became an important component of development projects.

The 1960s saw the first cautious criticism of the concepts. Dependency theories accused development cooperation of perpetuating the unequal relationship between the Global North and South and technology transfer was criticized for creating or reproducing dependencies. In the 1970s, failures of development projects were attributed to the unsuccessful transfer of 'modern' technologies. It was argued that most advanced technologies were not adapted to conditions of 'developing countries'. Following this, the economist E.F. Schumacher introduced the concept of so-called *intermediate technologies*. By this he meant technologies that lie between 'traditional' and 'advanced' technologies in various respects: they should be less complex, easier to operate and easier to repair. It should be possible to produce them locally and they would not require skilled workers. In their production, they are more capital-intensive than 'simple' tools and cheaper than high-tech variants. A more discreet increase in productivity would allow innovations to be integrated into local production cycles instead of completely upsetting them (cf. Schumacher 1973: 169f). Schumacher's concept is based on an evolution theory of technology, he was a classical development thinker (cf. ibid. 157ff). He was critical of development planners who wanted to produce modernity in one fell swoop and argued that 'development' would be an evolutionary process with development aid being tasked with accelerating it. The concept of intermediate technologies was soon replaced by the notions of adapted or *appropriate technologies*, "indicating any technology that is small scale, labor intensive rather than capital intensive, energy efficient, environmentally sustainable, and controlled and maintained by the local community of a developing region" (Cherlet 2014: 781). The concept of appropriate technology strongly influenced development cooperation in the 1970s and 1980s, and many elements of this concept were seen as having the potential of reducing dependence on the Global North.

The economist and philosopher Serge Latouche (1993) critiques the concept of adapted technologies in the North-South context from a post-development perspective. Historically, it would be once again the case of Western actors assuming responsibility for the problem of ‘catching-up development’ and E.F. Schumacher would be a good example of this. Latouche also understood the concept as primarily being a result from a Western critique of modernity. The search for *soft technologies* (Lovins 1978) resulted from the counterculture of 1968, the debate about the Limits to Growth (Meadows 1972), and the idea of creating a human technology. Later, this idea was exported to the 'Third World': "Once again the same motif: the West will save the Third World and resolve the problems that its intrusions have stirred up" (Latouche 1993: 178). It remains to be an engineer's view of the world and very technocratic: ‘development’ takes place through technology. Thus, the problems of the Third World would be reduced to technical problems, even if they were supposed to be 'alternative development’. As a result of the idea of intermediate technologies, there are very few examples of adapted technologies in sectors such as the automobile industry or electronics (cf. Latouche 1993: 182). For the case of biogas, the focus on small scale biogas plants for households and the neglect of larger-scale plants in African countries (cf. Mshandete & Parawira 2009) could also be linked to this observation.

Besides academic critique, like that of Latouche, the concept of adapted technologies was partly rejected by political actors in the South. Schumacher himself already mentions this rejection and characterizes it as being of a 'psychological nature'; some countries (or actors) would suspect that they were to be kept down and fobbed off with something second-rate and old-fashioned (cf. Schumacher 1973: 170f). They wanted 'proper' 'development', and 'modernization'; with the help of the 'big' technologies like nuclear power and oil (cf. Ullrich 1993: 405). Schumacher's characterization of the argument as 'psychological' and also the assessment that he did not mean it that way[6] is not as satisfying as an interpretation of this reaction from a postcolonial discursive perspective: 'Adapted' or 'intermediate' technologies are regarded similarly to 'traditional' technologies and are opposed to 'modern' technology, as a deficient deviation in hierarchical dichotomies. From this perspective, they are second-class because they are not 'big' and 'modern'. Through the concepts of 'adapted' or 'intermediate' technologies, these countries are thus discursively classified on a lower level, as not yet ready for 'proper' technologies. From this perspective, then, one could turn

[6] This is what Eckart Löhr says in a book review: www.literaturkritik.de/public/rezension.php?rez_id=18756 (accessed 08/10/2022)

Latouche's critique of the concept around: The problem is not as Latouche noted – that these adapted technologies, as a form of ‘development’, also served 'Westernization' – but on the contrary, they cause a discursive (and material) reproduction of the 'Third World'.

Decentralization as a concept of development policy

At the turn of the millennium, the theory crisis in development research resulted in the favoring of ‘the local’ on a theoretical-normative and analytical level as well as in development cooperation in practice (see Mohan & Stokke 2000). Geographers Giles Mohan and Kristian Stokke identified this tendency in four areas: local governance, local knowledge in connection with participatory approaches, social capital, and social movements and radical democracy. On the discursive level, they view decentralization as a "fluid and flexible discourse that can be utilized by different ideological interests" (Mohan & Stokke 2000: 250). This also results from the long history the term’s use, which denotes very different interpretations depending on the context.

It is necessary to mention the indirect rule of the British colonial administration in the 19th century (cf. Slater 1989, Esteva 1995: 32). A system of decentralized exercise of control was adopted because of the lack of white personnel and communication problems caused by the great geographical distances (cf. Mamdani 1996: 76). "Centralization of control was accompanied by the 'decentralization of discretion'" (Slater 1989: 510). This means that the administrators posted in the respective colonial territories and regions had a relatively large degree of discretion of how to relate with Indigenous actors and the population.

After decolonization, many leftist parties and governments in postcolonial states pursued centralized approaches to push social and economic development. They saw a strong centralized state as a form of advancing nationalization and socialism. The local level was associated with the power of privilege over land ownership and was seen as backward (see Slater 1989: 505). A devolution of power to decentralized levels could strengthen those power positions at the local level. On the other hand, the “self-accumulating growth of the bureaucracy itself" (ibid. 503) resulted in state bureaucracy, and certain interest groups that were associated with it, turning into a source of power and privilege.

Early decentralization programs of the 1970s, such as the Thaba Tseka project in Lesotho, studied by James Ferguson, stated two core goals. The first goal was the decentralization of public administration to make it more effective; multiple responsibilities and bureaucracy were to be reduced to

cut costs. The second goal was to increase understanding of the population and its needs. While not being a core goal, a third aspect that appeared to be relevant for some actors involved bypassing the central administration in the capital (cf. Ferguson 1990: 198).

Geographer David Slater carved out a gradual change regarding the preferred strategies of decentralization in development policy during the 1980s. Decentralization initially meant:

> *„[the] transfer of planning, decision-making, or administrative authority from the central government to its field organisations, local administration units, semi-autonomous and parastatal organisations, local governments or non-governmental private or voluntary organizations.“* (Rondinelli & Cheema 1983, zit. in Slater 1989: 519f)

Regarding the organizational arrangements for implementation, Slater points out that privatization and deregulation, as a possible means to administrative decentralization, developed from being rather subordinate options to main strategies (cf. Slater 1989: 519). By the end of the 1980s, decentralization was already considered to be a situation in which public goods and utility services were primarily provided through market mechanisms (cf. ibid.). The arguments given were, firstly, that planned economies had failed, and secondly, that the number of small scale projects that aspired to reach the poor had increased. These small scale projects would be hindered by over-centralized management. This argument demonstrates a connection between the political-administrative decentralization of the state and the decentralization of development cooperation. The civil society level of cooperation through NGOs and other non-state actors became more and more important (cf. Slater 1989: 516).

From a neoliberal perspective, the interventionist state appeared more as an obstacle than as a promoter of ‘development’, and lenders increasingly made decentralization programs a condition for funds. According to the World Bank, market-friendly reforms and administrative decentralization go hand in hand: "Competitive markets permit the necessary flexibility and responsiveness and, because they decentralize the task of handling information, also economize on scarce administrative resources" (World Bank 1983, see also World Bank 1988). Decentralization in this sense was linked to the goal of reducing the economic functions of the state (cf. Slater 1989: 519). Increasingly, public institutions were conceptualized as service systems. "Society is reduced to the characteristics of people as consumers" (Mohan & Stokke 2000: 251). The rational choice theory, underlying these arguments "permits the more political readings of decentralization to be transformed

into a narrative of capital and 'efficiency'" (ibid. 250). The other possible meaning of decentralization in this context - participation in (governmental) decision-making, is not mentioned. Participation is understood as market participation.

Slater (cf. Slater 1989: 523), Mohan and Stokke distinguish decentralization as effective service delivery from decentralization as empowerment of grassroots democratic practices and collective organizations, which corresponds to the radical democratic version of post-development. According to post-development, the system of representative democracy serves only the interests of a small elite, meaning that power should be limited to a regional or local level (cf. Esteva 1987, Esteva & Prakash 1998: 156). Therefore, from a post-development perspective, decentralization is about self-empowerment and autonomy of local (Indigenous) communities (cf. Esteva 1995: 107). Dimensions of localisation in this context include the reappropriation of politics, independent thinking, communitarian religiosity, the decentralization of agro-economic and epistemological structures, and the reappropriation of technology (cf. Banuri 1990: 97f, Escobar 2012: xxiii).

Thus, the great conceptual variance of decentralization and the diverse history of its use must be noted. Mohan and Stokke endorse the focus on the local and decentralization but point out some voids and implications that an unreflective emphasis on the local entails.[7] Brian Smith, who analysed the debate on decentralization in the 1980s (cf. Smith 1980, 1985, 1988), emphasizes that all notions of decentralization are implicitly or explicitly influenced by ideas about the role of the state (cf. Smith 1985: 202). He suggests a more nuanced view. Centralization, he argues, has many negative associations; however, under certain circumstances can also lead to a more equitable distribution of wealth and have a positive impact. Therefore, the advocacy for centralized or decentralized structures should be based on a context-specific analysis (cf. Smith 1985: 91). Following his analysis, Slater calls for a strategic approach to the concept, to not leave it to technocratic meaning, but to give the term meaning from an emancipatory perspective (cf. Slater 1989: 524). In any case, a critical situational analysis of the political use of the notion of decentralization is necessary.

[7] They criticize that local communities tend to be essentialized and romanticized, and local social inequalities and power relations are neglected. Another problem they see is the tendency to view the 'local' as a small bounded entity independent of larger economic and political structures. "This means that the contextuality of place, e.g. national and translational economic and political forces, is underplayed" (Mohan & Stokke 2000: 249). Finally, they criticize that by emphasizing the local, the importance of the state is degraded and it is thus no longer accountable.

The role of decentralized approaches for access to energy

The central reference document for the UN Decade SE4All, which contains calculations for access to energy, is the 2011 World Energy Outlook (WEO), (cf. OECD/ IEA 2011). The report refers to the SE4All initiative and the calculations in the report are therefore geared toward the same goal of universal energy access by 2030. To find the most suitable technical solutions, regional prices and population density were considered, and the regional cost per megawatt hour was selected as the decisive variable (cf. ibid. 21). As a result, the report finds grid expansion the favorable option for urban regions and approximately 30% of rural areas. For the remaining 70% it recommends mini grid (65%) and stand-alone off-grid (35%) solutions as the most cost effective.

The report's calculations preference technical and economic parameters as criteria for the choice of technology, which thus appears objectively to be the most efficient solution. The sociology of technology allows to question the neutrality of that result. Norbert Gilson, for example, presented a historical study on the de/centralization of energy supply structures in Germany (cf. Gilson 1994). He traced how the centrality paradigm was enforced in the German energy industry at the beginning of the 20th century, based on the argument of profitability. He showed that due to the extremely high complexity and high number of factors influencing system design, it was political and capital interest-driven convictions that pre-structured the scientific calculations. Based on this, it became indisputable that electricity supply "in the form of centralized large-scale power generation was the only economically rationally justifiable option" (Gilson 1994: 239, own translation), especially in comparison to a less centralized power plant system or greater consideration of possible power-heat coupled systems (ibid. 239).

In the UN SE4All documents, the WEO calculations are taken as a reference point and presented as neutral calculations highlighting that appropriate measures must now be taken (such as the creation of legal frameworks and investment incentives for mini grids). The fact that the factors influencing the respective regional costs of technology, resources, raw materials, and manpower are influenced by political factors is not addressed in these texts. Considering sociological findings on technology, this seemingly apolitical calculation should be examined to determine which political-normative reasons and presuppositions underlie it.[8] The sociology of technology research shows that technical decisions tend to appear efficient retrospectively. This is because after a decision,

[8] It is not possible to pursue this question further here. It could be the subject of further research.

which can be based on a variety of reasons, investments and further efforts are made to develop and improve the favored solution (cf. Feenberg 2010: 7).

