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"Nano" Regeneration: How Human Agency Intermediates Between Nature and Technology in Community-Based Energy

Charlotte Marie Walther[1], Kim Poldner[2], Helen Kopnina[2], and Domenico Dentoni[1]

Abstract

This article provides a nano (hyperlocal) view of climate change mitigation by viewing regenerative organizing through the eyes (as well as bodies and senses, etc.) of the households engaged in community-based energy projects. By showing what humans make up for in the largely absent relationship between nature and technology in these projects, we envision an incremental extension of the literature on community-based energy. The radically different contribution we aim to make is a tripartite imbrication that brings in natural agency alongside the human and the technical but specifies precisely how nano (smaller than micro) embodied practices afford mis- and realignments.

Keywords

nano, regeneration, human agency, community-based energy, nature, technology

Introduction

Small-scale, distributed, and collective experimentation and learning represent critical approaches in organizing to address the grand environmental challenges of our time (Ferraro, Etzion, & Gehman, 2015). Yet many of these promising projects do not deliver desirable results as they might overlook regenerative organizing at the mundane level of nano (smaller than micro) practices. This research note aims to address such a gap by examining regeneration at the neighborhood level, thereby focusing on the bodily practices of members of two community energy projects in Germany. We follow the definition of community energy by Walker and Devine-Wright (2008) who state that the projects have to be run *by* and *for* their participants. We build on Walker's perspective of community energy projects, especially on the mundaneness of households' engagement with climate change mitigation (Walker, 2014). Walker's investigations have contributed to our understanding of how community energy works by disclosing the interplay

[1]Wageningen University, Wageningen, Netherlands
[2]The Hague University of Applied Sciences, The Hague, Netherlands

Corresponding Author:
Kim Poldner, Faculty of Business, Finance & Marketing, The Hague University of Applied Sciences, Johanna Westerdijplein 75, 2521 EN The Hague, Netherlands.
Email: k.a.poldner@hhs.nl

between nature, technology, and human agency. While his work has centered mainly on the *social practices*, such as trust, of community energy projects (Walker, Devine-Wright, Hunter, High, & Evans, 2010), we are specifically interested in the nano level of *bodily practices* and how these practices intermediate nature and technology.

In this comment, we marry a bodily perspective on community energy projects with the concept of imbrication as "the interweaving of human and material agencies" (Leonardi, 2011, p. 150). Earlier work revealed the value of emotions and bodies in imbrication of human and material agencies to achieve collective sensemaking (Berthod & Muller-Seitz, 2018). We build on this relevance of an *embodied* human agency and include "natural agency" in the equation, which has thus far been left out of the imbrication literature. We argue that by zooming in on these nano practices and how they imbricate with material agencies (technology and nature), we can better understand the success or failure of community energy projects. Our goal is to take a nano organization claim for the special issue by examining regenerative organizing at the community level and specifying "how embodied human practices imbricate natural and technological agencies."

First, we leverage Walker's work on community energy to further explicate the mundaneness of households' engagement with nature by focusing on the nano level of embodied practices. We then review the concept of imbrication, which draws attention to human–material interactions (Leonardi, 2011) but leaves out nature as a third form of agency. Third, we set up the method (abduction) and the context thereby contrasting the two community energy cases. In the Findings section, we establish the missing links and thus the impossibility of directly imbricating nature with technology. We bring in the many ways in which human agency imbricates with both—and thus enables a tripartite nano organization. In the Discussion section, we go all the way back to community energy projects and enlighten Walker's work with our tripartite nano view. In the Conclusion section, we aim to provide an incremental extension to community energy literature by adding the value of studying bodily practices.

Theoretical Framework

We examine nano practices in community energy organizing and pair them with the concept of imbrication to come to a theoretical framework that enables to unravel the role of embodied human practices in imbricating technological and natural agencies. Walker's work on community energy projects forms the foundation of our study, especially its disclosure of the multifaceted relationships between social practices, time, and energy demand (Walker, 2014).

Nano Practices in Community Energy Projects

Many authors stress the guiding role of social factors in community energy, for example, social justice and empowerment (Kunze & Becker, 2015), trust between individuals and different groups (Walker et al., 2010), or the rootedness of initiators in agriculture and in the local place (Süsser, Döring, & Ratter, 2017). Walker (2014) and Koirala, Koliou, Friege, Hakvoort, and Herder (2016) consider the importance of periodic happenings such as diurnal patterns, seasons, as well as socially constructed entities like weeks, opening hours, social events, and distinct local practices that drive energy demand, for example, heating in wintertime (Walker, 2014). While Walker (2014) examines social–ecological interactions driving energy demand, Muñoz and Cohen (2017) are more concerned about the conditions and inputs of the social–ecological context of a place that shape and restrict sustainable organizational activity. The natural agency depends on the biophysical world and therefore provides a largely immutable set of conditions (Muñoz & Cohen, 2017). Natural cycles such as seasonal and/or daily variations in wind, sunlight, or availability of biomass influence the output that energy installations produce (Koirala et al., 2016; Walker, 2014). Thus, the technological agency is in their view closely linked to a natural agency. When we consider climate change mitigation in the context of community energy projects, *change* refers to elements that are altered over a period of decades (Walker, 2014). More precisely, Walker (2014) speaks about "some kind of conversion of energy resources to provide services (e.g., heat, light, movement, power) that are integral to the ongoing performance and reproduction of those practices" (p. 50), for example, sleeping, washing, cooking, and labor in the conventional sense. Because renewable energy sources usually are more dependent on natural input and thereby natural rhythms, balancing natural rhythms (supply and demand) with social rhythms (demand) becomes an important question to social acceptance of new technologies (Walker, 2014). Whereas Walker and others assume that nature and technology go hand in hand, we argue in this research note that to make the alignment happen, we also need a nano-level focus on human agency, such as bodily practices of alignment.

