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Which media for whom? The implementation of microgrids as a trigger of transformational adult learning opportunities in formal, informal and situational settings in times of change

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Which Media for Whom? The Implementation of Microgrids as a Trigger of Transformational Adult Learning Opportunities in Formal, Informal and Situational Settings in Times of Change

Abstract
Der folgende Beitrag bezieht sich auf Bildungsmedien für das Lernen Erwachsener. Auf der Basis von Dokumentenanalysen und Feldforschung zu Transformationsprozessen, die durch die Einführung nachhaltiger Energieversorgungsstrukturen im ländlichen Ostafrika ausgelöst werden, werden Bildungsmedien in formellen sowie informellen Kontexten untersucht. Aufgrund der Heterogenität der Zielgruppen und Anwendungskontexte wird eine sehr offene Mediendefinition verwendet.

The following article focusses on media in adult learning. Our presentation is based on results from document analysis and field research focussing on transformational processes induced by the introduction of electrical energy provision in East African rural communities. As we approach the search for respective media in use, we concentrate on formal (tertiary) educational settings as well as on rather informal or situational settings studied in the field through observations, focus group discussions, and interviews. For this reason, we start with an open definition of media. According to this, media either produce and/or transfer information on socio-technological change. As we need to remain open to very different settings with different stakeholders and actors, we follow a performance-related approach. Coming from a very broad didactical viewpoint, we are also aware that media are not merely artificially produced artefacts but also, and very much so, the people transferring the knowledge and information that is believed to be necessary. Our theoretical approach to media in general and to the "staging" of learning contents, as it has been described here, is very close to that given by Hallitzky et al. (2017, pp. 28–30). Media, here and there, are discussed as performatively efficient, and observed according to their interrelations with the people choosing, preparing, or presenting them. Yet, the East African rural community setting we will be looking at is very different from that in German classrooms, which Hallitzky et al. are describing. So, before we present our findings, we give a brief description of our research context.

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1. The meaning of microgrids for electrification in East Africa

Transformations are the key points of the 2030 Agenda for Sustainable Development of the United Nations (UN), the world's biggest political plan to secure a liveable future for everyone on the planet. To specify the transformations, 17 Sustainable Development Goals (SDGs) with 169 sub-targets were developed as a new universal agenda at the 2015 UN General Assembly (UN, 2015). Eradicating poverty in all its forms is one of the biggest challenges, although it is a crucial requirement in achieving the ambitious goals. In the rural areas of East African (EA) countries like Uganda, Kenya or Tanzania, this point comes along especially with the defined SDG 7 which aims at worldwide "access to affordable, reliable, sustainable and modern energy services" by the year 2030. Since access to electrical energy is strongly connected to the growth of economic potential (Castellano et al., 2015, p. 1) and the general quality of life for each human individual (Pasten & Santamarina, 2012), placing a closer look at this point is crucial. Governmental programs such as the African Union Agenda 2063, which aims at a 50 percent increase in generation and distribution so that 70 percent of the population in Africa may have access to electricity in 2023, have not shown the required success (Ajewole et al., 2018). A constant increase in both the electrical energy demand and human population are key problems in achieving the mentioned goals (Adefarati & Bansal, 2019). Also, the huge dimensions of the African continent are problematic in this regard. Many villages in remote areas are far away from the public grid, and the responsible authorities are struggling with the large amounts of money required to extend the grid in areas with a dense population.

Avoiding the high costs of huge connection lines and energy losses due to the long distances, local approaches tend to be part of the solution for those areas. The number of new power connections by decentralised so-called microgrids already exceeds the grid connections in sub-Saharan Africa within a distance of 5–20 km from the public grid (IEA, 2022, p. 110). With larger distances, therefore, microgrids are often the only possible way to electrify a village.

Microgrids in East Africa

Microgrids are basically decentralized small energy grids which typically consist of one or more types of renewable energy sources such as solar panels, wind turbines or small-scale hydroelectric generators. Since those power sources are usually not constantly providing power, and the consumption fluctuates during the day, methods of storing power or bridging gaps are usually required. Specifically, small systems have a high demand for storage systems since the relative differences over the day are generally higher compared to larger grids. Due to the declining prices for PV panels, the batteries are often the most expensive parts of a microgrid system. In comparison to power electronics like inverters, cables or construction materials, batteries are extremely costly. Unfortunately, they are also the most fragile parts of a grid. Depending on the type, the usual lifespan of those batteries is limited to 5 to 10 years. Improper use, however, can reduce this time drastically and significantly increase the required costs of continued grid investments.