Interim summary

In the field of energy and development, a variety of debates and understandings of decentralization converge. Decentralized (energy) technologies can describe aspects of production/energy conversion and consumption/use, the energy sources themselves or their procurement methods, repair and maintenance systems, operating models, as well as financing models (cf. Laufer 2011: 24, Paramashivan Kaundinya et al. 2009). Decentralization can describe the tendency towards smaller projects, and NGOs and non-state actors in development cooperation, or the restructuring of administration. Decentralization can refer to (political) economic structures and describe forms of colonial and postcolonial political control; it can delimit regional autonomy from state control or describe 'effective service delivery' via market mechanisms for individual consumers.

For the case studies presented in the present work, I am interested in the lingering and current impacts of this mix of understandings at the discursive and practical levels. On February 19, 2014 a symposium was held in Berlin as a kick-off event for the SE4All Decade in Germany, where the company Phonergy[9], the subject of the second case study, was presented as an example of a sensible approach to fulfill the SE4All goals. Phonergy's fulfillment of the goals was emphasized in particular by the representative of the NGO Forum for Environment and Development. The NGO underlined three aspects of the approach: it is renewable, decentralized and does not use ODA funds.[10]

3 Solar home systems and biogas plants – Two case studies of North-South cooperation

The first case study looks at the cooperation between a Tanzanian smallholder farmers' association, based in the Kagera region in north-western Tanzania, and a German NGO with a focus on technical assistance. The aim was to develop a new type of household or small scale biogas plant that can be operated exclusively with plant residues from agriculture. There were plants already built in the region in the 1980s, designed to run on cow dung; however, most members of the farmers'

[9] The names of the organisations and companies in the case studies are pseudonyms.
[10] This information is not correct, see chapter 3.

association did not have enough livestock to run such a plant. The two partner organizations therefore decided, based on a feasibility study, to jointly conduct research and development (R&D) of such a plant. The project was the first research project of the German organization.

The project won an innovation award from the German Federal Ministry for the Environment and the Federation of German Industries (BDI) in the category of technology transfer. At the time of data collection, two pilot plants had been built in Germany, one in Tanzania and another was in preparation. The plan was to subsequently implement 15 more plants. However, after the construction of the second plant in Tanzania, the project remained in a test phase for approximately two years. It was not until 2015 that another (third) pilot plant was built. Compared to the original goal of developing a household biogas plant that can be operated exclusively with plant residues, the third plant is technologically different. It is a large institutional plant for a school cafeteria that can run on both cow manure and plant residues. The plan was that the R&D process would return to household plants, which has subsequently happened. However, the construction of the institutional plant was the moment when data collection in the project finished and thus is the basis of consideration.

The difference between the original goal and the (intermediate) result should not be simply understood as evidence for hidden intentions of the actors. First, technology development is a complex process of *socio-technical* negotiations that cannot be explained and understood exclusively by technical or human actions alone. Second, the process and results also depend on the power relations between those involved. In terms of the sociology of technology, technology development is understood as a social process of closure, in which meanings and interpretations are negotiated, narratives are established, and options are excluded. The following chapter will illustrate how, in the case of partnerships in development cooperation, postcolonial power relations influence this process.

Case study 1: Domestic biogas plants		
	Tanzanian partner	**German partner**
Organisation	**Kilimo:**[11] small scale farmers association (farmers combine subsistence and cash crop production)	**Technical Cooperation (TC)**: association of mostly volunteering engineering students
Objective	Improving quality of live in rural areas, runs various projects, agroforestry, rain-water harvesting systems, microcredit program, construction of a secondary school for girls.	Technical support in the field of basic infrastructural needs, emergency aid, R&D for technologies and constructions relevant for development aid
Established	1993	2003 as German chapter of an international organization
Legal form	Membership-based NGO	non-profit association (*gemeinnützig*)
Size	9 employees, members are 350 households in seven communities	Biogas project group: 10 members, one of them employed (Association as a whole: 2500 members, of which 800 are actively working in approx. 30 regional groups, most of them volunteering)
In a **biogas plant**, biomass raw materials (such as plant mass, animal excrement or fermentation sludge) are fermented via bacterial digestion under exclusion of oxygen (anaerobic). A household biogas plant supplies a household with gas for cooking. The residual substrate can be used as fertilizer. The plants in this case study are built underground from cement and mud bricks and are fed with banana logs. Costs are approx. 1000 Euro.		
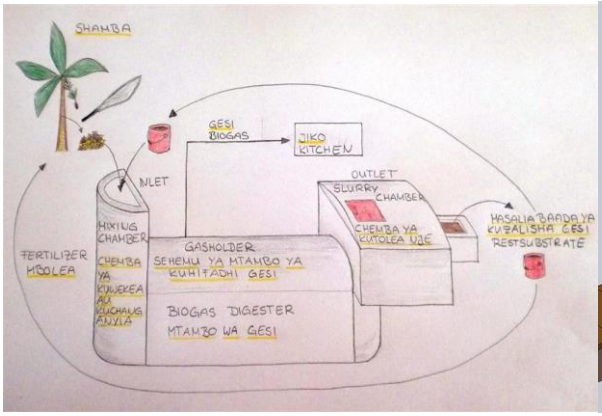	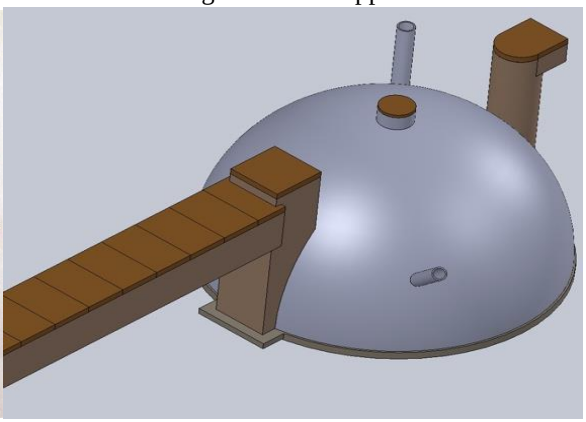	
Figure 1a: drawing Karen Bremert 1b: technical drawing if the institutional plant for mixed substrate 2015 (Source: TC)		

Table 1: Fact sheet case study small scale biogas plants

In the second case study, a German startup company developed photovoltaic systems for households (solar home systems) in cooperation with a Tanzanian social enterprise. The financing concept, also developed by the company, is based on a mixture of microcredit and prepaid installments due for the duration of three years. It is called a pay-as-you-go model. If the user pays a rate, the system is activated and the user can access the electricity. In case that clients do not pay, the systems are (automatically) switched off via mobile phone technology, remotely controlled by servers

[11] The names of the organizations and companies are pseudonyms. The data refer to the period of data collection.

at the company's headquarters in Germany.[12] At the time of data collection, the process of technology development and the pilot phase had already been completed, so that there is more information available on the distribution and use of the systems for this case study. At the beginning of the data collection, 1000 solar home systems (SHS) had been sold in Tanzania, Rwanda, and Kenya, and 5000 by completion. The company had grown into a transnational enterprise and intended to become Africa's largest electricity provider. The plants are sold through a subsidiary company established in Tanzania. Marketing and sales are mainly carried out by a network of sales agents who are paid through sales commissions. Installation and maintenance are carried out by installation technicians.

Case study 2: Solar home systems		
	German partner	**Tanzanian partner**
Organisation	**Phonergy**, profit oriented start-up company	**Shirika**, social enterprise
Objective	Off grid power supply, sale of household solar pv systems and equipment	Rural development, prevent rural exodus through technology transfer for water and sanitation, nutrition, and renewable energy.
Established	2011	Mid-1990s
Legal form	GmbH and subsidiaries as limited companies	Limited by guarantees without shares, non-profit company
Size	Approx. 300 persons, mainly temporary German interns and Tanzanian sales agents on commission, in Germany 20 permanent employees for technology development, in Tanzania 100 permanent employees	Between 7 and 17 employees
A **solar home system** consists of a solar panel, a battery, and a controller. The company sells four system sizes (30, 80, 120 and 200 watts), which can be used to run a variety of end devices (lamps, radios, charging stations for cell phones and flashlights, and televisions). These devices are specially manufactured for operation with direct current and basic equipment is included in the purchase price. Charging stations for mobile devices and solar lamps are offered for business activities. Costs, depending on the size, between 300 and 1500 Euro.		
  Figure 2a: 30-Watt system with equipment, 2b: Business-Kits for charging mobile phones and renting out solar lanterns (sources: Phonergy)		

Table 2: Fact sheet case study solar home systems

[12] If after a certain period of time the user cannot continue to pay the installents during these three years, the company removes the system, regardless of the percentage of the total price already paid.

The location in which the pilot phase was carried out is an inner-city area of a major city close to the grid, which could have easily supplied electricity by the state utility TANESCO. People had been waiting for the grid connections for years; however, it had not arrived. The German start-up targeted it as an easy market. From there, the company expanded, primarily to small rural towns. None of the residents told me that they saw any advantage in state provision. From the users' perspective, there is no significant difference in supply, as both options would be similarly priced, similarly structured via prepaid meters, and similarly unreliable (albeit for different reasons). If inhabitants tried to get the grid connection, then it is because more electricity would be available, except for instances when there is a power outage. Only the combination of grid connection and SHS is considered sufficiently reliable. The activity of private companies, including foreign ones, is welcomed, especially because the experience with the government and public administration has been one of disinterest and neglect.

Fig 3: The end of the electricity grid in the Phonergy pilot phase area (Source: own material)

Fig. 4: Phonergy advertises with empty poles (Source: own material, the company logo is removed for anonymization purposes.)

Basically, we see a story of a start-up company from the renewable energy sector. However, the company is linked to the development dispositif in various ways and can be understood as a development industry actor (cf. Barthel 2019: 399ff). In this context, financial inclusion and the energy sector are two development policy fields in which the firm can be assigned to. The company's business model fits well into the development policy trends of the time:

> *„Household solar (and especially solar micro-credit schemes) are the big buzz in the world of international development these days. […] It has been interesting to watch the boom in small solar home systems (and solar lanterns) over the last ten years. Instead of conceptualizing electricity as a public good or state utility, the supporters of the big solar markets*

> *emphasize electricity as a consumer good. Of course development banks endorse this privatizing strategy.“* (Garwood in Degani et al. 2013: 197)

The company was able to access development aid funds (grants and loans) from a German development bank and EU funding, amounting to several million euros. They participated in public events, including events of the UN Decade SE4All, the World Bank and CGAP (Consulting Group to Assist the Poor), thus institutionally positioning itself as a development actor. The company founder justifies the profit orientation with the deficit narratives of the SE4All Decade and SDG 7:

> *"Yes, for me the most important aspect of Phonergy is that it is profit-oriented. You can only scale if you have enough money. And you can only get enough money if you can prove that you are profitable. [...] if you need something that is essential for half of the world's population, there is no funding for it. If what they needed cost just one euro, you would need three billion euros. I don't know how many billions Germany spends on development aid? And our plants don't cost one euro. They cost more."* (int. company founder, CEO Phonergy, 07/06/14)

It becomes clear that the attribution of a deficit to 'half the world's population' or the universal goal of energy access serves to legitimize a profit-oriented approach. A discursive appropriation and neoliberal twist of development semantics, and especially the critique of the development paradigm, is evident (cf. von Schnitzler 2008: 906). The term empowerment is a typical example. The way in which the term is used is linked to the ICT4D discourse, which has been pursued by the World Bank since the end of the 1990s and for which postcolonial theorist Gayatri Spivak already noted:

> *„It was all about selling access to telecommunication - as empowerment as such. There is this picture of a very tall and lovely African woman, in her cloth, with a spear in her right hand and a cellular telephone in her left. It is scary. Global telecommunications combined with actually women's 'micro credit' is spelling out the importance of finance capital.“* (Spivak 1997: 3)

3.1 Problem definition and project initiation

In critical development research, the genesis of a project, the question of who defines a problem and the solutions is an important aspect in determining whether self-determination of the actors in the Global South, or of the population affected by development projects, is realized (glokal 2016, McEwan 2009).