Imbricating Human and Material Agencies Over Time

In our quest to explore *how embodied human practices imbricate natural and technological agencies*, we depart from the notion of imbricating as "arranging distinct elements in overlapping patterns so that they function interdependently" (Leonardi, 2011, p. 150). Leonardi (2011) argues that human and technological agencies are "by themselves not empirically important," but when they become imbricated—interlocked in particular sequences—they together produce, sustain, or change either routines or technologies. To explain "what changes when" depends on an understanding of the sequence of imbrications between human and material agencies (Leonardi, 2011, p. 149). While the interweaving of human and material agencies produces routines and technologies that are regularly used by organizational members, Leonardi argues that past human–material imbrications influence how human and material agencies will be imbricated in the here and now (Leonardi, 2011, p. 152). As Leonardi (2009) suggests,

> Technologies are as much social as they are material (in the sense that material features were chosen and retained through social interaction) and [routines] are as much material as they are social (in the sense that social interactions are enabled and constrained by material properties). (p. 299)

In his work, Leonardi (2011) describes a sequence of imbrications producing changes in both routines and technologies to improve the working process of the studied organization. It is clear that the imbrications are path dependent and describe a ripening of the interplay between human and material agents. However, as "material agency is defined as the capacity for nonhuman entities to act on their own, apart from human intervention" (Leonardi, 2011, p. 148), it is to a certain degree unpredictable both in the outcome and the time dimension. This counts also for the technologies used in community energy projects, where natural input is conversed into energy. The availability of, for example, sun or wind energy is out of human control just like to a certain degree the working of microorganisms in a biogas installation (Koirala et al., 2016; Walker, 2014).

Because of the tight connection between organization and technology that is embedded in a social–ecological context, sudden changes of the context are of consequence for technology and organization. Consequently, community energy projects are confronted not only with more or less linear changes based on imbrications between their organization and the technology but also with the natural cycles they depend on (Walker, 2014) and the possible disruptions they experience due to malfunction of technology or disruption in their contexts. As such, we borrow natural agency from Walker (2014) to complement Leonardi's imbrication of material and human agencies. In tandem, we appreciate the value of a nano view on embodied practices in imbrication theory offered by Berthod and Muller-Seitz (2018). Thus, we marry these insights from the two bodies of literature to arrive at a conceptual lens to study community energy.

Method

This section describes the research context and shortly introduces the two cases. Then, we explain our embedded research approach in how we have observed and analyzed *how embodied human practices imbricate natural and technological agencies*.

Research Context: "Friends and Strangers"

Despite the different legal forms and types of technology that community energy projects use, the selected cases met three key requirements of this study. First, the projects were set up, managed, and run by the community members themselves. Second, the participants were the ones who benefit from its output—may that be economic, social, or other benefits (Walker & Devine-Wright, 2008). Third, the participants lived or worked in the same geographical area, for example, one or more neighboring villages or neighborhoods, in which the installation was placed. The two selected cases used a similar technology—a combined heat and power plant (CHP plant). The technology produces electricity when burning (bio)gas or other types of fuels. The excess heat that comes with this process is converted into useful thermal energy—in our cases, hot water. This water in turn is transported through a local district heating network and used as input for heating and hot water in bathrooms and kitchens at the homes connected to the network. The CHP plant and the heating network together form a local district heating system (LDHS). Case 1 uses petroleum gas as input, which per definition is not respecting the biophysical replenishing cycles. In Case 2 manure and corn is used as input, which is dried and stored so that it can be put into the biogas installation at constant rates, but small variations are possible. Both cases went through similar technological life cycle phases: (1) setting up and adjusting the technology, (2) operation, (3) end-of-life and possible replacement. The different phases ask for different actions by the participants. The following two cases were part of the study.