So, besides the mentioned advantages, many of the microgrids deployed in Africa prove to be unsustainable (Namaganda-Kiyimba & Mutale, 2018, p. 426–431) which shows the need for a more customer-sensitive planning as well as suitable knowledge transfer strate-

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gies to the local population as crucial for a long-lasting success of those grids (Bogere, Bode et al., 2023, p. 675).
The BMBF-funded A:RT-D Grids project (https://www.art-d.net/en/) works as an international and interdisciplinary project with high involvement on the engineering side in search for applicable and robust power supply solutions. The authors joined here, however, work in Didactics of Technology and Education Sciences and, as such, have taken on the objective to research and improve community and learning needs.

2. Education for sustainable development as transformational learning

As our research subject quite obviously implies, we are closely linked to basic ideas of Education for Sustainable Development (ESD). We follow Musana (2023) in his conviction that ESD has a strong focus on relational teaching and learning. We stress that the most meaningful relations are those coming from the shared realities of environmental challenges, added by those coming from changed realities brought about by so far unexperienced energy supply. Education in a more general sense is seen as being brought about by and leading to further socio-technological transformations. Education is thus considered as the result of negotiation processes concerning inner-individual as well as contextual relations and opens possibilities of transforming ways in which individuals relate to the world and to themselves (Marotzki, 1990). Whenever educational processes are triggered by the experience of crisis, meaning that there is a problem which cannot be solved by applying those relations known and used so far, new negotiations need to be started, which initiate and necessitate a transformative educational process (Koller, 2018; Mezirow, 1978). Such an understanding of transformative education implies that its theoretical foundation always considers greater social (here: socio-technological) changes, so that it is possible to recognise the mutual relationship of the individual and society. Such a broad and somehow basic understanding of education seems most suitable to research transforming communities, gender relations as well as didactical concepts related to transformations brought about by energy supply solutions that are meant to meet local needs and, at the same time, to be truly sustainable. Such transformational learning tends to be intentionally accompanied by media, which can be shown in our research results.

2.1 Media for adult learning in the focus of Didactics of Technology

From a Didactics of Technology point of view, Bachelor of Science in Electrical Engineering (BSc EE) students and electrical energy consumers are among the stakeholders that ought to be taught microgrids-related knowledge to achieve sustainable microgrids in EA. Developing and offering materials and strategies for teaching microgrids-related knowledge is a vital strategy to solve electrical energy access, affordability, reliability, and hence sustainability challenges in EA. To effectively transfer knowledge and achieve relevant competencies/skills, particular attention is paid to the teaching-learning media. To this end, this section highlights media for teaching and learning microgrids-related knowledge and competencies to adults in EA. Teaching and learning of microgrids-related knowledge to BSc EE students and electrical energy consumers can take place in both formal and informal settings using verbal and non-verbal media. Verbal media that have

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been employed in the A:RT-D Grids project include presentations, conferences, seminars, and workshops. The mentioned examples are considered forms of media because they involve the transfer and reception of information through various modes including sight, sound, and text. Texts as media on the other hand also include paper publications offering information addressing students, scientists, and practitioners in the field. However, paper publications are for formal settings and, generally speaking, not for the consumption of electrical energy users in rural communities. There, live audiovisual media such as excursions, demonstrations, and hands-on experiments exist, in addition to audiovisual media such as videos and online platform media like the virtual and interactive microgrid learning environment (VIMLE), which was developed by us (see below).

Presentations – a traditional didactic approach – remain vital media that offer microgrid learning opportunities to adults. Materials to convey new microgrids-related ideas, products or power supply solutions, in general, are prepared for delivering presentations. The materials are in most cases shared with participants after presentations to further facilitate transformational learning. Presentations apply to the two categories of adults considered, that is, BSc students and consumers of electrical energy services in formal and informal settings respectively. However, to eliminate learning by rote that characterizes presentations, both Bogere, Temmen et al. (2023, p. 2) and Khan et al. (2019, p. 3) emphasize that active microgrids, called live laboratories, are instrumental. Live laboratories are handy as testbeds in enabling students to test-run developed prototypes. In addition, live laboratories offer excursion opportunities to both students and local community members. For this reason, a live laboratory was designed and installed at Lwak in Kenya. The Lwak microgrid is helpful in teaching school learners and members of the Lwak community about microgrid basics.

