Technoecologies of Solar Commoning: Activating the Immanent Potentials of Solar Infrastructure, Practices and Affect

Dagmar Lorenz-Meyer

ABSTRACT In the context of accelerated climate crisis this article investigates the energetic-political possibilities of solar energy in the Czech Republic. In the absence of solar cooperatives, the article examines residential PV installations and a ground-mounted solar mono-plantation as a terrain for possible commoning. It proposes technoecologies as a framework and tool to not only focus on what solar infrastructure brings together, but also what is left out or *dis*articulated in specific arrangements but can be seen as infrastructure's productive "limits" that entail possibilities for differential inclusion, regeneration, and care. Ethnographic technoecological analysis shows how unexpected plant growth within the plantation points to multispecies refuges transforming the electric monoculture, and how electrical rewiring could connect PV arrays to households in multiple occupancy buildings (*paneláky*) in ways that enable new forms of sharing and joyful squandering of electricity in times of energy abundance.

KEYWORDS communing, solar energy, technoecologies, plantation, sense-ability, infrastructure, re-articulation

Introduction

Against the backdrop of environmental degradation, species extinction and climate crisis in late liberalism, there is renewed interest in the energetic-political potentials afforded by solar energy (Szeman and Barney 2021; Smith and Scott 2021) and in recrafting communal forms of being, knowing and doing that activists and scholars in the Global North term "the commons" or, to denote the activity, "commoning" (Haines and Hitchcock 2019; Gibson-Graham et al. 2016), and those in the Global South might call *buen vivir* or *mino-mnaamodzawin* ("living well") (Escobar 2018; McGregor 2021). But even though scalable photovoltaics (PV) have been envisioned as a "community technology" (Hess 1978) already in the 1970s, these concerns have largely remained on parallel tracks. Social science research on solar energy has examined the "energy use behaviour" of consumer-producers, solar cooperatives, and energy policies that facilitate "solarisation pathways" (Mah 2019). Inequities in access and participation, and the ecologies embedded in photovoltaics, however, often remain side-lined in this work.

Sociální studia / Social Studies 1/2022. S. 91–110. ISSN 1214-813X. https://doi.org/10.5817/SOC2022-29554

Studies on the commons have explored the practices and protocols of sharing resources held in common within and against market-driven practices of enclosure and accumulation ranging from the commoning of city squares and a city's air to open-source software development and guerrilla gardening. While thinking with resources entails a focus on material limits, commoning also emphasises the potential of creating cascades of abundance, for example in the form of regenerative economies (Bollier and Helfreich 2016). Emerging conceptions of an "electric commons" (Melville et al. 2017) have arisen in conjunction with information technologies, particularly smart meters, and tend to draw on experiments with producing and sharing electricity at the neighbourhood level. More radical possibilities of interlinking peer-to-peer microgrids in an "energy commons" (Griotitas et al. 2020) that respond to electricity's mobility and resistance to being "thingized" (Bakke 2019) and "owned" are currently impeded by "regulatory barriers in capitalist market structure, non-participation from network operators, or community acceptance itself" (Griotitas et al. 2020: 5).

This lack of public acceptance is noted particularly in postsocialist countries, where the dearth of renewable energy cooperatives is often attributed to antipathy to the historical collective action mandated during state socialism (Capellán-Pérez et al. 2020). While the absence of solar co-ops in the Czech Republic would suggest that solar energy commoning cannot be researched, this article examines existing solar infrastructure in the form of a ground-mounted solar farm and grid-connected residential PV rooftop installations as an immanent potentiality for commoning (Berlant 2016), a terrain for possible transformation and regeneration towards what LaDuke and Cowen (2020: 245) call "alimentary infrastructure – infrastructure that is life-giving in its design, finance, and effects". The article proposes technoecologies (Lorenz-Meyer et al. 2019) as a feminist materialist framework and tool to examine these potentials within infrastructural arrangements, or assemblages, that sustain some lives and thwart others.