To be able to answer this question it is necessary to understand the context of the case studies. Tanzania's energy sector has been co-financed by international donors since colonial times and is thus shaped by (post)colonial North-South relations and changing development policy paradigms (cf. Barthel 2019: 193ff). In addition to state actors, churches and NGOs were particularly active in the field of energy supply in the 1970s and 1980s. Phonergy's company founder used to say that there were two preconditions for his business: the mobile phone revolution and the decline of solar cell prices. However, these are only two techno-economic components of the complex set of conditions from a socio-technical perspective. It is also essential to have a framework of basic regulations for foreign companies and investors who want to do business in Tanzania. To this end, the Rural Energy Agency (REA) was created in 2005 and, with the support of the World Bank, the Energy and Water Utilities Regulatory Authority (EWURA) was established in 2006. REA's mission is to coordinate rural energy supply projects and integrate the private sector (see URT 2005). In this context, the rural electricity sector has been separated from the core business of the state utility TANESCO. Rural electrification shall take place with the help of investments from communities or the private sector. According to Ghanadan, Tanzanians fear that non-commercial electrification of these areas could thereby be removed from TANESCO's sphere of influence (see Ghanadan 2009: 421).[13] Decentralization of energy supply is also seen as reducing power for the state, which is seen as one reason why there is little motivation to promote the sector (field notes 13/03/15). The two case studies, which deal with solar home systems and household biogas plants, are therefore projects in a sector that did not receive much attention from the state.

[13] As of 2013, however, 98% of the funds distributed through RA had been returned to TANESCO and used for network expansion (see URT 2014: 31).

Case study: small scale biogas

During presentations of the biogas project, it is always emphasized that the request for the biogas technology was made by the Kilimo farmers' association. However, how exactly did Kilimo come to request this specific technology? And to what extent can the project be understood as an articulation of the needs of 'the community'? A closer look at the perspectives of both partner organizations reveals several different stories.

The farmers' association Kilimo can be characterized as a family NGO (Yakimov 2011), as the core management - the manager and the three project coordinators – is comprised of the four sons of the NGO founder. They grew into this position through family and education. A chairman and co-founder of Kilimo reported that the issue was raised by the initiator of the organization and father of the current manager: a long time ago, he had built a biogas digester at his home. When he died, the issue was forgotten and then resurfaced when farmers became increasingly distressed as firewood for cooking became scarcer. They would then have asked Kilimo what to do in this regard. The NGO's coordinator of the agricultural projects told me that the idea of the project is connected to deforestation. However, he presents it primarily as a project for climate protection, which would contribute to reducing CO2 emissions. The coordinator of the biogas project reports that the project came into being because of increasing droughts in the region, which raised the question of what could be done with the existing biogas plants in the future, if farmers could no longer keep cattle. The manager of Kilimo explained to me that the request to TC was aimed at the further development of the already existing biogas plants for rural households. His specific request, he said, was for a plant that would function exclusively with residual materials from agriculture, so that 'the community', in particular the members of the association who do not have cows, could use the technology. The idea was to adapt the technology to the given conditions and available plant-based resources.

In June 2012, a first user workshop on biogas was held at Kilimo. The aim of the workshop was to introduce the biogas project, to provide general information about biogas and the new biogas plants for the members of Kilimo (workshop documentation TC e.V., June 2012). When asked, the farmers said that they did not know that there are already biogas plants in the region. Many of the participants' questions were about the difference between gas and electricity. After the presentation of the technology, the farmers considered the use of the residues as fertilizer as one of the most important aspects. An engineer from Sweden, who spent many months at Kilimo, stated that it is

certainly not a bottom-up approach that Kilimo is practicing. However, she said it may be that the manager and employees of Kilimo are most likely to look at the farmers, consider what might be good for them, and then 'translate' that into biogas, for example. Although, if the farmers had been asked, they would probably say they needed more firewood (field notes, 02/28/13). In this sense, the articulation of the needs of 'the community' could be described as a translation process in which the articulated problem of the farmers - the lack of firewood - was taken up by the representative organization and translated into a solution in the form of a certain technology already available in the region. Kilimo translated the farmers needs and adressed a request for a certain technology to a partner organization from Germany that specialized in technical assistance.

From the perspective of the TC association, the genesis of the project is primarily the story of a student who, as part of his diploma thesis, conducted a so-called feasibility study, which also functioned as a 'fact-finding trip' for TC. At a group meeting in July 2012, he traced the history of the project in a presentation: in the early 1980s, there had been a large biogas program by the Evangelical Lutheran Church of Tanzania (ELCT), a Danish organization, SNV (the Dutch governmental development cooperation organization), and CARMATEC (the Tanzanian governmental Centre for Agricultural Mechanization and Rural Technology), in which many household biogas digesters had been built. In 1989, the family of Kilimos's founder also got a biogas plant that ran for almost 15 years.

> *"[...] that is, all the brothers at Kilimo were already familiar with biogas, they cooked with biogas when they were children and they operated the plant, took care of it. At some point, it was no longer operating. It was losing gas, it couldn't be stored and nobody knew why. So that was Kilimo's basic problem, that they had a plant but realized there are just no skilled people who can take care of the plants, doing maintenance and get the plants back in operation."* (technical manager & member biogas project, presentation, 07/28/12)

Because the cooperation between Kilimo and TC went well – they implemented a rainwater tank project – Kilimos manager said in 2007 that they would like to set up a biogas program and asked TC for support. The request was initially rejected because TC was still too small and would not have been able to handle such a task. When the student was looking for a topic for his diploma thesis in the context of development cooperation, he was offered the topic of biogas by TC. His feasibility study looked at how large the households were, how much gas a family would need, and what potential substrates were available in the region. He then found that there are huge cattle herds

in the region owned by a few rich people, but that most Kilimo members have only one or two cows, which is not enough to run a biogas digester. In addition, he said, he saw great potential in the banana plants residues. Bananas are the staple food of the region and most of the families have enough. But therefore the biogas technology would have to be adapted. He concluded that the project would be a research and development project. It can be noted that in this version of the genesis, in response to Kilimo's request for a biogas program, the student concluded that those farmers who were part of Kilimo's target group did not have enough cows to benefit from such a biogas program. In addition, in his version, the lack of maintenance structures for the founder's family's own plant was decisive for the program request.

There is another version of the story of how the project came about: a federal board member of the German TC told me that the idea for the biogas project was his idea. As a volunteer at Kilimo, he had seen the plants and then told the student, who was looking for a topic for his final thesis, that there were broken biogas plants. When I asked again, he assured that there had never been an inquiry from Kilimo. The manager of Kilimo had only shown him the plants and said that they are stupid because they do not work and this was what he had in mind when the student asked for a thesis (int. federal board member TC, 05/24/16).

Did the request come from the South?

The different versions of the genesis story can be understood to reflect different prioritizations, perspectives, memories, and different background knowledge. The articulated lack of firewood, the discourse around climate change, the interest in fertilizer, the adaptation to a specific target group, or lack of maintenance structures, may have all played a part in the emergence of the request in their own way. Nonetheless, the variations seem contradictory with respect to who came up with the idea that it would have to be a biogas digester that operated *without cow manure*. Either this was already part of the inquiry into TC, or it was the result of the feasibility study that was carried out afterwards. From a postcolonial perspective, it is of no advantage to find out which story is 'true', which would most likely be a doomed endeavor. Rather, it is necessary to understand polyphony as a central characteristic of the postcolonial contact zone (cf. Pratt 1991, Anderson 2002).

The acceptance of polyphony then implies not so much the question of who is right, but to what extent the stories are influenced by power relations and structural requirements.[14]

The perspective of the engineering student was influenced by the search for a feasible project and by an idea about development cooperation, in which his expertise as an engineer could be crucial. The freshly trained German engineer quite naturally looks back into the history of technology and sees himself in a position and role to further develop this technology for the use by Tanzanian smallholder farmers. Almost as an aside, he can tell that the Kilimo management family wanted spare parts for their digester and that the inquiry arose from this. In contrast to Kilimo, there is not much at stake for the student. However, for the Southern partner, a version of the story that depicted that they needed spare parts for their own plant would seriously call into question their claim to represent the interests of 'their community' (see the following section on project origins). The managing family is economically much better off than the ordinary members of the organization. They do not own large herds of cattle but they have enough cows, so maybe out of their life experience they did not see the substrate shortage as a problem of ‘their’ community.[15]

Five points can be made about the genesis of the project. First, mutual influence is a characteristic of the project that both partner organizations ultimately agreed to implement. Through exchange, mutual borrowing of ideas, and the encounter of actors with their specific interests and self-understandings, something new was created and the origin of the idea cannot be traced back to either of the partner organizations in the North or the South. It can be understood as the result of a process of mutual borrowing located in the postcolonial contact zone (cf. Pratt 1991). It therefore represents a hybrid concept (cf. Eriksson Baaz 2005: 56f, Rosaldo 1995: xv, Anderson 2002: 615). Homi Bhabha understands colonial power in general a form of hybridization (cf. Bhabha 1994: 33). Similarly, according to Mudimbe, an *espace metissé* (Mudimbe 1997: 153) emerges. It is the result of an acculturation process that was neither complete absorption of the weaker, nor acceptance or adoption. Instead, a transculturation process produced a mixed cultural order (cf. ibid. 141ff). Regarding the postcolonial development partnerships, this makes sense insofar as they often have quite a long common history in the region. These partly intensive, long-term contacts that involve

[14] The first influence of course is my position as a white researcher, being losely connected to the German partner organisation. What is *who* telling *me*?

[15] What is also remarkable here is the strong socio-spatial disparity in the area. The family of the NGO founder used this technology and grew up with it, while the neighbors had never seen a gas flame. This points to the differences within 'the community'.

families and friendships and ongoing communication have the effect that the origins of certain ideas can hardly be exactly determined or 'localized'. Thus, the empirical impossibility of originality or purity comes into play. On the other hand, the power asymmetry to the disadvantage of the southern partner within the hybridization processes must also be considered.

> *"The operation of power and the dominance of the North within the development industry cannot be neglected. However, recognizing hegemonic structures and power inequalities also allows for recognition of hybridity in which Northern values are mediated, and sometimes challenged and remolded by actors in the south."* (McEwan 2009: 219)

Second, it was equally necessary for both partners that, according to the project narrative, the request came from the South in response to a problem that Kilimo had diagnosed. The narrative of the request from the South fulfills the central legitimizing function of the project. This can be seen as a result of criticism of development cooperation, which rejects paternalistic problem definitions from the North and projects that are not wanted by the target group. Third, defining the problem and the solution emerges as an additional task that is transferred to the southern partner. The task shift is explicitly communicated as such by the northern partners to the southern partner (field notes, 06/01/16), who would otherwise bear the risk of being perceived as passive. So Kilimo proposed a project appropriate to the 'target-group' to the German NGO, which is oriented towards the concept of adapted technologies. According to Ferguson (cf. 1990), the problem constitution of development aid institutions depends on the institutionally available solution. Problems formulated in the context of development discourse must be technical and local to be suitable for Western development assistance, which relates to the fourth point: Kilimo is good at articulating appropriate problems in a form that can be taken up by an organization like TC. Thus, by having considered the criteria of proper problem formulation in the development discourse (from the South, decentralized, local, technical, non-political, solvable by Western experts), the interests and perspectives of both organizations could come together. They agreed on the development of a new type of plant and started a joint research project.

Fifth, the fact that the search for the origins of the idea was difficult and that biogas technology could be framed as an inquiry from the South is also due to the history of this project already building on a longer history of the use of biogas technology in Tanzania. The historian David Arnold proposes a long-term perspective on the history of technology, as an element of a postcolonial history of technology, and as a way of provincializing Europe. He sees provincializing Europe as

a way to overcome diffusionist and Eurocentric biases of the history of technology. From this perspective, it should be noted that small scale biogas technology never played a major role in Europe due to unfavorable climatic conditions (the temperatures get too low for the bacterial strains). The socio-technical form of the small scale digester or household biogas plant can therefore be seen as an example of a technology that was "bypassing Europe" (Arnold 2005: 99, cf. Barthel 2015). Nevertheless, it was primarily European development institutions that took on the task of 'transferring' this technology to Tanzania in the 1970s (cf. Mshandete & Parawira 2009: 117). Coming from China and India, small scale biogas plants were identified as appropriate or intermediate technology in the 1970s and thus interpreted as a technology for ‘development’. It was clear that "industrialized countries neither had sufficient experience nor appropriate technologies to build on in developing countries. Rather, this experience was identified in India and China" (ISAT/ GTZ 1999a: 8). GTZ stated, that it was "transmitted by a South-North-South transfer" (ibid) which reveals the subject position of European and Western actors as the active and responsible subjects who seek technical solutions for ‘development’ and bring them to Africa. Even today, almost naturally, the group of German engineering students see themselves in the position of developing technologies for Tanzanians. German engineering students seeing themselves as technology developers for Tanzania is also an aspect where the similarity to the second case study becomes visible.