While executing our mandate as the A:RT-D Grids project team, we have made many conference presentations that have given birth to conference paper publications. Presentations made during conferences, seminars and workshops are listened to by attendees from across an interdisciplinary spectrum including but not limited to BSc EE students, researchers, academic instructors, practising electrical engineers, vendors, developers, and service providers of microgrid solutions. It is vital to note though that conferences are expensive for participants, and this is restrictive. In addition, conference presentations are made during parallel breakout sessions and thus, they are in most cases attended by audiences that are interested in the subject matter.

Online learning platforms are an important resource to leverage in equipping stakeholders with knowledge and skills relevant to microgrids in both formal and informal settings. In the A:RT-D Grids project, a virtual teaching and learning platform (VIMLE) was designed. As indicated in Bogere, Bode et al. (2023, p. 673), the VIMLE platform enables synchronous, asynchronous, and co-operative functionalities that facilitate learning in formal, informal, and situational settings. The objective is to upload microgrids-related content, training materials, and virtual laboratories that enhance stakeholder learning experience and trigger transformational learning while providing practical skills and knowledge that are applicable in the world of work and solve electrical energy challenges.

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2.2 Documenting and analysing community conflicts for community work

As we have seen, there are strong efforts to develop media for teaching sustainable energy technology. However, we have realized in our research that energy change brings manifold stakeholder conflicts and community discourses based on different economic interests, on social injustices, and on gender issues. Local communities are teaching us that general solutions may not work and that specific situations call for situational solutions in very informal settings, for example, project meetings and direct target group reactions to practices and information on changes. Often, it is the different stakeholders that direct information according to their roles in the project and thus become media themselves. The following examples from the field illustrate such informal educational events:

Informal social gatherings are a medium for information sharing in local communities where structured education means are not only minimally spread but also absent in some communities. Local leaders in these communities are a point of information and knowledge transfer. They target social gathering times such as evening social activities and market days, during which they move through communities. They then pass on intended communication to groups of gathered community members by word of mouth. While it was counted upon that information shared, through ripple effect spreads far and wide, the leaders acknowledged that this did not happen. Conflicts and divergencies from the expected terms of operation always cropped up in the communities attributed to this imbalanced and insufficient information access. Some community members were stated to reject initial enrolment to the electricity project due to limited and/or lack of information about the project. In other instances, local leaders were accused of discrimination and favouritism, i.e., they made microgrid-related information available to preferred community members and groups.

Despite the presence of microgrid operators' structured means of knowledge transfer, leaders in microgrid communities stood as strong references for microgrid-related concerns. They are an existing trusted source of inquiry, mediation, and advocacy. Community members gravitate towards their leaders even when microgrid operators have field offices and staff in the communities. The residents seek answers to microgrid operations-related inquiries such as newly introduced fee charges and/or ways of access to electricity services from their leaders. Residents report microgrid-related complaints such as interrupted electricity supply and unsuccessful electricity payments to their community leaders. Community leaders empowered with project-related knowledge by the microgrid operators and national electricity regulatory authorities, as well as those with active interaction with the microgrid operators, transferred this knowledge to their communities and vice versa. They advocated for community electricity access on terms that were favourable and fair to their communities. They liaised with microgrid operators and related stakeholders to identify and respond to points of conflict to reach mutually beneficial solutions. They convened community gatherings and put operators and their operational partners to task to dialogue with communities regarding raised concerns. Using existing structured media of knowledge transfer that include periodic community meetings and structured capacity building trainings, plus informal means that include door-to-door visits, public address/community radio systems, and social and impromptu convened gatherings, community leaders, microgrid operators, and their partners and community members not only received and generated but also transferred information. Interlinking the microgrid operator's formal structures with the existing community's formal and informal structures trig-

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gers transformational adult learning in situations of energy change. For societies to achieve their envisioned goals in energy transitions, all policies and initiatives must be harmonized to aim in the same direction of change. To do so, societies must become aware of how energy transitions will change them (Döring et al., 2018, p. 1).