Technoecologies is informed by scholarship that has emphasised the mutual imbrication of ecology and technology (Guattari 1980; Haraway 1992; Barry 2001) where "the machinic and the textual are internal to the organic, and vice versa in irreversible ways" (Haraway 2003: 15). As I have developed it, technoecologies put the onus on situated practices of articulation, disarticulation, and re-articulation of heterogeneously constituted assemblages and attend to their "sense-ability" (Treusch 2017) and ethos (Stengers 2005), particularly the possibilities of care and solidarity, albeit without obfuscating their partiality, precarity, and violence (Lorenz-Meyer 2017). According to Donna Haraway and Anna Tsing, assemblages are "open-ended gatherings" (Tsing 2015: 23) of bodies, substances, and forces, "knot[s] in the always historical and heterogenous nexus of social nature" (Haraway 1992: 311). Articulation refers to the contingent practice of joining heterogenous elements in assemblages whose "boundaries take provisional, never-finished shape in articulatory practices… [that change] the patterns, flows, and intensities of power" (Haraway 1992: 313, 314). Haraway points to "the empty space, (…) the 'negativity'" (p. 313) *within* articulatory practices that constitute the potential for the unexpected, the indeterminacy that is important for transformational infrastructure (Berlant 2016; LaDuke and Cowen 2018).

The technoecological ethnographic analysis of solar infrastructure as a conduit and embedding environment of commoning that I present here contributes to the theory of infrastructural assemblage and its potentials for commoning in three ways. First, it demonstrates not only what solar infrastructure brings together or articulates, but also what is left out or *dis*articulated in specific solar arrangements. Inspired by Haraway (1992), Karen Barad (2007) and Isabelle Stengers (2005), technoecological analysis shows that what is disarticulated can be seen as infrastructure's productive "limits", nodes where relational elements reveal their transformative capacity. While Tsing (2022) explores these "edges" of infrastructure arrangements as sites where feral entities emerge, technoecological re-articulation shows how edges that exclude also point to productive possibilities for differential inclusion, regeneration, and care.

Second, in focusing on the generative ambivalence of what the solar infrastructure "dis/articulates", the analysis also creates an analytical opening to explore the entanglement of time: vestiges of the infrastructure's past that remain barely sensible can, when rearticulated in technoecological analysis, become "elements" or pointers for infrastructural transformation in a future that might already be emerging. Third, in order to attune to particular traces of dis/articulation, technoecologies examine situated "sense-abilities" (Treusch 2017) of the "lively and mechanical interconnections that remain unseen prior to establishing a common relation" (Weber 2018: 85). By sensing boundary incursions and unexpected connections, technoecological sensibilities disrupt a sense of self-possession and sovereignty, thereby contributing to what Lauren Berlant calls "revisceralizing the commons" (2016: 408), potentially dishabituating a sensorium adapted to containment and separation and opening it to sensing regenerative potentials.

Empirically, this inquiry of solar commoning focuses on two case studies that emphasise enclosure, private ownership, and the severance of community bonds: a utility-owned solar farm or plantation in the countryside, and so-called "solar island systems" on rooftops in Czech cities and villages. Ethnographic fieldwork was undertaken intermittently around the solar farm in a former military training area between 2016 and 2019, complemented by a series of participatory photography workshops with Roma and ethnic Czech residents and immigrants from Ukraine who lived near the solar plantation. Interviews were conducted with an ecologist, five members of the solar industry, and 14 solar householders and micro-producers. These data were complemented by information from sources such as PV advertising displayed at technology fairs, an online group of micro-producers, and a local memoir.[1] I now turn to the technoecological analysis of the first infrastructural arrangement, the photovoltaic monoculture.

---

1 This research was supported by the Czech Science Foundation (GA17-14893S). I am indebted to the research participants who were willing to share their experiences, and to Olga Senkova and Lenka Weinbergerová for accompanying me to "Orlik" and helping organise the photo workshops. I am grateful for the comments by the two reviewers and by Bob Kuřik and Pavel Pospěch that helped me to clarify the argument.