Case study: solar home systems

The idea was born on a trip around the world. One of the two company founders was in the final stages of his studies in renewable energies when, as part of a campaign for electric mobility, he drove a solar-powered electric vehicle around the world for a year and a half. On the trip, he said, he met many people, built a network and was able to accumulate the knowledge and resources that enabled him to subsequently build a business from it. "I built up during that time what enabled the emergence of Phonergy in the first place" (int. CEO Phonergy, 07/06/14). He met an elderly Swiss businessman who buys broken solar cells and processes them so that they can be resold as refurbished solar cells. He was the one who had the idea for Phonergy (int. new products manager Phonergy, 02/13/14).

> *"Phonergy was founded because an acquaintance at the time put the idea in my head that the combination of solar energy and mobile phone technology [...] solves a bottleneck, this bottleneck of pre-financing. The core topic is that the BoP needs microcredits or a source*

> *of money [...]. I found that very exciting, a product that is a solution for three billion people, a very highly scalable product."* (int. CEO Phonergy, 07/06/14)

The solution is that remote control via the mobile connection makes it possible to shut down the solar home system if the installments are not paid. The socio-technical core is, so to speak, a sanctioning instrument that is intended to increase payment discipline. A key success factor was the Tanzanian partner organization Shirika, especially its managing director, who sees himself as a mediator between the 'global' or 'European level' and the 'local' and is convinced of a commercial approach. They got to know each other at a Lighting Africa conference in 2010 (int. managing director East Africa Phonergy, 07/23/14). Shirika as a suitable partner was crucial for the decision in which country Phonergy started (int. CEO Phonergy, 07/06/14). The small core team of the German startup met with the managing director of Shirika in Dar es Salaam to demonstrate the technology to him and explore opportunities for collaboration. The managing director of Shirika remembers the first meetings:

> *"[…] and then we met again to discuss the idea of promoting prepaid solar systems and if I am interested to join hands in developing this concept. So for me under the concept of Shirika, which is a technology transfer company, mainly appropriate technologies that could reach the population in the rural areas, […] I was convinced and I knew before that the hindrance of solar technology accessing the rural areas was end user financing, which was not proper structured in many projects. In many cases many people were just given free services, donations through the government, through the donor communities. I thought this is not sustainable. Someone should buy his own energy, find a way of how it can generate income to cover the cost of the system. So I found the prepaid philosophy is the best to try."* (int. managing director Shirika, 07/24/14)

He helped develop the business model and was able to build trust in Tanzanian communities. Another stroke of luck would be one of the first investors. He was one of the co-founders of Q-Cells, a highly successful German solar cell manufacturer in the 2000s. He is not an active entrepreneur, but "is giving money to the next generation of companies that are helping to drive this solar revolution" (int. head of business development Phonergy, 2/27/14).

It can thus be stated that the business idea of the German engineer and the Swiss entrepreneur – the decentralized energy supply at household level, combined with a sanction mechanism to secure

the payment of installments – was formed based on a circulating ‘development’ knowledge about the so-called BoP and its deficits, as well as microfinance as a solution (see also chaper on financing). Primarily, technology and business ideas were available, whereas country and context were secondary. They would depend on a suitable local partner who could organize access to the target group.

Interim conclusion

In summary, the case studies allow differentiation between a community-based and a technology-oriented approach. Phonergy's approach to energy supply is technologically based. The starting point was not the circumstances of a particular community. It was not to see if there are other technological options or more community-oriented approaches that might be a better solution for the population at large. Such a perspective is also reflected in the fact that the company itself does not collect data about what percentage of residents in a locality are reached. Instead, they count the number of systems sold individually. In a side sentence, the database developer puts this in a nutshell: "We just sell to individuals, our problem is not community [...]" (int. database developer Phonergy, 03/03/14). In the biogas case, even if the question of the actual project idea and the translation of needs formulated by the members of Kilimo is not easy to answer, the approach can be classified as quite community based. The technology choices in the case studies may also be understood against this background. The hype around solar systems in the context of development cooperation is also connected to the fact that, from a technical point of view, it is an easy technology to implement and scale up, and that there were expectations to make a quick profit out of it. However, in Tanzania, thermal energy for cooking and heating overwhelmingly accounts for the largest share of total energy consumption and is therefore much more relevant for the population from an everyday perspective. Thus, in one case, the initial problem is the lack of firewood or energy for cooking, and in the solar home system case it is the "financing bottleneck".

3.2 Partnership – egalitarian or paternalistic?

Partnership structures in development cooperation are a central topic in development research. Often, equality and common goals between Northern and Southern partners would be emphasized in

practice (cf. Eriksson Baaz 2005: 8). Long & Long (1992), on the other hand, emphasize that development partnerships should not be analyzed as a harmonious relationship. They characterize them as a "battlefield of knowledge" where the actors involved can also have different interests and goals. However, because of postcolonial power relations, possible conflicting interests cannot be articulated equally by both sides. Caution of the southern partners then is often interpreted as passivity and unreliability. Economic resources are at stake because many partnerships get terminated with the argument that the goals no longer coincide, that the southern partner has not understood them, or that the project is heading in a direction that was not intended (cf. Eriksson Baaz 2005: 22).

> *„The image of the unreliable Other obfuscates the ways in which the power inequalities inherent in the aid relationship determine that partners cannot articulate goals without putting the partnership at risk. Contrary to the message that urges partners to articulate their goals as if there were no stakes involved, there are indeed risks involved in articulating goals that differ from those of the donor. In this sense, complete openness is impossible if one is to become and remain a ‚partner'.“* (Eriksson Baaz 2005: 172)

Therefore, the downplaying of one's own interests is not to be understood as false intention. Following Eriksson Baaz, partnerships are located in an unequally shared discursive space and are to be understood as a conflictual contact zone characterized by asymmetrical power relations (Pratt 1991). Thus, I focused the examination of the partnership on the question of whether and to what extent the rhetoric of equal partnership found in the case studies obscures unequal power relations, and to what extent the partnership can be assessed as paternalistic.

While the partnership of the biogas case study can be analyzed stringently against this theoretical background, the assessment of the partnership between the profit-oriented German startup Phonergy and the Tanzanian social business Shirika is more difficult because it is a business partnership. Particularities of this form of partnership and other requirements that result from its commercial nature are not covered by the development research literature. It is more the field of strategic management, which is concerned with the poor as a market, that looks at such collaborations and highlights them as an important success factor. Here, it is assumed that the poor, referred to as the 'bottom of the pyramid' (Prahalad 2005), are unserved customers who represent a huge untapped market because they are excluded from mass consumption (critical: Pansera 2014: 43ff). If the private sector understood the poor as a target group, it could make profit and do good at the same

time (a recurring narrative since US President Truman). Multinational corporations are seen as the most suitable actors (cf. Prahalad 2005, Boston Consulting Group 2007, London & Hart 2011). London & Hart (2004) and London & Anupindi (2011) found out that much of the success results from alliances with and local actors and institutions: “They found for example that local institutions and social networks influence purchasing decisions at the BOP in rural India and as a consequence they suggest drawing on those webs of relationships to promote BOP products' (Pansera 2014: 45). According to Sesan et al. (2013), the spread of improved herds in Nigeria worked primarily through strong collaboration between for-profit companies and local NGOs.

Kilimo & TC

Both organizations, TC and Kilimo, are explicitly civil society oriented and thus stand in the tradition of decentralized development aid. Both refer to similar principles (sustainable development, local materials, adapted technologies, concept of ownership) and share similar ideas regarding their respective roles in the development sector. On a discursive level, they reproduce the asymmetrical relationship between donor and recipient, as experts, transmitters of technological solutions and knowledge from the North to the 'beneficiaries' in the South.

Empirically, I found processes and narratives that reflect the asymmetrical power relations as well as those indicating an equal footing. The negotiations were arduous and conflictual. Attempts to structure the fields of action (cf. Ziai 2007: 31) by TC did not have a completely determinative effect and show Kilimo's scope for asserting its own interests.[16] For example, Kilimo managed to run the biogas project over several years without making any major contributions of its own, although this is actually a central principle of TC for the implementation of projects. The reason given by Kilimo was the lack of results from the research project. They characterized their community as disinterested and with limited understanding of technology and research, which is why they could not be convinced to contribute to the project. They addressed the engineers from the North as solution providers and attributed to them the responsibility for everything concerning research and technology. So, in a sense, they used their inferior subject position in the development discourse to strengthen their own bargaining position.

[16] Although TC hold and controlled the contact to the (German) donors. Direct contact between the funding foundation and Kilimo was prohibited.

As a second example, the construction of the large 'institutional' biogas plant can be considered. To show the members of the farmers' association a result of the years of research, while avoiding the risk of building dysfunctional digesters in private households, Kilimo decided to build an 'institutional' plant for their school, another project they had started in the meantime, and to design it to run on cow dung and vegetable substrates. Although TC conducted a feasibility study on this request and concluded that this plant would not be feasible for Kilimo's school and that this was a different project, indeed a different technology, Kilimo was nevertheless able to achieve that TC supported and financed the construction of this very plant in 2015 (cf. Barthel 2019: 335ff).

I identified various reasons why it is possible to speak of a certain equality of cooperation here, more so than in other partnerships. First, TC e.V. has a high profiling interest and needed successful projects. Second, Kilimo has many other donors and they have their own budget through membership fees. I characterized the Kilimo management according to Bierschenk et al. (2001) as development brokers who take the role of being the link to ‘the community’ and being the 'mouthpiece' for the local, while also being acknowledged as "speaking for" the community by TC. This connection to the community represents Kilimo's central asset. This met with the norm internalization of 'better development aid' by TC. They tried to recognize the priority setting and problem definition of the southern partner. Moreover, due to the long unsuccessful research phase, TC was unable to fulfill its self-image as a competent solution provider from the North, and Kilimo succeeded in reversing common attributes and portrayed the Northern partner as the unreliable and unorganized partner. Kilimo’s staff are very successful development brokers who mobilize external resources from development assistance into their socio-geographical arena (cf. Bierschenk et al. 2001: 213).

Shirika & Phonergy

If one includes all the business partnerships necessary to build the company (such as with a mobile provider), Phonergy is built on a reasonable number of partnerships. However, the partnership with Shirika is central to the pilot phase of the technology development and implementation. Both sides described the partnership as a good, ambitious, and friendly collaboration. Shirika describes it as equal. The shared principle or ideas that formed the basis for the cooperation was the profit-oriented approach; the ‘prepaid philosophy’ and the promotion of income generation through the PV system. The areas of responsibility were clearly divided. Phonergy, as the “supplier of the technology” (int. new products manager Phonergy, 02/13/14), was responsible for the technology development

of hardware and software and the product design, whereas Shirika was responsible for the introduction of the technology in Tanzania, for marketing, awareness creation, customer education and the after sales service (ibid.).[17]

There was a change in the relationship over time that was striking. At the beginning of the cooperation, during the implementation of the pilot phase, the expertise of the southern partner in the form of knowledge and trust of the local structures was an irreplaceable factor for success for Phonergy. The qualities of the Tanzanian partner were even a decisive reason for the selection of the country. In addition to organizing the first field tests and the acquisition of the first customers, another important support was the contact with local authorities and to achieve acceptance for the market entry. Shirika was as a kind of protective shell for Phonergy (int. workshop manager Phonergy, 06/18/14). The importance of the Tanzanian partner could thus hardly be greater for gaining a foothold in Tanzania.