2.3 Tracing media in gender and conflict discourses

In our data we find community discourses displaying convictions that have great influence on transformation processes regarding acceptance and rejection of change. We focus on gender-related issues and give some particularly meaningful examples of "gender discourse at work".

The focus on discourses has been born out of the epistemological assumption that "reality" is socially constructed and rooted in society's experiences (Alvesson & Sköldberg, 2009, p. 29) and this reality is reflected within the individual's or the group's discourses (Foucault, 1972, pp. 1ff; Riessman, 2008, p. 183). We therefore deploy discourse analysis together with the conceptions of gender, masculinity, femininity, intersectionality, and sustainability to ascertain the role played by gendered discourses and discursive practices on the delivery and acceptability of different media and related messages associated with social transformation. These gender discourses and associated power relations influence the acceptability or rejection and the sustainability of renewable energy projects in EA. The gender discourses from the field also aid in identifying the gender gaps in the energy and training media whose fixing would enhance gender justice and contribute to the sustainability of said renewable energy microgrids.

The field findings reveal long-held and sometimes obstructive gender discourses and beliefs that energy-related work and other forms of participation are inherently masculine-oriented and less suitable for women. This is compounded by discourses that paint associated conduct like females' climbing buildings and electric poles as abominable, which reportedly defiles the sanctity of the female body. When the microgrid operators reach the community, they undertake a series of trainings and other community education sessions aimed at popularising the electricity project and in the process, they allow the community members to buy into the project. As already stated, this is done through different media like community meetings, organised training sessions at community centres and even word of mouth. However, in patriarchal communities like those in EA (Hopwood et al., 2018, p. 40), the gender division of labour dictates that women can only be available at certain times of the day and not others, while men can be available most of the time. For example, it was discovered that any educational and training sessions that are organised during morning hours are missed by women as they are busy on the farms or taking and picking up children to and from school. Likewise, in the evening, women are more likely to be engaged in household chores like cooking dinner and tethering domestic animals. This makes their time to attend training sessions limited to early afternoons, which may not coincide with the trainers' timetable. For this reason, it was found that most women find it challenging to attend such educational sessions, which in turn limits their knowledge about, and consequently participation in, the operations of the microgrids. Worse still, in some communities, when women get an opportunity to attend such information exchange sessions, their participation is sometimes restricted to listening quietly or speaking with measured tones as local discourses hold that women should not speak much or louder in public especially where elderly men are present. According to the local

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discourses, a woman who speaks loudly with confidence might be branded disrespectful and unruly with nicknames depicting her as someone who has crossed the socially prescribed feminine standards. This therefore calls for the use of integrated media channels to include those that may not require movement out of the households.

In addition, we observed that other forms of media like radio and television that women would use without leaving their premises are also affected by gender power relations. For instance, a television in most households is dominated by men who use their power to control the type of channels and programmes the family will watch or use their financial power to refuse to pay for monthly television subscriptions since in most households, men are breadwinners and therefore controllers of the household's financial resources. Some male heads of household however reported that they use the television to control and manage their wives and children from moving out of the house since they claim that the wives and children cannot roam around the neighbourhoods when there is television to watch. In this case, television also directly or indirectly turns into other tools of subjugation and gender injustice.

In the local schools, the teaching and learning environment is delineated by discourses promoting gender divisions in subject choice and career decisions. For instance, STEM courses like Mathematics and Physics necessary for the energy sector are perceived to be difficult and thus not appropriate for females as local discourses hold that females are comparatively less intelligent and only suitable for Arts courses which are discursively assumed to be simple. These discourses and beliefs result from lengthy periods of socialisation associated with body politics and sex typing that lead to the development of gendered schemes (Bem, 1981, pp. 354–364; Scott, 1986, p. 1056).

Similar biases are also prevalent in the textbooks and other curricula used to train learners in schools and in other content used to train about microgrids in communities. An examination of these materials reveals that they are dominated by clearly gendered discourses, influencing learners to form cognitive models that create dichotomies between masculine and feminine professions. Moreover, these perceptions are reinforced by the examples, names, terminologies, illustrations, drawings, quizzes, and assignments contained in the textbooks and other instructional materials or literature. It is these gendered textbook contents and illustrations that may bias the children into believing that certain professions like energy work are masculine. This happens especially when the teachers continuously reinforce such beliefs in teaching, as education plays a big role in children's socialisation and conforming to or challenging particular perceptions (Tang & Hu, 2022).