Case 1. *Strangers*, is an owners' association of 20 households in a neighborhood in a German city with half a million inhabitants. The houses were newly built in 2012 and delivered with the CHP plant and the local district heating network. The future homeowners did not have the possibility to opt out from heating with the CHP plant and had to join the newly founded owners' association. Neither did they know their future neighbors before moving in. The Strangers feed their CHP plant petroleum gas, sell the electricity, and use the excess heat. The participants' main motive for this type of community-based energy was, first, to reduce costs and second, to keep up the promise of environmental sustainability. They assumed that because of the increased use of the output the CHP plant produces, efficiency also increases, but at the same time, fossil fuel is still used. One interviewee of this case is a family friend of the first author. Through this participant, we occasionally received updates on recent developments such as their decision that when the CHP plant breaks down, the Strangers will most likely switch to conventional gas heating (July 2019).

Case 2. *Friends*, is a cooperative in a German village with about 1,400 inhabitants. It uses the excess heat of a local biogas installation, which burns biogas for electricity production for the CHP plant and delivers heat via a 5-km-long local district heating network to 50 premises in the village (47 homes, one sports club, and two businesses). Together with two board members, the son of one of the owners of the biogas installation decided to set up the cooperative in 2009. The investment of 1.2 million euros is partly subsidized by the German state and partly made up of the members' deposits. The 55 members share financial benefits allowing membership even if a participant is not connected to the grid. From the technical perspective, the local district heating is dependent on the biogas installation. No or less production of electricity translates into no excess heat and therefore no input for the CHP plant. On this part, the two systems work closely together, and the son of one of the owners is involved in both. Despite the obvious link between the two systems, the organizations are separate in terms of finances and decision making. The biogas installation guarantees 10 years of free excess heat for the CHP plant. How to get the heat to the premises and at what price is the business of the cooperative. The participants know one another well from village life and feel like a well-working community. The Friends' main motive was that the biogas installation was already in place and people wanted to use the excess heat. The owners of the biogas installation offered it for free to the villagers, partly to appease the resistance in the village against the biogas installation. They consider their CHP plant as environmentally friendly because they use something that otherwise would not be used as input. Apart from that, the two main community members in organizing the LDHS have the CHP plant as a hobby, a side motive. Most of the technical and maintenance work, the board members do themselves. In early 2019, the city council allowed the biogas installation to expand. This means that they can have more members, and they plan to add the local school to their LDHS.

Embedded Research Approach

We adopt an embedded researcher approach, whereby our field trips could count as iterative observations, and thus, absences could be as theoretically generative as presences. We collected the data between November 2015 and July 2019 in the form of semistructured interviews with two Strangers and five Friends. We first interviewed the community members from late 2015 to early 2016, followed by second and third round of interviews on the progress of the project in May 2018 and July 2019, respectively. Every participant was interviewed several times at their own residence or via telephone; thus, the developments within the community were retrospective and the participants presented their personal point of view. In both cases, we gained access through family relationships of the first author who actively engaged in the field, visiting the sites multiple times. In Case 2, we were able to state a preference for whom to speak to, and the interviewees were eager to establish contacts with other participants. In this village, we had the opportunity to collect ethnographic data: Four interviews took place at participants' homes where they showed the researcher their installations and how they engage with them. During these visits, the first author took photographs of the biogas installation, the office, and the heat buffer. Being "embedded" as a scholar—via family and plant visits—enabled the first author to have access to the bodily practices of the participants. Additional interviews with external experts from a utility company and an organization supporting community energy helped increase the understanding of technical and policy aspects of community energy projects in general and specifically the two cases. As the first author works as a municipal policy advisor on energy transition, she works with community energy projects on a regular basis, which gives her a contextual perspective on the dynamics of organizing (finance, legal issues, community dynamics, etc.). Since November 2018, she has had conversations with many other communities that share characteristics similar to our two cases, which has additionally informed this study.

Data Analysis

We looked for three kinds of agencies and their dual and triple interactions and tracked all the ways in which we observed instances of agency and/or interplays between the different forms of agency as this was the unit of observation and analysis. Figure 1 illustrates how memos written during fieldwork helped us establish these interplays. The four Roman numerals in this figure can be found back in Figure 2, thereby tracing back why Imbrication 2 (adjustment to "seasons driving energy demand") failed for the Strangers. In that sense, the memo reflects, in terms of steps in our analysis, one step before we arrived at the aggregated dimensions. We now turn to the