However, at the time of data collection, a replacement process was taking place. The German CEO explains that the partnership worked very well during the year-and-a-half pilot phase. However, they then drifted apart as Phonergy grew faster, "more unconventionally" and "more untraditionally" (int. CEO Phonergy, 07/06/14) than Shirika was able to keep up with. After the commercial launch, the partnership relatively quickly became irrelevant from the German company's point of view. The manager of Shirika has been given a position on the advisory board of Phonergy's Tanzanian subsidiary. Shirika operates one of the sales outlets for the solar systems. They are responsible for the quality control of these market hubs and continue to be Phonergy's "lobbyist". The (German) managing director of the Tanzanian subsidiary characterizes the relationship as one of dependency that they maintain out of goodwill:

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[17] Shirika offers market research for the goal of using market-based approaches to strengthen local economic cycles and ensure that more money flows into rural areas. In this respect, Shirika fits perfectly into the role envisaged for such organizations in the strategies of the BoP strategic management as cited above. The role of NGOs or non-profit consultancies has been highlighted in this regard. However, based on my research, it is necessary to also consider the role of community leaders or public community representatives. On the one hand, residents see them as persons of trust who can assess projects and companies coming from outside. They are asked to read and explain contracts. They are also addressed as authorities that offer protection against over-indebtedness and act as mediators in case of conflict. On the other hand, Phonergy engages the same group of people to act in the interests of the company. They are asked to organize solvent customers and to ensure that the company can remove the solar systems if residents have difficulties to pay the loan. They thus secure the private property regime. The community representatives, as well as sales agents, technicians and local NGOs, actively offered to help the company establish links with the communities. They are therefore important links in the chain through which foreign companies can enter the market. Trust is the key asset and financial incentives also play a role. However, this role overlap was not mentioned or problematized by the interviewed residents or community representatives.

> *"We are a substantial funder for Shirika, that they still exist. So, for us, if we were really profit-driven, we would say we don't need them. We can also hire two people internally to do monitoring and pay somebody in the local government to be our facilitator. But that way Shirika have this task and they take it seriously, and it's good for us to know that they are dependent on us. So we can also make demands, which would not necessarily be the case with other partners. It's more convenient for us, but it's not a crucial partnership that influences how successful Phonergy is in Tanzania now."* (managing director East Africa, Phonergy 07/23/14)

Shirika already looks back on a number of cases in which it had the role of enabling market access for foreign companies and then the organization was dropped. They showed them how things work there, then they were gone, the manager explains. "They are no longer with you. They no longer come and disappear" (int. managing director Shirika, 07/24/14). Despite many bad experiences, however, he emphasizes: "I am not blaming them, it's business philosophy. If you are able to maximize, of course you take the advantage" (ibid.). The partnership with Phonergy is maintained in a weakened form, but from the German company's point of view, it is now merely a courtesy. Shirika is no longer involved in decisions concerning Phonergy.

Although, the Shirika manager had ideas about how Phonergy could benefit the local economy. In his mind, Phonergy would have cooperated with independent small Tanzanian companies or franchises that would become distribution partners. Starting up these local companies is one approach he is trying to implement:

> *"So the idea is to train them, the locals, to become business people, entrepreneurs. Once they are trained, they can create companies. Then they can see their future. That was my idea for a sustainable future and the growth of Phonergy. But not from Franke's perspective, it is from my own thinking perspective. That we can really see the synergy, that was my idea. […] My idea was not to reproduce the Phonergy size or grow the local ones to the level of Phonergy. My idea is to have a lower level size of the company to support the bigger companies that are coming from abroad, looking for partners but cannot find a real partner."* (ibid., 07/24/14)

However, he explains, it is not possible to find support for this idea to help small and medium-sized local businesses in the current development funding structures.

> *„I was trying to replicate the Shirika idea to other companies, but we didn't receive any donor funding for this matter. […] It's only from impact investors, multilateral donors, foundations, that is where the money is to support renewable energies. And this size is not at a level where these companies are. For them it is too small, but how do you want to have capacity to have it big, before you are empowered? […] It seems there is no chance for small companies to be given a chance to try and grow. They want big or not, the impact investors."* (ibid., 07/24/14)

Impact investors seem not to be interested to support a local economic structure.[18] Until the end of the data collection, Phonergy also did not take into account Shirika's ideas about starting up Tanzanian small and medium sized businesses that would support the German company, and at the same time enable Tanzanian entrepreneurs to enter the business field.

Seen through the analytical perspective of postcolonial development research, it can be said that the business partnership between Phonergy and Shirika has a similar rhetoric of equal partnership, but that the interests of the southern partner are not given equal weight. However, the impetus for cooperation appears much less paternalistic. In summary, therefore, the partnership can be characterized as *neither* equal *nor* paternalistic.

3.3 Technology development and use: Potentials and limits of appropriation

One part of the research question was how to assess the technologies in terms of changing dependencies and possibilities for appropriation. Common sociological models of technology can only contribute a limited amount to answering this question, as they focus on possibilities of control by state actors and set ideal-typical capitalist market economies as a framework. Therefore, I also use concepts of emancipatory or self-determined technology development and use, as they develop criteria and concepts from a capitalism-critical perspective against the background of anarchist conceptions of society (cf. Stiftung Freiräume 2011, AK ANNA 2011, Boeing 2011 and 2012, Barthel 2019: 101ff). These concepts emphasize the necessity of opening up the capitalistically structured technosphere, in the sense of an open design, as transparency of technical structures, and

[18] On the neglect of SMEs (albeit in favor of microfinance), see also Bateman (2010: 97).

as the freedom to make decisions about the use of technology (cf. Boeing 2011: 52). The physicist and journalist Niels Boeing elaborates on emancipatory technology use in the most differentiated way (cf. Boeing 2011, 2012). He refers to the classification of different forms of technical knowledge, which arose from the technology philosopher Günther Ropohl (see Ropohl 1979: 209ff): Functional rule knowledge or technical function (the capacity to operate technologies or devices without causal knowledge of functional principles), structural rule knowledge (the capacity to recognize and change compositions, open devices and repair them, based on experience or learned via instructions), technological law knowledge (construction knowledge, theoretically systematized and natural science laws) and sociotechnical system knowledge (knowledge about the social contexts within in which technology is embedded). According to Boeing, the only path to self-determined technology is via the appropriation and sharing of knowledge about technology, and in particular of structural rule knowledge, technological law knowledge, and sociotechnical system knowledge (cf. Boeing 2012: 193, see Fig. 6). These technical knowledge classifications are useful for characterizing the case studies. The classifications can be assigned to technology-related practices in a broader sense: use – maintenance/installation - production - construction/design/invention - and the political dimensions of technology control. Such areas need to be evaluated separately, especially when examining decentralization or 'local' control in relation to technologies.

Classification of technical knowledge (Ropohl)	**Technology practices**	**Biogas project TC/ Kilimo**	**Solar home systems Phonergy/ Shirika**
Technical function knowledge	Usage	‚Target group' should learn to use it	‚Target group' should learn to use it
Structural rule knowledge	Maintenance and construction based on instructions	Knowledge Transfer and capacity building intended (described as mutual learning process)	Minimal training of technicians (Ikea-like assembly), better training for repair technicians
	Production	Production in Tanzania	Production in China and Germany
Technological law knowledge	Construction, design, invention	Core capacity of the Northern partner, main area of knowledge production, knowledge transfer considered to not be possible, not intended	Knowledge transfer not intended: For efficiency reasons and to create jobs in Germany.
Sociotechnical system knowledge	Political/social context of technology, control of technologies, techno-politics	no explicit subject of the project	No explicit subject of the project, Phonergy profits strongly from the Tanzanian partner concerning knowledge about social and political preconditions

Fig. 6: Forms of technical knowledge and knowledge transfer in the case studies. The shaded grey in the first two columns mark the types of technical knowledge that are necessary for technological self-determination according to Boeing 2012. The grey in the third and fourth column mark the actually transferred knowledge in the projects.

Technology development/ technological law knowledge: Regarding the transfer or appropriation of technological construction knowledge, the similarity of both case studies can be noted. The technology development of SHS was seen as the task of Phonergy and in future, the R&D department shall remain in Germany. Similarly, in the biogas case study, the actual process of technology development is understood to be the contribution of the German project group. It was described by the participants as an intensive learning process for 'the Germans', during which the design knowledge was produced and acquired by the German engineers and was seen as difficult to transfer. In this sense, regarding technical knowledge, dependencies on the northern partner are created or reproduced in both cases, and design knowledge remains in Germany. However, what is different is the openness of the design. Strict non-disclosure agreements apply at Phonergy, which are intended to protect the knowledge against competing companies and thus offer little room for appropriation. The technical design of the biogas plant, on the other hand, is open source.

Construction & production/ structural rule knowledge: In the case of solar home systems, a distinction must be made between two areas regarding the necessity for technical knowledge. The practice of installation and maintenance lies between technical functional knowledge and structural regulatory knowledge. The original plan was to make the system as simple and modular as possible so that users could build it themselves. The customers in the test phase succeeded in doing so. However, they did not want to install it themselves. They were worried about destroying the expensive equipment during assembly (int. new products manager Phonergy, 02/13/14). Therefore, the company proposed to train installation technicians in two-day seminars, who set up the "IKEA-style systems" for the customers. The installation technicians make up most the company's technical staff. No in-depth training is required for them. The company's repair shop, on the other hand, where broken SHS are reconditioned, is a different matter. Here, personnel with vocational training are employed and structural rule knowledge is taught. The workshop is the area where the most technological knowledge is imparted.

In the biogas case study, the training of draftsmen for construction and maintenance of biogas plants was considered the key capacity building component of the project. The key difference between the two projects is the possibility of a local production. Following the guiding principle of adapted technologies, it was central for the biogas group to develop a technology that would be possible to produce in Tanzania with locally available materials so that the eventual value creation

can take place in Tanzania. The production of the SHS, on the other hand, takes place in China and Germany and there is no motivation to change this.

Utilization: In both case studies, only technical function knowledge is given to the users. However, in the case of the SHS, a notable effort is made to prevent the further appropriation of structural rule knowledge. The system is therefore protected from appropriation by users, who are told not to touch the system at all. Opening the system is sanctioned by contractual penalties and loss of warranty. Opening of the system is also made visible by seals, double-sided adhesive strips, and by combining the controller and battery in one housing. The reason is connected to the payment mechanism: without this precaution, customers could get electricity without paying, as they could bypass the controller and take electricity directly from the battery terminals (field notes, 06/27/14). Once the system is open, the device could not be turned on and off remotely.

The contractual sanctions are removed when the system is purchased in cash, or when the loan is paid off after three to four years. From that moment on, the system is the property of the users, who are then free to use the system as they wish. However, the properties of the artifact that have been inscribed and materialized during the design process and the production continue to exist. This does not completely exclude further appropriation, but structurally hinders it significantly. The possibilities of appropriation of the technical knowledge, by the users and at the community level, are thus limited. However, the users did not bring up these issues. From their perspective, the necessity to commit to a loan agreement was far more relevant and problematic.

Socio-technical system knowledge is not a central subject of the project in any of the case studies. At the same time, it is an essential prerequisite for the successful development of the business model, especially for Phonergy. It was the southern partner, Shirika, who significantly contributed the necessary knowledge about the target group, and the economic and political context.

Phonergy was founded with the aim of supplying electricity in East Africa. It had not been founded to dedicate itself to knowledge transfer, which is why there was no focus on it (conversation with the new products manager Phonergy, 06/17/17). However, according to the staff, a shift can be observed; in the beginning, during the phase of technology development, quite a lot of knowledge transfer took place. However, this was made increasingly difficult by time pressure and growth. In addition, the profit orientation is seen as the main reason why no deeper knowledge transfer took place. In the biogas project, on the other hand, capacity building is emphasized as a central project component. Given the different approaches of the projects, their similarities should be emphasized.

With regard to technology development in both cases, socio-geographic inequalities in the distribution of technical knowledge were reproduced in a similar form. There was no attempt to involve Tanzanian engineers or corresponding institutions in the technology development process. In this sense, both projects generated or reproduced dependencies on the Global North.

Both case studies thus reproduce previous patterns of dealings with technologies in the context of North-South relations. With regard to biogas, it was noted previously that actors from the Global North tended to be involved in the further development (R&D) of the technology, while the areas of dissemination and application were to be found in the Global South (cf. Mital 1997: 50). The promotion of basic research in African countries tended to be neglected (Mshandete & Parawira 2009: 118). Regarding solar PV, Tanzania was purely a sales market during the period of data collection (cf. Ondraczek 2013: 411). The PV systems and subcomponents are almost completely imported from other countries (Kenya, South Africa, China), as there are no domestic production capacities.