The clearest community education perspective derives from conflict analyses done in and with communities. Such analyses are a powerful means of Action Research, and they lead people involved to get deeper insights into existing conflicts that may also convey ways out. The working-with-conflict perspective (Fisher, 2000) helps us to address and understand existing conflicts and jointly develop and try new ways and changes.

The failure to consider and understand the nature of these complex systems can result in problems of greater magnitude than the original problem of concern, often because of unforeseen and unintended consequences (Simmons & Gregory, 2005, p. 143). Local communities are both custodian of their existing knowledge conceptions and forerunners in developing interventions to address the conflicts that come up as a result of the interactions between the microgrid and the existing community context. Working with them is very instrumental in customizing education campaigns to address community knowledge

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(mis-)conceptions that hinder embrace of the electricity projects. In some communities, it was feared that microgrid solar electricity was far more expensive than the existing traditional means of energy; in others, that embracing the electricity projects would mean death – that the project needed massive human blood sacrifice to succeed; in others, that the erection of electricity poles in the soil killed the fertility of the soil, the animals, and the proximate people themselves. Only by working with the communities were these conflicting perceptions identified and through working with the community leaders, a trusted, credible source of authority, these conflicts were addressed to enable the communities to move towards the promised transformation of the electricity projects. To become sustainability change-makers, individuals require the knowledge, skills, values, and attitudes that empower them to contribute to sustainable development (UNESCO, 2017, p. 7).

In ongoing project implementations and interventions, the affected populations are a rich source of media. They offer insight into what is really going on in the energy project scene and can generate viable solutions to ongoing conflicts. As revealed, community members would report fellow members engaging in deviant activities that were detrimental to the microgrid operations such as power theft and illegal connections. This information was stated to be valuable, as it saved the microgrid operators days and expenses of technical fault finding and resolution. Community members and their leaders brought to light concerns associated with embracing introduced technological initiatives such as suspicions that a newly installed 'electricity consumption reader' device was contributing to increased power blackouts in the community, or that a current technician was sabotaging the success of a new technological intervention with intent of remaining relevant and maintaining a manipulative monopolistic hold on the community. Grounded action involves a process of continually discovering, learning, rediscovering, and relearning. It presents a way to design effective actions that are grounded in what is really going on, not what you think, hope, or wish is going on (Simmons & Gregory, 2005, pp. 150, 154). Integrating continuous knowledge exchange and review sessions in project implementation allows stakeholders affected by the situations of energy change to identify and share sources of conflict. It presents various formal and informal knowledge exchange interfaces where all the relevant and affected stakeholders generate and transfer knowledge and jointly work with conflicts to achieve mutually beneficial contexts of energy and societal transformation.

3. Insights on media in transformational learning processes – Conclusion

As we browse didactic material and the field to find media that are active in transformational learning processes on socio-technological change, we seem to be able to define media that are intended to be instructional as far as the construction, the use, and the maintenance of microgrids are concerned. Their level of technological expertise rises from consumer to constructor level. In addition, the didactical and methodical variety of media-transferred information is growing according to the level of formality the learning processes are reaching. We meet exceptions in those few cases where media designs are left open in a way that leaves choices with the learners, like the VIMLE platform or live laboratories. So far, we have no data on the accessibility and use of these media, although it

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is feared that the barriers to their accessibility could be rising where there is no formal institution of learning involved. As we have seen in the case of gender inequalities, we also need to realize that the level of expertise is not rising for all members of the target groups and that there is a lot to be done to improve equal access.

The level of media and learning acceptance seems to decrease with the level of formality of learning. The closer we get to the ground, the more we realise that it is not only the media that are the problem. If community members cannot accept socio-technological change, they are losing their willingness to be approached by formal learning. When conflicts occur, they often indicate good reasons for non-acceptance. This is when artificial media lose more of their meaning and people must take over. Instructions on how to use and maintain a microgrid don't seem to address the questions and educational needs of the people, so room is needed first to find out about the questions and then find the media to work on answers. As we have seen, many of those media will be social processes of different forms and will be represented by people, not by artefacts. A lot of our "work in progress" seems to indicate that the use and influence of educational media in a narrower sense is limited as soon as they don't hold true to existing social circumstances, and that transformative learning will always remain a challenge to the production of suitable media.

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