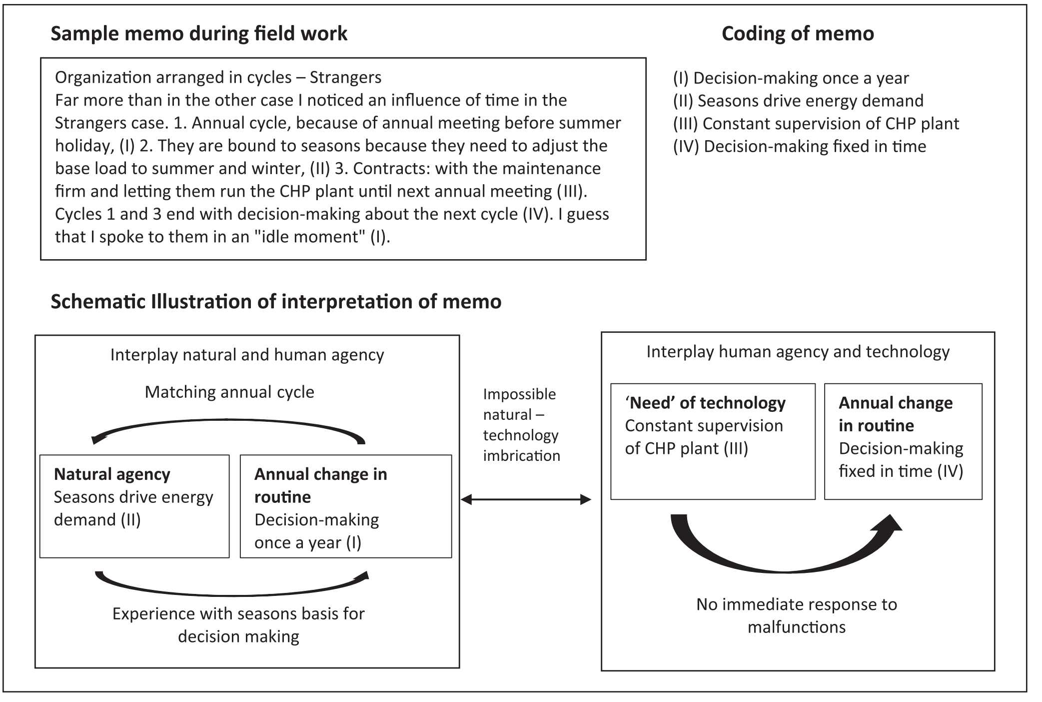

Figure 1. Example of analysis of the interplay of natural and human agencies.

results of our analysis through the conceptual lens of taking into account natural agency and nano-embodied practices in imbricating material and human agencies.

Findings

We found that human agency intermediates between natural and technological agencies, with different degrees of success. The data made us decide to focus exclusively on the practices by which human bodies engage with nature and/or technology. In the following, we will first explain how this dual intermediation leads to a tripartite nano organization between human, nature, and technology (Figure 3). We thereby juxtapose the two cases as they disclose different levels of embodied engagement. After that, we disclose how humans repeatedly imbricate with nature and technology opposing the intuitive nature of the phenomenon with counterintuitive insights (Figure 2).

Tripartite Nano Organization

We found six ways in which embodied nano practices intermediate human, nature, and technology (Figure 3). While discussing the six arrows of Figure 3, we juxtapose the two cases.

Household Engaging With Nature (Arrow 1). Even though in both cases, the strong connection to nature is watered down and human agency is in the foreground, they display very different ways of engaging with nature. Most of the Strangers do not enact a direct engagement with nature, even though a more environmentally friendly way of heating was one of the motivations to move into the complex. The Friends, on the other hand, had the choice to be connected to the grid as for some of them efficient resource use of the excess heat was an important motivation to join. They have strong ties with nature as they always chopped their own wood as a source of heating.