These material patterns reflect the colonial and development discursive categories innovative/passive or creative/application-oriented. It also (re)produces on a practical level the actors from the North as being those who are capable of the creative, innovative process step of technology development or 'adaptation'. The fact that the German students take the constellation of the biogas project for granted, in which German engineering students supply the 'local population' of Tanzania with a technology suitable for them despite it being a technology that they must first acquire the respective knowledge themselves, builds on subject positions and available roles in the development discourse that have been consolidated for decades. The self-conception also relates to assumptions and presuppositions about the character of the technology there. In the descriptions, the technology in Tanzania was assumed to be a simple, less complex technology or low-tech, so that one can 'just go down and build'. In the conception of the project and as the orientation guiding the design process, the construction of low-tech plants was again the goal., which could be interpreted as Tanzania being reproduced as a place of lowtech.[19] However, from a technology-critical perspective, the ambivalence of the low-tech concept must be emphasized. On the one hand, from the perspective

[19] However, this tendency does not remain unbroken or unquestioned in the biogas project. Based on their experiences in the project, some participants considered the NGOs being the actors as the core problem and conclude that a cooperation with Tanzanian universities or research institutions would have made more sense.

of colonial discourse patterns, the distinction between high-tech and low-tech must be problematized as a binary-hierarchical dichotomy. On the other hand, the ‘low tech’ requirements represent important criteria for self-determined technology development and use.[20]

The postcolonial perspective enables a deeper understanding of how technological law knowledge (technology development and design knowledge) is located in the North and use and application knowledge in the South. This unequal distribution of technical knowledge mirrors the intersection of two types power relations: that between designers and users in technology development processes and postcolonial power relations. An example can illustrate this: The German development team and the Phonergy management were discussing a new product, solar-powered water pumps. They were considering whether to offer these for sale.

> *"The thesis was: There are small pumps that can be solar-powered, and the insinuation is that because the kilowatt hour ultimately costs nothing, regardless of whether the pump runs all day or not, that Africans are so stupid that they run the thing all day or think 'cool' and after three days the groundwater is gone. [...] we try to see if our worries of providing something fundamentally unsustainable are justified, if they can be proven."* (int. head of business development Phonergy, 02/27/14)

The solution for the company in the first step is a (scientific) investigation of the issue. As a second option, they discuss the remote switching-off of the pump:

> *"We can turn the system off, after all. Then you could say we're turning it off, but then we're restricting the user's rights, which we don't really want. After all, we want to give them more options, not restrict them."* (int. new products manager Phonergy, 02/13/14)

The decision-makers - as ecologically responsible subjects - are now faced with the dilemma of deciding whether the target group in question would deal responsibly with such a valuable resource as water if they had the possibility of unlimited access. The technology-related asymmetrical power relation works through the fact that the designers can widen or limit the users' scope of decision-making and action. In this way, the company structures the possibilities for action. As designers, they see themselves in a position to control the users' access to water via remote-controlled shutoffs.

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[20] The Biogas Group was also part of a working group that developed its own positive and political definition of the term and pursues low-tech projects also in Germany. Cf. www.bauraum-lowtech.org/definition (accessed 03/05/2019).

The postcolonial power relations are shown by the fact that the decision-makers of the German company see themselves as responsible for ensuring that 'the Africans' use their resources carefully. By shutting down remotely, they would be controlling the resources of the African population in a quasi-trusteeship. They take over responsibility by ordering the investigation of the problem. In doing so, they construct themselves as responsible subjects, while the African population's sense of responsibility must be tested first.[21]

3.4 Financing: Sustainable energy for all?

Roughly speaking, the two technological products in the case studies are in a similar price range. Around 1000 Euros must be paid for the larger SHS, which is also the price of the systems in the biogas case study. The question of financing is therefore raised; target group and end user finance. Which group of people should ultimately use the plants, and which part of the costs should or could the target group bear? In both cases, this question cannot be considered separately from the question of funding through development funds and subsidies. Phonergy aimed at a market and profit-oriented approach from the beginning, where the 'customers' pay the price, including profit margins and calculated risks. Whereas the financing of the biogas digesters was unclear for a long time.

Financing domestic biogas plants

In an overview article, Bond & Templeton (2011) draw a rather mixed picture on the dissemination and function of biogas technology. The repeatedly emphasized high potential (measured by the available substrate) contrasts with the poor quality and low spread of the plants. They mention many reasons for this; however, government involvement proved to be a key success factor:

> *„Worldwide, effective and widespread implementation of domestic biogas technology has occurred in countries where governments have been involved in the subsidy, planning, design, construction, operation and maintenance of biogas plants.“* (Bond & Templeton 2011: 351)

[21] Ultimately, they decided against selling water pumps. However, this was not because of the points mentioned, but because of the lack of standardizability of the product. The pump would have to overcome different lengths and elevations at each location and would therefore have to be adapted too much to the individual location. These case-by-case solutions did not fit into the company's standardization and scaling plans (managing director East Africa, Phonergy, field notes 04/25/14).

At this point, it is necessary to connect development policy with a sociotechnical system perspective. During the 1970s and 1980s, different ‘development’ impacts were associated with biogas technology. However, when considered in relation to poverty reduction, the high upfront costs of construction often made the technology a questionable candidate. It was therefore difficult for the technology to reach the 'target group'. This means there was a politically intended target group that did not equate to households with the ability to pay. In India, for example, calculations were based on the total supply of the population (ISAT/ GTZ 1999c: 20).[22] From this perspective, technology diffusion and government subsidy programs make sense. Therefore, many millions of small scale digesters have been implemented in China and India with the help of large government subsidy programs (between 30% and 100%, see Tomar 1995, Bond & Templeton 2011: 348). GTZ's dissemination programs in African countries in the 1980s and early 1990s were not accompanied by similar subsidy programs. They were instead based on self-financing, which led to problems that became evident in Tanzania in the late 1980s. The poor households - the politically defined target group - were not willing to take on the high financial risks and costs and did not purchase the digesters (ISAT/ GTZ 1999b: 45f).

> *„With an economic approach, socio-ecological objectives [reduction of poverty, health promotion, gender equity, and ecological impacts] were more difficult to achieve.“* (GTZ 2007: 25, taken from the Special Energy Programme final report of GTZ 1995)

According to GTZ's analysis, when it comes to biogas technology, development policy goals and private-sector dissemination mechanisms tend to be mutually exclusive. GTZ's conclusion in the 1990s was to redefine the target group. "The target group of recent rural biogas programs has shifted upwards. Biogas technology is no longer regarded as a means to alleviate poverty" (ISAT/ GTZ 1999b: 45f). Since subsidies were not politically opportune, GTZ recommends countries with

[22] “The high overall costs in dissemination can be justified if they are compared with the costs of alternative energies. In its annual report for 1990-91, Gram Vikas compares the performance and the costs of the 39,000 biogas plants built between 1982 and 1991 with the investments necessary to generate the same amount of thermal energy. The calculation is as follows: assuming that 80% of the plants are operated with 60% of the performance theoretically possible, daily gas production amounts to 47,586 m3. This corresponds to the thermal generation of 4,079.9 million kilowatt hour (kWh). With the same service life of the plants, assumed to be 25 years, and a price of Rs 1.50 for the generation and distribution of one kWh of electric energy, the investment costs for the generation of electricity amount to 31 times as much (6,119.9 million Rs) as the investment costs essential for biogas plants (195.3 million Rs). If the thermal energy required for power generation is used, biogas plants would only be 3.8 times cheaper” (ISAT/ GTZ 1999c: 20).

a clear focus on poverty reduction to not work with this technology (cf. ISAT/ GTZ 1999b: 6), mentioning risks of socio-economic division in a renewed feasibility study of 2007:

> *„HHs [Households] collecting firewood, the far majority of Tanzanian HHs, only sees little financial benefits and may require large subsidies. Consequently, this technology will only be affordable for rich HHs and may increase the gap within society.“* (GTZ 2007: 46)

This example illustrates the difference between the observation unit 'technical artifact' and the socio-technical system or network. On the artifact level, it is simply a micro biogas plant that is operated with cow dung. At the socio-technical system level, one can identify a technology for the better-off that potentially reinforces inequality, and another where the technology can be used by poorer segments of the population through subsidies, thereby generating different social effects.

Nevertheless the biogas project of TC explicitly chose poor households (with an annual income of about 250 Euros) as a target group but wanted to reach them through technical developments: The plant was to be operated with plant residues only, and secondly, a modified plant design should reduce the costs.

The R&D was financed by the foundation of a large German company from the agricultural and construction sector. In addition, the biogas project group acquired the laboratory equipment as donations in-kind. The foundation did not originally intend to fund research over such a long period of time but wanted to support the construction of 15 plants. However, the contact was good, and the donors were very sympathetic to the project goals, so the research phase was supported. In addition, a large part of the work involved was based on voluntary commitment. The question of financing the digesters in the event of further project implementation was often raised at project meetings; however, it was not really discussed. On the one hand, this was due to the goal of making the digesters more affordable for the target group through changes in the design. Secondly, Kilimo also fended off discussion of this issue for a long time. They always emphasized that *first* the plant had to be ready and working, and *then* it could be considered how it should be financed.

The fact that the question of financing was discussed separately from the functionality of the technology is unusual from the perspective of the sociology of technology. Normally, the financing component is a central part of sociotechnical system building. In the private sector, the development of a technology is usually considered solely in the context of how it can be commercialized. From the outset, the technology is imagined in the context of a concrete 'business model' and is

thus shaped in capitalist terms. Here, however, the separation of technology development and financing seems possible in the context of development cooperation. This allows Kilimo to first demand a finished technology from the northern partner (with the technical competence).

Due to the manufacturing costs of the new type of plant remaining high, the question arose of how to deal with this. During the period under study, various options were considered, which I detail now, numbered 1-5. 1) According to Kilimo's wish, the costs for the industrially produced materials would be paid by donors, and the beneficiaries' own share would consist of the provision of materials that could be obtained free of charge. This would be in line with a subsidized model that was similarly applied to the construction of water tanks earlier. The water tank project was the first cooperation project between TC and Kilimo. 158 water tanks were built to collect rainwater. These water tanks hold approximately 20,000 liters and each four families share one tank. The material costs of the industrially produced materials (concrete and steel) were borne by the German Federal Ministry for Economic Cooperation and Development. One tank cost about 2200 Euro and the families' own contribution consisted of digging the hole for the tank and providing food for the craftsmen. The board and the federal executive director of TC said that this was also their initial idea for the biogas project and emphasized the low capacity of the target group for financial contributions (int. federal board member TC, 05/24/16, int. federal executive director TC, 01/07/14).

However, parts of the project group explicitly reject this model. "From the beginning we had the idea of not having a donated project, but that people can afford it and buy it, because they can afford it. And that this is not development aid but development cooperation." (member biogas group of TC, field notes, 03/10/13). Also, energy was not seen as basic as water (coordinator biogas project, group meeting September 2014). They focused instead on 2) the idea of microcredit financing and 'productive use' of the plants by selling the residues as fertilizer for refinancing. This idea came from the Climate-KIC program of the European Union, who promoted private sector business approaches as social entrepreneurship. Climate-KIC says it is "Europe's largest public-private innovation partnership focused on climate innovation to mitigate and adapt to climate change".[23] One biogas group member participated in a KIC summer school and said he learned ways to create value and develop business models, and how you could use it for yourself if you had an idea. He was also looking for a way to make money with the biogas project to sustain

[23] Http://www.climate-kic.org/ (accessed 06/06/2017)

himself. The idea was discussed controversially in the German biogas group. Members of the group criticized that there would be a flow of money from South to North, as Tanzanian farmers would have to pay for German salaries. This was also seen to be a contradiction to the mission of development cooperation to make itself superfluous. The group member does not deny the problem of the outflow of money to the North but argues that he wants to bring progress and development. It would be a question of progress or status quo (ibid.). Associating the business with bringing progress thus served as legitimizing strategy to justify their own financial advantage. Two group members developed the plan further, but Kilimo refused to implement it because the participation of profit-oriented investors would be necessary: "Investors are normally profit-oriented. Kilimo is providing a service. Attracting investors would mean to change to business, and Kilimo would be forced to change its role" (biogas project coordinator if Kilimo, field notes, 03/10/13).