Replenishing Photovoltaic Plantation

Dis/articulating the Assemblage of Electric Monocrops in "The Zone"

There is consensus that ground-mounted photovoltaic power plants, which still produce most of the Czech Republic's solar generated electricity, are best installed on brownfields, or land already contaminated through agricultural, military, or industrial activities. The programmatic article "From Wasted Land to Megawatts" (Klusáček et al. 2014) suggests that even the most "unattractive locations" on the peripheries of Czech towns and districts could be made profitable through large-scale solar infrastructure. Assumed to be inhabited by no one, such land notably does not appear to require care about socio-environmental impacts. This was the case with the dispersed solar farm that I have researched in northern Bohemia. Located within a vast former military training area, it became the Orlík Photovoltaic Power Plant (pseudonym) when the largely state-owned electric utility ČEZ purchased and leased plots from private investors and the municipality. While these deals were enmeshed in suspected fraud alleged to have produced wealthy "solar barons" (Klímová 2020) – a figure pointing to plantation lineage – here I trace the plant's dis/articulations onsite.

A challenge of researching photovoltaic installations is their inaccessibility and uneventfulness. To get a sense of these plantations of electricity harvesting that people in Orlík did not much want to see, I had to walk along the fences enclosing the arrays of photovoltaic panels or "mirrors" that the local Roma called Mirrorland, a term denoting the vastness but possibly also the mirror maze's effect of sensual and economic deception. These walks took me through untended edge places, areas bordering on forest slopes, savannah, an accommodation road, a nature reserve, an incinerator, and an annihilated Sudeten German church. The following field notes pick up on the delimitations of the enclosure as well as minor boundary incursions and a sense of institutional abandonment whose significance for commoning appeared only later:

> A small passageway had been cut through the thicket so that one person could walk next to the high wire fence [of the solar farm], fitted with motion detectors halfway up. I notice deer tracks; I gaze into the security camera – anybody looking? Eerie silence. On the inside, the grass is kept short, broken up by patches of asphalt (…) The site looks orderly in the regular array of identical black panels, boringly so! Later I see a small hole cut in the lower fence, and notice molehills and rabbit droppings inside the field. (Fieldnote 2016)

> Again, we did not meet anyone on the hours-long walk around the field. Autumn fog, grey skies and light rain blur the contrast between the grey shimmering panels and a deserted factory in the distance. Our Wellington boots stick in the mud as we walk along deserted railway tracks, then climb up a shooting stand overlooking the field. (Research assistant) Olga remarks that this feels like the Zone in Tarkovky's film *Stalker*. (…) A German shepherd barks fiercely in a tiny pound next to the boot of a security guard. (Fieldnote 2018)

Olga's reference to the contaminated exclusion Zone – filmed at a deserted hydropower plant which raises the spectre of renewable energy ruins to come – points to Orlík's ruins which include less visible damage caused by leakages from abandoned military equipment and ammunition, hinting of violence and evoking a palpable sense of abandonment. Conventional demarcation or disarticulation devices such as fences, guard dogs and surveillance cameras

cordon off the uniform rows of PV arrays from their feral surroundings. How incoming photons articulate with or rather bump into and displace electrons within the silicon wafers and draw them into a circuit generating electric current, and where this electricity will go, remained intangible to my human sensorium. Only the quiet hum of electricity and the lightning strikes on the transformer house alluded to the potentially deadly circuits of electric power generated within the plantation of electric monocrops. The presence of asphalt patches, moles and the one-way power mast within the enclosure signalled that the plantation's disarticulation was not absolute.

Referring to the proliferation of plantation systems, Tsing (2016) has argued that the *disentanglements* (or disarticulations) of plants and people from their surroundings are necessary for the plantation to produce standardised resources. Plantations, she writes, are

> those ecological simplifications in which living things are transformed into resources – future assets – by removing them from their life worlds. Plantations are machines of replication, ecologies devoted to the production of the same. (…) Yet, everywhere, they are formed in vernacular histories, which tie them to the contingencies of encounters and the peculiarities of places. They can never be everywhere because they depend on the entangled landscapes they disentangle. (Tsing 2016: 4, 5)

A closer examination of this infrastructural assemblage reveals the vestiges of seemingly disentangled histories, inhabitants and places of production that enabled the plant to be built at this site and which can become sense-able within the plantation. First, the traces of dispossession: military site plans suggested that the asphalted patches were residues of Soviet military storage facilities that had been costly to remove. Their presence was predicated on the expulsion of Sudeten German smallholders who had lived on this land until the end of World War II. A memoir by a former Sudeten inhabitant of Orlík recalled the grains and forest fruits that once grew here, now replaced by the asphalt and trimmed grass that bore the panels' cables and frames. Second, the traces of offshore labour: Roma residents woefully remembered that uninsured migrants from Slovakia, rather than local community members, were hired for the solar construction, underscoring that "it is more efficient in the logic of the plantation system to exterminate the local labour and bring in labour from elsewhere" (Haraway et al. 2016: 557). Although not legible from the perimeter of the fence, tags on the back of each module recorded the panel's capacities and place of production, including their street address and phone number in China (Figure 1), thereby recalling the materials and labour embedded in the solar panels.