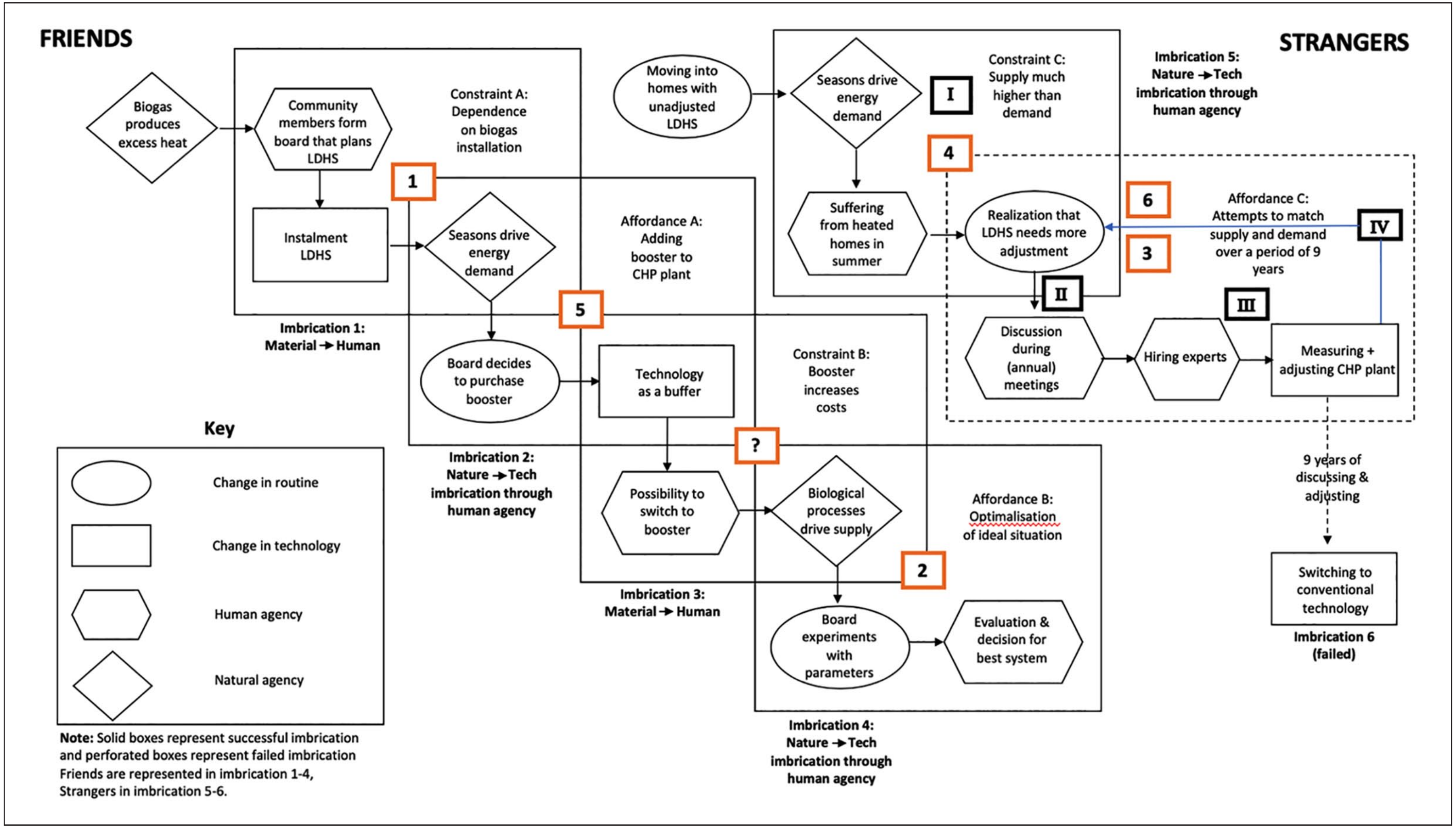

Figure 2. Imbrications of human, natural, and material agencies produce changes in routines and technologies. Roman numbers refer to Figure 1 and numbers in orange frames reflect the six bodily practices proposed in Figure 3.

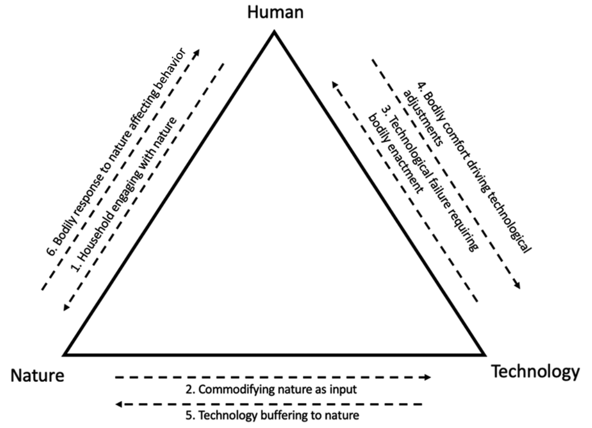

Figure 3. Tripartite nano organization of human, nature, and technology.

As counterintuitive as it seems, some of them still rely on wood for most of the year as one community member reveals:

> In winter we only use wood for our heating, because I have my own wood. In summer we do not use the wood stove, only the heat from the biogas installation. . . . you just have to move two levers. (F1)

Obviously, this family is using the LDHS only when it does not pay off to rely on their old method of heating, because energy demand is low in summer. They are physically engaging with nature—they go to their own forest for wood—when they are *not* using the LDHS.

Commodifying Nature as Input (Arrow 2). It seems as if only "the" Friends are conscious about the fact that nature serves as an input for energy generation. In accordance with the agricultural background of the area, they speak of nature as a commodity like "lumbering," "harvest," "fields," and "crop." It is a common practice to burn wood from their own forests for heating. For the members of the cooperative, connecting to the local heat grid means to switch from getting heat from the woods to getting heat from the fields:

> Part of the heat comes from our fields. It is just like in the past. Back then the heat came from our forests. Just like now, but less, because you need to chop wood and prepare it. The local district heating is easier. (F2)

With this switch, they are no longer dependent on engaging with nature when lumbering and preparing the wood, although some only use the district heating next to their wood heating:

> Now he can still manage the lumbering, but in five years' time he might not anymore. Whether my son will stay here, I do not know. So I said, "Then I will connect to the district heating network and I will not have to look after [the heating]." (F3)

This means that with the introduction of the local district heating, people are less in touch with nature on an experiential, embodied level.