3) In March 2013, after a long period of research on the pilot plants, Kilimo received a request to become an implementing partner for the National Domestic Biogas Program (NDBP) to build plants together with CARMATEC (the Tanzanian governmental Centre for Agricultural Mechanization and Rural Technology). The program was created in 2009 as part of the initiative called 'Biogas for a Better Life'. According to the initiative, it is an African initiative with the primary goal of creating investment opportunities in Africa.[24] Since 2009, CARMATEC and SNV have been implementing the new biogas program in Tanzania within the framework of this initiative. It is disseminating a cow manure fermenter, as it has been since the 1980s. The request for Kilimo to become a partner triggered a major discussion at Kilimo. The question of water supply and the small number of cows of Kilimos members - and thus, one could say, the commitment to the 'community' - led to the fact that the farmers' association finally decided against the cooperation with CARMATEC and continued to rely on a successful technology development by TC.

4) SimGas, a new biogas player that emerged in Tanzania in 2013 is a joint venture of Silafrica (a plastics producer from Tanzania and Kenya) and SimGas BV (Netherlands). As a profit-oriented company (in their self-portrayal they characterize themselves as a social enterprise with the aim to show that social enterprises can also be profitable) they offer a technology similar to the biogas project of TC. However, the fermenters are made of plastic. The advantage is notable cost savings compared to the masonry version. In March 2014, Kilimo contacted SimGas, as there were serious

[24] Www.ted-biogas.org/assets/download/Biogas_for_Better_Life_Brochure1.pdf, (accessed 08/15/2022). However, the initiative was co-prepared by the Dutch DGIS (Directorate General for International Cooperation).

doubts about whether a plant construction with TC would come to fruition. Kilimo needed biogas plants for the school under construction, which was scheduled to start operations in January 2015. SimGas said it would have to do a feasibility study for a larger mixed-substrate plant but it was so expensive that Kilimo had to withdraw the request. Kilimo solicited bids from CARMATEC that were also expensive, which led them to start looking for other organizations that could build a biogas plant for the school. So, they found offers within Tanzania; however, they did not include subsidy options from the state or development cooperation programs.

5) 'You can't reach the poor anyway. Make money!'. Also in 2014, the board of TC decided to schedule an external evaluation because they felt unable to assess the status of the project or technology, in part due to perceived conflicts of interest (int. federal board member TC, 5/24/16). The evaluator, a well known expert for small scale biogas from Germany, doubted that farmers articulated an energy problem but thinks that TC identified a relevant problem (households with too few cows) and developed a solution (feeding with banana waste), and saw potential in the path taken so far (Biogas Evaluation Report 2/2015: 11). The evaluator gave technical advice on plant design and recommended a demand-led focus on better-off sections of society as a new direction. He said that biogas technology cannot reach poor segments of the population because the investment costs are too high (ibid. 9). Consequently, the target group being 'unrealistic' (ibid.10). At the same time, he rejects subsidies on the grounds that they would 'force' the technology onto people: "Subsidizing these investment costs also has limits as there is an element of imposing a technology on people where the demand may be on the subsidy element rather than on the technology." (ibid. 9) "Lower the subsidy element" (ibid. 11) was therefore his recommendation. "Clients should get the technology on a commercial basis." (ibid.). Kilimo interpreted the recommendations as a departure from its community orientation, meaning the integration of all inhabitants of the region (field notes, 03/31/15). In the end, TC and the funding foundation agreed to build the institutional plant for the school and nine smaller plants at the homes of farmers of the association, which would then act as multipliers. Following these plants, TC demands that the distribution should run commercially.

The mixture of technical factors, framing conditions and discussed options illustrate the postcolonial ambivalence of the available options and strategies of Kilimo. Kilimo was familiar with the CARMATEC type of digester and the National Domestic Biogas Program (NDBP), which has been implemented since 2009 and has the goal of establishing a commercial biogas sector with as few

subsidies as possible. Poverty reduction or addressing poor parts of the population are not envisaged in this program, making the NDBP unable to supply the 'community' of the farmers' association. Therefore, Kilimo decided against cooperating with the local technology provider CARMATEC and instead made an inquiry to an NGO from the Global North. This request and the resulting project reproduce the Global North as a place of technology development and the idea of technology transfer to the South. However, Kilimo's strategy can also be interpreted as an attempt to circumvent neoliberal policies and programs (cf. Barthel 2019: 354).

Financing solar home systems

Fig. 7 "Africa at night". Slide of a company presentation 2013 (Source: Phonergy)

In Phonergy's presentations, as well as on the company's homepage, a satellite image of the African continent at night was used for a long time. This visual metaphor of the dark continent is linked to colonial discourse. Africa appears as an empty continent (*terra nullius*) by describing it as an untapped market (cf. fig. 7) or an unsettled market: "We are talking about the part of the market that has not yet been settled" (head of business development, Phonergy, 02/19/14).

During an event for the UN Decade SE4All, Phonergy was presented as an example of a reasonable approach to fulfilling the SE4All goals. The representative of Phonergy himself also classified the activities of his company in this way: "In essence, Phonergy does what the title of the event says,

namely sustainable energy for all. [...] Our goal is access to energy and also to increase the electrification rate in rural areas" (head of business development, Phonergy, 02/19/14). He describes the SHS of the company and explains that the peculiarity is to be able to sell a product that costs between 300 and 1000 euros. This sum is not available there, which is why the product must be offered with microfinancing. Apart from that, he emphasizes, people there already spend a lot of money on energy (for candles, diesel generators or kerosene lamps). Therefore, he said, the business model is a pure substitution model that no longer requires a subsidy. Both statements - making 'energy for all' and not needing subsidies are worth a closer look.

In public presentations, Phonergy has a kind of double discourse: On the one hand, Phonergy emphasizes they make energy 'for all', which creates the impression of fighting poverty. This association is reinforced by the target region 'rural areas' and the target group of the 'Base of the Pyramid'. The impression of fighting poverty is also nurtured by emphasizing the option of productive use (use energy to start a business) and by the fact that they explicitly refer to the concept of microfinance.[25] In this way, they use the connotation of microfinance as a development policy instrument and place their own activities in the development policy goal of poverty reduction. On the other hand, they offer a rather expensive system and pursue a profit-oriented approach. Therefore, they need to show that there are enough people who are not that poor, and that with the help of their approach it is possible to achieve the goal of access to energy for all. The argument is accordingly built on the fact that people there would already spend a lot of money on energy anyway. Second, they use the narrative of the rich people in the countryside, often heard at such events:

> *"So that you get an idea of who our customers are: How can people afford it there? So there's a widespread prejudice, a misconception that just because people don't have electricity and being off-grid, that they don't have money. I could show you several customers of ours, several hundred Maasai, customers who own 1000 cows in some cases. This customer is enormously rich, but at the end of the day they have no way to get access to electricity. When we arrive with our system, there is finally a way to get electricity."* (head of business development, Phonergy, 2/19/14)

[25] Although it is, according to Phonergy's manager for microfinance and partnerhships (int. 07/25/14), strictly speaking not microfinance, but a flexible way of paying in installments (see above). The company is selling a hardware product, where the financing costs are priced in. This is also the reason why there is no explicit information on interest rates.

These rich customers do exist. They can easily pay the SHS directly. They fulfill an important discursive function: by presenting the clients as solvent, the company does not run the risk of being accused of driving the users into a poverty trap through high loans, as has been criticized with regard to the microfinance industry. However, at the time of data collection, these rich customers made up only about 2.5% of the customer base and do not represent the actual clientele. In the non-public interview situations, the managing director, and the head of business development, report that they reach a Tanzanian middle class (int. CEO Phonergy, 07/06/14, int. head of business development Phonergy, 2/27/14).

During the time of data collection, in the two communities I studied, Phonergy systems were chosen by a relatively small proportion of residents (4% and 10%, respectively) for a variety of reasons. The high costs were the most important obstacle. But also, in both cases, either before or during Phonergy selling their SHS there, solar systems were also distributed through the program of both an NGO (non-profit) and another (for-profit) company. In both cases, these systems were smaller, cheaper, and purchased and used by most residents. Phonergy supplies many households; however, only to a wealthier middle class, and in most cases, it is not the first time these households get access to electricity.

As I showed, Phonergy emphasizes that it is a sustainable business case that does not require financial support. In the interviews, however, I found a general rejection of subsidies, as they would distort the market, inhibit competition, and the population would not understand that they have to pay something for, in this case, solar products (int. new products manager Phonergy, 02/13/14, int. managing director East Africa Phonergy, 07/23/14). However, this anti-subsidy impetus does not mean that the company wouldn’t make use of subsidies and government cooperation if Phonergy itself could benefit from them. In fact, in the early years, funding of various kinds accounted for one-third of total funding (int. head of business development Phonergy, 02/27/14). Some of the funding came from an advocacy group for mobile phone operators, but primarily from the development sector: among them is a fund that supports profit-oriented companies wishing to operate in Africa. It is an institutional funding pot aimed at creating access to new profitable markets, especially in the BoP sector and in rural regions. The fund is filled by several European countries and the United Nations. Furthermore, a German development bank supported the start-up with an initial € 500.000 via the develoPPP.de program of the BMZ, German ODA funds. This was followed by two further loans from the bank's own resources. Phonergy considers the support of this bank to be

very helpful. The conditions were so favorable that they perceive it as a gift (int. new products manager Phonergy, 02/13/14) but recognize that the project would have been implemented even if they had not received this funding (int. head of business development Phonergy, 02/27/14). However, this bank, they explain, also serves as a quality brand, which made it easier for Phonergy to get other funds or loans throughout the funding process. Most of the funding, several millions, came from a funding pot of the European Union, from one of the main instruments of EU development aid. More than once, Phonergy also contacted the Tanzanian Rural Energy Agency (REA) to present themselves as cooperation partners for rural electrification. However, it turned out that the money provided by the REA to promote electricity supply was reserved for U.S. companies. "[It] was made very clear, there were investments from the Gates Foundation, and that they can only go to American companies." (int. manager microfinance and partnerships Phonergy, 07/25/14). Therefore, in this case, not making use of government funding was simply because other external development actors were more successful in securing market segments for their companies.

Media theorists Richard Barbrook and Andy Cameron characterised this form of downplaying the contributions of government subsidies and government support as part of what they describe as neoliberal “Californian ideology” (cf. Barbrook & Cameron 1995). Their example is the development of the internet infrastructure in the USA in the 1990s. Its expansion depended almost entirely on the reviled government for the first 20 years but was systematically downplayed by ideologists of the free market (cf. ibid., n.d.). Byrne et al. (2014) showed a similar dynamic for the off-grid solar sector. Although government and other institutions created the market via targeted support mechanisms, the market now claims to have emerged on its own without intervention. The development of the market is presented as a natural process that functions without subsidies. In the case of Phonergy the share of ODA funding was one-third when the company was founded (int. head of business development Phonergy, 02/27/14). Few years later, in 2015, Phonergy reported eight million US dollar funding compared to 30 million US dollar of invested capital, so the share of funding was still about 20 percent. Considering their statement that they would have started even if they had not received funding, this might either be a case of windfall profits or another example of the frequently observed downplay of state support on the part of the private sector (cf. Barbrook & Cameron 1995, Byrne et al. 2014).

Subsidies are paid out to the company. The 'clients' pay for a relatively expensive system by international standards because defaults by other clients are priced in (10% according to the workshop manager of Phonergy, int. 6/18/14) and profits return to the company and investors.

Materialized Neoliberalism?

While democratic technologies were sought in the 1980s, more current research in the sociology of technology is concerned with the question of whether there is such a thing as neoliberal technologies. In particular, the role of prepaid technology has been debated in terms of its social impact and significance, as a "traveling ideology-technology package" (cf. Anand 2013: 3, see also McDonald 2008, Beckedorf 2012, von Schnitzler 2013). Phonergy's prepaid scheme in combination with the automatic disconnection, which is intended as a cost-recovery tool, ensures the desired payment discipline can be read as inscription of neoliberal policies. Although debates suggest that there are no more neoliberal technologies than there are inherently democratic ones (cf. Anand 2013), the concrete materialization of Phonergy's SHS offer two more features that can certainly be understood as inscriptions of neoliberal development politics: The business kits represent a paradigmatic manifestation of the concept of the entrepreneurial self, where the customer can or should work him/herself out of poverty (cf. fig. 2a, 2b, p. 17). The artifacts define the 'good customer' who becomes entrepreneurial, and the company disseminates this idea through advertising. The business kits also materialize the idea that the economically better off inhabitants of a place earn money from the less well off. So the existence of those multiple mobile phone and solar lamp charging stations is a materialized expression of socioeconomic inequality. The third inscription is the gradation of products by size. Four different sizes are offered to adapt the product to the different ability of customers to pay. This aspect materializes the logic that those who can pay less will get less, which was perceived as such in the communities studied. Existing relations of inequality thus become more visible. The reproduction and tendency to reinforce intra-societal inequality structures manifests in the visual property of the artifact. However, the price structure also matters, as those who have the resources to pay the full price immediately, pay 25 percent less. Those who must use the installment system, pay extra for it, as the cost of the loans taken by Phonergy is passed on to them. People who are not solvent 'customers' are excluded from access to electricity through that approach.