Cheap labour and weak environmental regulations had turned the provinces of Jiangsu, Qinghai and Xinjiang into global centres of PV production (Šoltés 2018). The tags are vestiges of the infrastructural logistics of sometimes deadly mineral mining, PV production and transportation by container freighters (Cowen 2014) that are dis/articulated with/ as the Orlík's solar plantation. In the framework of technoecologies, these multi-layered displacements and dispossessions of minerals, plants and people that include the supply chain as "the networked 'grounds' for a commons" (Cowen 2014: 229) remain a constitutive part of Orlík's solar plantation: a past and present that oblige care and accountability. Potentials for accountability (the ability to render account) emerged with the capacity to

sense being in common with others: the constitutive entanglement of bodies, soil, capital, and chemical compounds into the future that those living in the Zone reckoned with.

Figure 1: Chinese PV tags within a solar plantation, 2018. Photograph by the author

Sensing the Dis/articulations of Infrastructural Residues and the Potential of Care

Inspired by Treusch's (2017) conception of sense-ability as constituted by and constitutive of a milieu of human-machine intra-action, technoecological sense-ability here focuses on the capacity to attune to present, past and future entanglements of the technoecological bodies we are and become with. Given the plantation's remoteness, I was surprised how Orlík's residents felt personally intertwined with the solar infrastructure in ways that were monetary, affective, and corporeal. Not hiring unemployed Romani labourers who supported the feed-in-tariffs with their electricity payments rendered Mirrorland an embodied rem(a)inder of racist injury for many Roma (Lorenz-Meyer 2017).

The following exchange arose when we viewed the photographs that Mrs. Jirásová had taken for one of our photo workshops with Czech and Ukrainian participants. Although the panoramic shot depicted tree-framed solar arrays with sheep grazing between the panels (Figure 2), the conversation quickly turned to its gestation from the felling of onsite trees to the alleged bribery of a now departed member of the local authority who had certified the plant before its completion so that the utility company was eligible for lucrative feed-in tariffs.

Figure 2: Orlík's solar plantation, 2018. Photograph: Mrs. Jirásová (pseudonym)

> Mr. Procháska: People feel this is a big theft and *what will be*. If it served good things, they wouldn't mind, there are so many forests here that this is a drop in the ocean. But when you realise that the three people involved cleared off, and we will all pay for the rest of our lives with the electricity being a tenth more expensive. And especially in view of what will happen with it. In 20 years when the lifespan of these panels ends, we will have landfills here, and in them – how to say it politely – ugly chemicals, I don't want to say ecological catastrophe, but it will be terrible.
>
> Mr. Jirásek: The company pretends to go bankrupt, the state will liquidate it.
>
> Mr. Procháska: First the metal is stolen that can be recycled…
>
> Mr. Jirásek: … then the wire-mesh disappears so they have better access…
>
> Mr. Procháska: … and then there will be accumulated chemicals…
>
> Mr. Jirásek: … and we will still be cleaning it up. (Photo workshop 2018)

Likely informed by witnessing environmental contamination, theft, and the tunnelling of assets in the military training area after the collapse of state socialism and the departure of the Soviet army in 1991, technoecological sense-ability here entails the capacity to unfurl the solar arrays into a wider set of economic, political, and chemical relationships and vulnerabilities. This includes connecting utility profits with the participants' own increased electricity bills, and more significantly sensing the indeterminate agency of infrastructural residues: in looking *at* a photograph of the photovoltaic arrays these men *saw* landfills and accumulated chemicals leaking into and transforming the soil, groundwater and by extension

human bodies: a diffracting dis/assembling vision that makes tangible the impossibility of determinate borders between humans and solar infrastructure as it anticipated photovoltaic decomposition and institutional abandonment.