Technological Failure Requiring Bodily Enactment (Arrow 3). During its life cycle, any equipment can have malfunctions or problems because it is not adjusted well. These are instances of its material agency and from a temporal perspective are often disruptive events: They are rather unpredictable but ask for a response from the organization. Here, the two cases show a clear distinction as a consequence of the organizational arrangements. The Strangers did not know one another when they moved into their homes, and the CHP plant was part of the package of becoming a resident in that neighborhood. They had to sign a 10-year contract, and as a consequence, there was no possibility of developing a “let’s do everything ourselves” dynamic. So even if there would be someone in the community who has the know-how, the tendency is to reach out to external experts to adjust the CHP plant. None of the members actually interacts with the engine: The only thing they have control over is to make minimal adjustments at home (bodily practices, e.g., opening the windows and regulating the temperature of their hot water). In the case of the Friends, the organization of the CHP plant relies on skills, resources, and personal networks within the community. They do much more themselves in terms of repairing and technological choices (a higher degree of bodily enactment)—their wish to do so initially influenced their choice of organizational arrangements.

Bodily Comfort Driving Technological Adjustments (Arrow 4). To become more comfortable in their homes, the Strangers were forced to make technological adjustments:

> We have installed a meter to measure what the thing is doing exactly. This way you can get an overview and you can evaluate the data. Based on the results we can then say, “We reduce the temperature. Instead of 70 degrees the CHP plant has to keep the water at 50 degrees, because more is not necessary.” (S2)

In contrast to the Strangers, where the “point of most probable human agency” is in their homes, the Friends have this point at the installation. Because only interviewees F4 and F5 have the technical know-how, they are the only ones “responsible for embodied human agency.” The board decided not to outsource technical improvements, which allows these two interviewees to tackle problems as quickly and early in the chain as possible, usually at the CHP plant. Therefore, the other villagers do not notice the malfunctions at their homes and are not forced to take actions themselves, as in the case of the Strangers. In addition, the Friends also have the possibility to adjust the functioning of the biogas installation, which makes the technology more flexible, but at the same time more complex, from the perspective of the organization.

Technology Buffering to Nature (Arrow 5). The mismatch between demand and supply of heat at any given time poses a challenge for the organizations, and the technology serves as a buffer to nature. Both Friends and Strangers use the adaptability of the material setup to bring about change in technology. Next to having its own life cycle, it is a buffer helping the organizations achieve users’ comfort, and it is used to guarantee that people do not have to change their daily routines. They could collectively decide to accept a number of days without heating or arrange not to shower at the same time, but they choose to maintain their established routines. Thus, their preferred way of matching demand and supply is to adapt the material setup, which is also the preferred way of realizing cost-efficiency of the installation.

Bodily Response to Nature Affecting Behavior (Arrow 6). To a varying degree, all energy systems (also national electricity grids) struggle with a mismatch between demand and supply. The smaller and the less open the grid, the greater the challenge to match demand and supply. The Strangers—a closed and small microgrid—experienced a mismatch, when their installation produced too much heat in summer time:

> Just imagine: it continuously produces heat and we have 30 degrees outside. What do you do? You somehow need to get rid of the heat. So you are ventilating. First, the houses get warm, which is

> unpleasant. The heat has to stay somewhere, so it goes into the air. It means that we are heating the air and just sell for [X] cents. Most probably, the CHP plant does not pay off in summer. (S1)

The practice in both cases is to balance the mismatch between demand and supply to guarantee the users' comfort and to keep the costs low.

Imbrications of Human, Natural, and Material Agencies

We contrast the two cases in Figure 2 by disclosing how in the Friends case four imbrications (Imbrications 1-4) between human, natural, and material agencies surfaced from the data, while in the Strangers case only two imbrications surfaced (Imbrications 5 and 6). We include reference to the six bodily practices reflected in the arrows in Figure 3.

Imbrication 1 (Material→Human). It all started with the biogas installation producing excess heat nobody used. The biogas installation was built close to the village, but not everyone was pleased with its arrival. It was thus a strategic move of the owners to offer the excess heat to community members for free to heat their homes. A few villagers set up a cooperative to exploit the excess heat (change in routine). The village saw the environmental benefits of using excess heat for heating, and for some, it was an important reason to join the cooperative (Arrow 1). The board started to make plans to set up an LDHS (human agency), which they eventually did (change in technology), initially adding 10 houses to the grid. That first winter provided an eerie experience to the community members of trying out the new heating system as one interviewee reveals:

> It was important that this section, the first 10 houses, gets through the winter. We did not have an emergency heating then. So we also did not have a buffer or anything. We were totally dependent on the biogas installation. We just prayed. Either the winter will not be that harsh or it works with the biogas installation. It worked and was ok. (F4)

Thus, we see how material agency (what to do with excess heat coming out of the biogas installation) imbricates with human agency leading to the installment of a technology.