4 Decentrality in the case studies

The technologies of both case studies correspond to the technical definition of decentralization as the spatial coupling of energy production and consumption. From a socio-technical system perspective, however, production cycles, value chains, the location of socio-technical knowledge, management and administrative structures, and (political) decision-making structures on the directions of technology development must also be taken into account. Beyond the socio-technical system level, levels of economic decentralization, ownership, and political participation come into view with regard to decentralized (energy) technologies. Additionally, the discursive level also proved relevant, as the connotations and functions of the decentralization concept are fed by different backgrounds and debates in the policy field of energy and development. The result is that both case studies can be described as decentralized structures with regard to some aspects, and as centralized structures with regard to others.

Household biogas plants can be characterized as decentralized with regards to the energy conversion level, the utilization, and resources, insofar as no external fuel supply is required beyond the household level. The plants can be produced and maintained in Tanzania, and some of the technical knowledge is also available, although development policy has tended to neglect the promotion of basic research (Mshandete & Parawira 2009: 118). The development policy focus on micro biogas plants at the household level could be interpreted as an effect of the guiding principle of intermediate technologies. The associated classification of large/small or complex/simple could explain a neglect of larger-scale plants in African countries (cf. Mshandete & Parawira 2009). At the socio-technical system level, meta-studies on the conditions for success of biogas programs in general found that successful approaches and programs were often strongly supported by governments (cf. Bond & Templeton 2011: 351). Thus, if a prerequisite for successful implementation is organizational and financial government support, this sociotechnical system cannot unequivocally be described as decentralized. In Tansania in particular, the biogas programs that have been notably run well were interestingly organized by churches (cf. GTZ 2007: 20). With regard to developmental decentralization, both partner organizations are explicitly civil society-oriented and do not request support from the Tanzanian state, not even in the area of basic infrastructural services. However, this raises structural problems for the financing of the quite expensive plants.

Phonergy's solar home system is also a decentralized energy technology in the narrower sense. However, since the company claims to establish an off-grid infrastructure and wants to be seen as

a utility, the concept can also be understood as a large scale system (cf. Bierter 1993: 58f). The company's scale orientation also fits in with this. The company argues that the system is only financially viable when at least 10,000 units have been sold. Therefore from the company's perspective, 10.000 is the smallest possible batch and 'small scale' is not a goal. Another dimension of decentralized technologies are local production cycles, which is not the case with Phonergy. The solar cells, batteries, and part of the electronic technology come from China, and other parts of the technology from Germany (int. database developer Phonergy, 03/03/14). In terms of development policy, decentralization is demonstrated by the fact that the energy supply sector in Tanzania has been liberalized, and the company develops its activity without cooperation with the public electricity supplier and primarily in consultation with local authorities. Therefore, and with regard to profit orientation, the approach can be characterized as an example of decentralized service delivery (cf. Mohan and Stokke 2000). In general, anti-state and anti-subsidy statements show up in talks with the employees, while they also make use of subsidies if they can. [26] Phonergy is no example for decentralization in the sense of a transfer of power or democratization. The decision-making powers at Phonergy lie with the German CEO, some investors and, to a lesser extent, a core team of employees who helped start the company. The goal of no longer employing German staff in Tanzania as quickly as possible and replacing the positions in the Tanzanian subsidiary company with people from the region, was understood by some German employees to be an emancipatory orientation of the company, albeit a limited one. However, even if marketing strategies or personnel decisions are made in Tanzania; control over the direction of technical development, the transnational production value chain and, above all, questions of profit utilization or strategic development remain in German hands. There are no plans to give up control. The aim is to become Africa's largest electricity supplier.[27]

The term decentralization is used in some of the literature on micro biogas plants. "A biogas plant is a decentralized energy system which can lead to self-sufficiency in household fuel needs" (Mital 1997: book spine). It refers here to substrate, production, and consumption. However, in the context

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[26] "[…] Yes, selling electricity is the better solution, decentralized small systems that are independent of state power and function independently of a central organizational structure. Even if the village mayor is completely corrupt, it doesn't matter. That doesn't bother the individual with his solar system at all, because the mayor can't control it. It doesn't belong to him." (int. database developer Phonergy, 03/03/14).

[27] This goal was meant to be more structural than personal. During the 2014 interview, the founder was already considering a sale to a larger corporate group, which has happened some years later after the company filed for insolvency in self-administration.

of the case study, the term did not play a role. It was not used by any of the partner organizations, nor in any negotiations about the project. More important was the 'low tech' orientation (on the part of the German biogas group) and the orientation towards ‘adapted technologies’. However, the goal of using 'local materials' as much as possible, and for industrial materials to be paid by donors, can be identified as a decentrality dimension.

Phonergy, on the other hand, actively uses the notion of decentralization in its corporate narrative and in presentations. The company takes advantage of the narrative legacy of the environmental movement in Germany by using juxtapositions such as 'decentralized vs. nuclear energy':

> *"[The Federal President of Germany] was here and looked at it and [...] he tried to find out: can decentralized options really do what they claim? And now in this German thinking: decentral is more expensive than nuclear."* (int. head of business development Phonergy, 2/27/14).

Through this pseudo-contrast to nuclear energy, which is loaded with negative meaning in the German context, everything that is decentralized automatically appears to be the good. However, this goes hand in hand with de-naming central aspects of decentralization. In particular, decision-making structures, ownership, the global value chain and the centralization and closure of engineering knowledge are not related to the concept of de/centralization.[28] Via such a reduced understanding of decentralized energy supply a depoliticization of the concept of decentralization takes place.

Thus, according to a definition of decentralization that includes political and economic aspects, the sociotechnical constellations of both case studies are not decentralized. However, decentralized energy systems possibly more than other technologies create the illusion of autonomy, mislead by the level of the artifact and the spatial coupling of production and consumption (cf. Feenberg 2010). Autonomy as an effect is gradual - depending on who has what knowledge about repair, making spare parts, etc. In the narrow sense, there is much decentralization; in the broader, holistic sense, there is little. Lewis Mumford defined decentralized or democratic technologies in terms of the socio-technical system of the village, as a living production unit, and the direct feedback effects

[28] Or a possible production of solar cells in Africa is generously offered as a political option, which enables the company to present itself as a good development policy actor.

that exist there (cf. Mumford 1974). However, in the current reality of the capitalist technosphere (cf. Boeing 2012), such forms of decentralized technologies are hardly to be found.

5 Conclusion: Renewable energies, 'development' and green dependencies

While the focus of this study was on the process of technology development, to investigate wider societal impacts of technologies under study would be equally relevant to investigate. To get a glimpse, I looked at two communities where SHS are sold (see Barthel 2019: 460ff). An important finding from this is that the fact that energy is offered through a private company, which in itself seems to have a depoliticizing effect: The local administration of the communities, as well as non-users who couldn't afford to buy a system, indicated that supply via a profit-oriented private company was a reason for being unable to claim a supply for everyone, or for social compensation mechanisms. In this sense, the mode of supply seems to have a self-reinforcing effect in favor of viewing energy as a commodity rather than a common good. Negotiating questions of justice regarding the provision of public goods becomes beyond the realm of possibility.

Both technologies under study can be understood as flexible technologies (cf. Winner 1980) where the social contexts are inscribed in the artifact through many small decisions in the design process. The technologies could be used differently under different political economy conditions. With regard to the solar home systems, on the technical level there would be no reason to not consider payment systems in which poorer people are not marked by smaller systems and penalized by limited possibilities of use. They could instead be supported through subsidy structures, for example. Users are more or less satisfied with the technology, and the mobile phone connection allows for timely maintenance. As a technical option, SHS and small scale biogas systems at the household level fit well with the scattered settlement pattern that prevails in many regions of Tanzania.

Phonergy can be seen as an example of what would be a 'normal' process in the Global North - developing products and commercializing them - being called 'development' in the South. The target group is regarded as billions of people who are not yet provided with 'modern energy services' and thus suffer from a 'development deficit'. Phonergy cleverly uses the narratives of poverty alleviation and sustainability and plays on the positive image of the solar revolution. The use of the development discourse makes it possible to acquire funding from development-oriented institutions, as well as finding convinced and highly motivated employees. The German development

bank hyped it as a good example of the Green Economy, and the solar (hence green) mission justifies, from the perspective of the company founder, the capitalist structuring of the supply approach and the private appropriation of the generated added value. Without profit orientation and scaling, the goals could not be achieved. Solar energy - in very high numbers and very quickly - essentially legitimizes all the ‘trade-offs' inscribed in the structures, such as the orientation towards solvent clients, the appropriation of the added value generated by the BoP by investors and company owners in the Global North, poor working conditions for employees, etc. (cf. Barthel 2019: 428 ff). The employees see profit orientation, time pressure, and growth orientation as the factors that impede technology appropriation by actors in the global South.

According to Hirschl (2009), renewable energies were marginalized in energy policy for a long time and entered the international agenda in the 1980s in the context of the 'soft topic' development (cf. Barthel 2019: 140 ff). They were classified as particularly suitable for developing countries or as a technology for the poor. I would argue that in relation to fossil energies or large scale technologies, for a long time, renewable energies represented the 'Other' in the development discourse and that ‘development’ was equated with fossil energies. The extent to which this is changing while a global Green Economy or green capitalism is established (cf. Brand & Wissen 2015) would be worth a postcolonial discourse analysis of the discourse on energy and ‘development’. Geographer Natalie Koch, for example, analyzes how Arab countries with fossil-based industries are constructed as backwards, and that orientalizing takes place via the accusation of green washing (cf. Koch 2018). She indicates that in this context being modern means being green.[29]

New green megaprojects, especially the new hydrogen industry, are criticized under the keywords green colonialism or green grabbing with regard to old-new exploitation structures (cf. Hamouchene 2016, 2021). Against the background of these problematic large scale projects and large scale technologies, the developments and potentials of decentralized renewable energies should be further observed and researched to point out possibilities and obstacles for a fair international energy transition. However, renewable and decentralized technologies, especially in the German context, are susceptible to what David Slater (1989) noted for the concept of decentralization in general:

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[29] Cf. uni-freiburg.cloud.panopto.eu/Panopto/Pages/Viewer.aspx?id=102a4432-0e08-4d24-923a-ae8a009fe4c9, presentation date 06/02/2022, accessed 04/23/2023.

> *„Under the sign of ‚decentralisation', using the ‚mystique', ambivalence and allure of the concept, the forming of consent for something quite different can be more effectively nurtured."* (Slater 1989: 523)

Accordingly, I tried to explore the ambivalences and to make clear that decentralized renewable energies do not automatically lead to the reduction of dependency relations or economic inequalities or a socially just implementation. This paper aims to sensitize against such simplifying assumptions or narratives, because they can inhibit a more accurate and critical view on decentralized renewable energy projects. For this purpose, I carved out the various dimensions and aspects of decentralization. It remains relevant to investigate how off-grid approaches take hold in countries of the Global South and what impact the respective forms of decentralized energy infrastructure have, in terms of social inequalities, within communities as well as on a transnational level. It would be important to find out how technical decentralization and market liberalization interact.

Decentralized and renewable energies can be linked to the goal of greater self-determination and autonomy - collectively or in a neoliberal fashion in an individualizing way. Low-tech can describe approaches of a convivial society or, as an element of a high-tech/low-tech juxtaposition, contribute on a discursive level to the reproduction of asymmetrical North-South relations. Solar energy can be a sign of privilege and second-class status. Socio-technological constellations in all their forms are too complex to allow generalized conclusions for societal impacts on the basis of single technical characteristics. Those underlying assumptions impede perceptions of the more problematic developments in the field of decentralized and renewable energies. Decentralized energies in the South are often connected with privatization and commercialization, with supply reaching already privileged parts of the population. Decentralized and renewable energies can take the form of green dependencies.

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