While it was clear that participants cared *about* these interrelations that did not include the sites of PV production, this did not entail a blanket rejection of rooting future solar plants in Orlík. Sensing the permeable boundaries of infrastructural bodies thereby presents an occasion for "unlearning the expectation of sovereignty as self-possession" (Berlant 2016: 408) and directs attention to the possibility of more generative co- and decompositions. Here the account speaks of a distrust of institutional oversight that has been linked to Czech peoples' experiences of state corruption and their disappointment in institutions that "have shown neither the interest nor the competence to tackle the important problems and to work out proposed solutions" (Horáková 2020: 68). And yet, given the importance to "acknowledge the limits of traceability [lest they] merely become an exercise in public relations" (Sovacool et al. 2020: 31) emphasised by European industry watchdogs and programmes for PV recycling and supply chain monitoring (Mulvaney 2019), such institutional distrust might also be a potential for rejecting procedural fixes and activating "many different minor worlds of reparation" (Papadopoulos 2021: 57).

Environmentalists who have conducted research in Orlík have contributed to the nuancing of technoecological sense-abilities by conversely unfurling Orlík's "military nature" (Davis 2007: 132) into dynamic processes that disrupt any sense of ecology as a harmonious balanced environment. Geographers and ecologists have found that military activities do not merely destroy social natures but by disturbing some areas and not others, and making industry and commercial agriculture impossible, assist in creating mosaics of habitats that are more bioculturally diverse than nature reserves (Marhoul and Zámeční 2012). In other words, random violent events that "cause mortality and change resource availability and composition" (Newman 2019: 2) are also life sustaining. My interview with ecologist Tomáš suggested that it was the *absence* of military disturbance events that ushered in the loss of "places of refuge" (Haraway 2015: 160) for machinic-multispecies regeneration.

> Tomáš: The most interesting areas are patches with bare ground and short grass, and open grassland, places created by disturbance produced by fire, tanks, and explosions (…) And we know that over the past 20 years in some military areas we have *lost* species that need these specific conditions – I'm talking about butterflies, for instance. Some of these species lived there when the soldiers were there, and after the army left, they continued living there for another five or six years, and then went extinct.
>
> Dagmar: So, these species are *gone*? They are gone from that area? Or are they gone – completely?
>
> Tomáš: They are gone from the area, and some are gone from the Czech Republic. (Interview 2017)

Tomáš reminds us that even in their wake, infrastructural residues can still inflict violence, often in ways not anticipated by humans. While I had been elated to learn about biocultural diversity in land ostensibly wasted, my hopeful suggestion that species losses might be

spatially limited underscores how hard it was to affectively reckon with the fact that Orlík's solar infrastructure was irreparably also a site of extinction and expulsion of both human and more-than-human inhabitants. For ecologists, solar enclosures with their cropped grass have been excluded from experiments with recreating disturbance, for example through re-introducing European bison. What cues, then, can a focus on technoecological sense-ability of infrastructural dis/articulation provide for a nonreproductive refiguring of how Orlík's solar plantation can become a more promising site of annihilation and attachment for a future in common?

Re-articulating Edge Places

In their critical analyses of plantation zones, Black feminist scholars have pointed to the "plot of land planters gave slaves to grow food to feed themselves to maximise profits" (Wynter 1971: 99). Silvia Wynter (1971) has examined these ambivalent breeding and burial grounds as sites of "transplantation" (p. 99) that re-articulated African plants and knowledges to gestate alternative values and resist the plantation order. Haraway (2015) has identified these plots as places of potential multispecies collaboration:

> Nurtured in even the harshest circumstances, slave gardens not only provided crucial human food, but also refuges for biodiverse plants, animals, fungi, and soils. Slave gardens are an underexplored world, especially compared to imperial botanical gardens, for the travels and propagations of myriad critters (p. 162).

During my last research trip to the Orlík solar plantation I was preoccupied with sensing the plant's soundscape. Following the hum of electricity emanating from the transformer house along the fence, I heard buzzing bees. Shrubbery around the enclosure had erupted in abundant blossoms of different colours. Suddenly, I noticed that grasses and flowers had grown waist-high inside the plantation grounds. Whether by accident or negligence, the inaction of subcontracted maintenance workers, the seedlings of untended edge places and the partial permeability of the fence had conspired to produce new articulations that had infiltrated the electric monoculture. Alternative plantation futures might indeed still be possible – if we rebuild dis/articulation devices to assist in regeneration and "replenishing refuge" (Haraway 2015: 160).