Imbrication 2 (Nature→Technology Imbrication Through Human Agency). The community quickly realized though that their dependency on the biogas installation and the LDHS (Constraint A) might be risky. The weather, usually following a seasonal pattern, drives energy demand (natural agency): In winter, more energy is needed than in summer. At that stage, the system was still fairly new to the community members so they were not able to fully trust it yet. Driven by a fear of a mismatch between demand and supply and then ending up with cold homes, the board decided to purchase a backup booster (change in routine). This new piece of technology was added to the existing LDHS (Affordance A), which then altogether functioned as a buffer to nature (change in technology, Arrow 5). As one interviewee clarifies,

> If the [biogas installation] fails in winter, all our houses turn cold. That is not acceptable. So they have a large oil heater that can supply all the households. It is only meant for emergencies or for winter days with minus 10 degrees and there is not enough heat. (F1)

Here, we observe how nature and technology imbricate through human agency: Nature has seasons, which make it necessary for people to react and adjust technologies as they cannot change the seasons or the weather.

Imbrication 3 (Material→Human). The possibility of switching on the booster when the biogas installation fails or does not produce enough heat to serve all community members enables community members to control their indoor climate (human agency). As one interviewee describes,

> Every now and then the installation fails, but as a user you hardly notice it. Since we have been connected to the grid, we always had enough heat at home. (F3)

The technology appeared to work well as a buffer to nature, but the next problem they encountered was that the booster uses fossil fuels, which the community members need to pay for (Constraint B). The buffer needed to be improved in terms of cost (continuation of Imbrication 2, Arrow 5) and forced the board to go back to the drawing table and change their routine. They started thinking how to reduce costs and turned to the biological processes in the biogas installation to come up with an answer. What we observe is that they start off with technology, and in turning actively to the natural or biological processes, they imbricate from material to human agency.

Imbrication 4 (Nature→Technology Imbrication Through Human Agency). While community members were first insecure about a mismatch between supply and demand, the added technology had reduced this fear and boosted their confidence. In case anything would go wrong, nobody needed to suffer from a cold home as the community members now had the booster as a backup. It empowered them to work together with nature in experimenting with the parameters of the biogas installation, such as temperature or composition of material entering the biological process (change in routine). Once again, nature is not more than an input to an installation, which you can control and adjust (Arrow 2). They collect data and evaluate these data, which helps them decide for the best option in certain situations (human agency). As one interviewee explains,

> By now we are trying to run the [biogas] installation in a way that it produces more heat in winter, because that is when you need it. During summer we produce less. (F5)

Through manipulating nature (the biological processes in the biogas installation), they have created the optimal system in their situation (Affordance B).

> We have optimized several things in the installation. Nobody can measure and evaluate data for hours. So you need your own ideas for optimalization. (F5)

Imbrication 4 thus discloses how nature imbricates with technology through human agency (manipulation of both biological processes and technologies).

Imbrication 5 (Nature→Technology Imbrication Through Human Agency). The Strangers moved into newly built houses, and the LDHS was included in the package. However, in the beginning, the CHP plant was not adjusted—producing the same amount of heat every day. In the first summer, this led to problems as the demand for heat was much lower than the supply (Constraint C). As the community members were unable to turn off their heating, they suffered from high temperatures at home. Their bodily discomfort triggered the need to adjust the system (Arrow 4). Also due to disproportionally high bills for heating, they realized that they needed to adjust the CHP plant:

> But the supplier practically delivered the CHP plant, put it here and then said: "have fun with it." You can vary the efficiency with different adjustments. It is absolutely clear that a CHP plant needs to be adjusted differently in summer than in winter. But how? (S1)

We see here that different energy demands in summer and winter makes it necessary for community members to act if they want a system that caters to their needs and patterns.

(Failed) Imbrication 6. The Strangers had to come up with a solution to the problem: How to match supply and demand? (Affordance C). They realized that they had to address the problem themselves

and organize a way to repair or adjust the system (Arrow 3). Because none of them had the know-how or was willing to figure out the right settings for the CHP plant, they decided to hire an expert during their annual meeting. This expert measures the activity of the CHP plant and adjusts the parameters, if needed:

> We have installed a meter to measure what the thing is doing exactly. This way you get an overview and you can evaluate the data. . . . Based on the results we can then say: "We reduce the temperature." (S2)

The contract between the Strangers prescribes that important decisions, like the operation of the CHP plant, need to be taken unanimously or at least with a majority. Decision making takes place during the annual meetings or extraordinary meetings that the community members initiate themselves. Because of this fixed pattern of decision-making moments, they are unable to quickly react to the discomforts they experience at home. The first adjustment of the CHP plant did not bring the desired results, and thus, a cycle of collecting data, experimenting with the setting of the CHP plant, and decision making about the next step started. Their wish to finally live in comfortable homes with reasonable bills made them continue participating but over time with decreasing eagerness (Arrow 6). After 9 years of trying to adjust the system, they have given up (July 2019):

> That is why the motivation is low to keep the CHP plant after the period of the guarantee (in total 10 years) and to replace it later. Most likely it will run until the end of its days. Then we will use a conventional gas heating to guarantee heat supply. (S1)

The Strangers were unsuccessful in imbricating nature and technology and thus matching supply and demand. Slow decision making and lack of know-how or willingness to use it inhibited the prompt that the human agency needed to guarantee comfortably heated homes at a reasonable price. The Friends succeeded in matching demand and supply, because they were able to take action at the right time. The Strangers failed to do so because their way of organizing prevented them from taking timely actions to reach imbrication between nature and technology. Their yearly decision making is aligned with the season cycles but makes it difficult to take ad hoc decisions in case the technology malfunctions. In addition, it remains unclear to what extent the CHP plant is overdimensioned for the number of households. Because they did not know one another before moving in, a community-based way of organizing like what the Friends have established was impossible. In addition, they did not have anybody with the technical know-how or willingness to use it. While the Friends reached an optimal situation, the misalignment of nature and technology in the Strangers case resulted in them wanting to switch to conventional heating systems.

Discussion

In this research note, we have built on earlier insights regarding the role of nature in the interplay of human agency (social practices) and technological agency in community energy projects. The challenge for both cases lies in intermediating human agency with nature and technology, which makes it the dependent variable of the set. If not "corrected for" by community members, energy production would only take place when sufficient natural input is available. On the other hand, we have the energy demand, which is driven by social activities. In the case of Strangers, the bodily aspects of human agency for all community members are restricted to their homes. In the case of the Friends, bodily aspects of human agency are wide ranging: from installing the pipes from the streets to their homes themselves to be able to connect to the grid to the maintenance practices that members enact on a daily basis.

Our analysis brings us all the way back to community-based energy projects and supports incremental extension of Walker's work (e.g., Walker, 2014) with our tripartite "nano" view. We also elaborate on the concept of imbrication, which draws attention to human–material–technology interactions but misses out nature (Berthod & Muller-Seitz, 2018; Leonardi, 2011). In Leonardi's case, goals change technology and technology changes goals, but in our case, however, nature and technology *do not* imbricate *unless* human agency intercedes. As we have shown, overheating is felt by community members before the controls are turned down, and venting to maintain the technology is suffered by them. Thus, we attempt to contribute the value of natural agency to studying imbrication, especially in the context of regenerative organizing and climate change mitigation.

Conclusion

The radically different contribution we aim to make is a tripartite imbrication that brings in natural agency alongside the human and the technical and specifies precisely how nano (smaller than micro) embodied practices afford mis- and realignments. We use imbrication as a key concept to theorize how human, bodily, intermediation occurs between nature and technology at the community level of sense making (Berthod & Muller-Seitz, 2018). Sociomaterial performativity tends to remove the ability to draw on the body as "the most fundamental interpretive vehicle for how to understand the world" (Berthod & Muller-Seitz, 2018, p. 64). In the light of an increasing interweaving of human, nature, and technology (notably in the work of author Yuval Noah Harari and designer Koen van Mensvoort who argues that technology is human's *next nature*), the study of imbrication—with a nano focus on bodily practices—will only become more relevant. Our nano view familiarizes households with regenerative organizing since they already rely on it. The absences of embodied practices also explain the breakdown, why meta-challenges remain disconnected—perhaps because they do not bear down on their bodies every day and every season. The uber-concreteness of our observations makes them accessible, and relevant, to strangers and friends alike in neighborhoods the world over.

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ORCID iD

Kim Poldner https://orcid.org/0000-0003-1781-7546

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Author Biographies

Charlotte Walther graduated from Wageningen University in Urban Environmental Management (cum laude). She successfully defended her thesis on entrepreneurship in community-based energy and is passionate about renewable energy, climate change and qualitative research. At the moment she works at the Dutch municipality of Oude IJsselstreek where she advises policy makers on community-based energy, energy saving at household-level and large-scale generation of renewable energy.

Kim Poldner (PhD, University of St. Gallen, 2013) is Professor Circular Business at The Hague University of Applied Sciences. Her research interests evolve at the crossroads of entrepreneurship, aesthetics and sustainability and she has published in journals such as Organization, Journal of Business Venturing, Business & Society and Journal of Cleaner Production.

Helen Kopnina (PhD, Cambridge University, 2002) is currently employed at The Hague University of Applied Sciences in The Netherlands, coordinating Sustainable Business program and conducting research within three main areas: environmental sustainability, environmental education, and biological conservation. Helen is the author of over ninety peer-reviewed articles and (co)author and (co)editor of sixteen books.

Domenico Dentoni is Associate Professor in the Business Management & Organization (BMO) group of Wageningen University and Senior Expert on Entrepreneurial Learning in Inclusive Agribusiness for the Consultative Group for International Agricultural Research (CGIAR) and Dutch Scientific Organization's partnership on Climate Change, Agriculture and Food Security (CCAFS). Domenico's research, education and outreach activities focus on the organizing of multi-stakeholder partnerships to address grand sustainability challenges in socio-ecological systems. On this theme, Domenico made scientific contributions in the domains of entrepreneurship, organization studies, and business and society. He currently manages six transdisciplinary projects seeking to address climate change and food insecurity issues in Sub-Saharan Africa and South-East Asia with funding from five public institutions worldwide