Even though they start from a conceptual separation of technological and ecological systems, "techno-ecological synergy" (Bakshi et al. 2015) approaches can help cultivate sense-ability for the multitude of actors and relationalities across the commodity chain. Aiming to devise "mutually beneficial or synergetic relationships" (p. 1752), this research has paid careful attention to the situated effects of minutia like panel shading and precipitation loss, heat island effects, soil microbiota, fencing, and site-specific mortality of plants, insects, and animals (Moore-O'Leary et al. 2017; Hernandez et al. 2019). In the vein of technoecologies, instead of providing ready-made solutions such as "agrivoltaics" or "rangevoltaics" – the combination of photovoltaics with crop production or livestock grazing (Hernandez et al. 2019) – that risk exacerbating a plantation logic of assetification, techno-ecological synergy helps us attune to the specificities of dispossession and disturbance

and explore who and what is at stake in partial technoecological regeneration. What if we build solar infrastructure attachment sites for diverse species assemblages that subsist in the edges? This would suggest a more variegated relational design (Escobar 2018) and above all require calibrating the disruption of vegetal growth to *not* "conform to uniform treatments and regular schedules" (Newman 2019: 4), for as Tomáš explained, "if you uniformly cut a meadow the majority of species will be lost".

While it remains to be seen whether such experiments that already might unfold in the present would produce more relational designs of PV production and decomposition, they are beginning to build "minor worlds of reparation" (Papadapolous 2021) that thwart a logic of extractive monoculture. Energy-poor households in the blocks of flats standing in the shadows of the solar plantation remind us that more collaborative design also concerns the conduits of solar generated electricity, as I will examine next.

Multiplying Electric Connections in Housing Estates

Dis/articulating the Assemblage of Solar Island Systems

With PV plants above 30kW ineligible for state subsidies for renewable energy sources after 2010, almost exclusively rooftop photovoltaics were installed over the past decade in the Czech Republic. Until 2013 these installations were supported by initially lucrative feed-in tariffs, and from 2015 by one-time subsidies for up to 40% of the costs of PV panels and batteries on condition that at least 70% of the generated electricity was used in the home. Mobilising the appeal of "the so-called island concept" (Scheer 2001: 105) of off-grid solar arrays that emphasise energy autonomy, residential rooftop PV arrays combined with batteries are often called solar island systems (*ostrovní solární systemy*). Together with the idea(l) of a turnkey technology, imperatives to "Invest in your independence" (X-Solar) were endlessly replayed in PV advertising addressed to middle-class white men who, according to industry representatives, were also their main customers.

The following blog post from an online group of solar micro-producers, who shared information, advice and occasionally electricity converted into chemical energy in the form of batteries of layered chemicals, begins to complicate the appeal and the reality of electric independence. At a time of abundant electricity production, visualised in a graph from his digital solar app and with an emoji of feeling disappointed, micro-producer Pavel wrote:

> With a heavy heart I have just shut down the solar system because of high overflow that at this moment I can no longer consume myself. Well, I could send the energy to the neighbours but according to my distributor I could be fined, so I'd rather not produce green energy at all. A very logical and thoughtful attitude. I wouldn't say anything if there was a photovoltaic system on every fifth roof but as far as the eye can see there is only one other system out of hundreds of roofs. So here in Prague my few kW would dissolve like nothing. (…) Does anyone have a solution for this? (Blog Post 2019)

In contrast to self-sufficiency, this post speaks of the mandated necessity to temporarily cut off a domestic PV power plant from the infrastructural assemblage of the electricity

grid. It thereby draws attention to the solar island system's constitutive articulation with the grid, legal regulations, and the micro-producer. Here the blog post makes tangible the producer's practical and affective involvement, enabled by a digital application, specifically his desire to *share* excess electricity via horizontal transfers with others that were contractually blocked by the utility or distribution company (cf. Griotitas et al. 2020).

This does not mean that energy autonomy is unappealing. In interviews, solar micro-producers have spoken of a longed-for independence from utility companies, price hikes and grid failure – often grounded in a sense of bodily vulnerability.

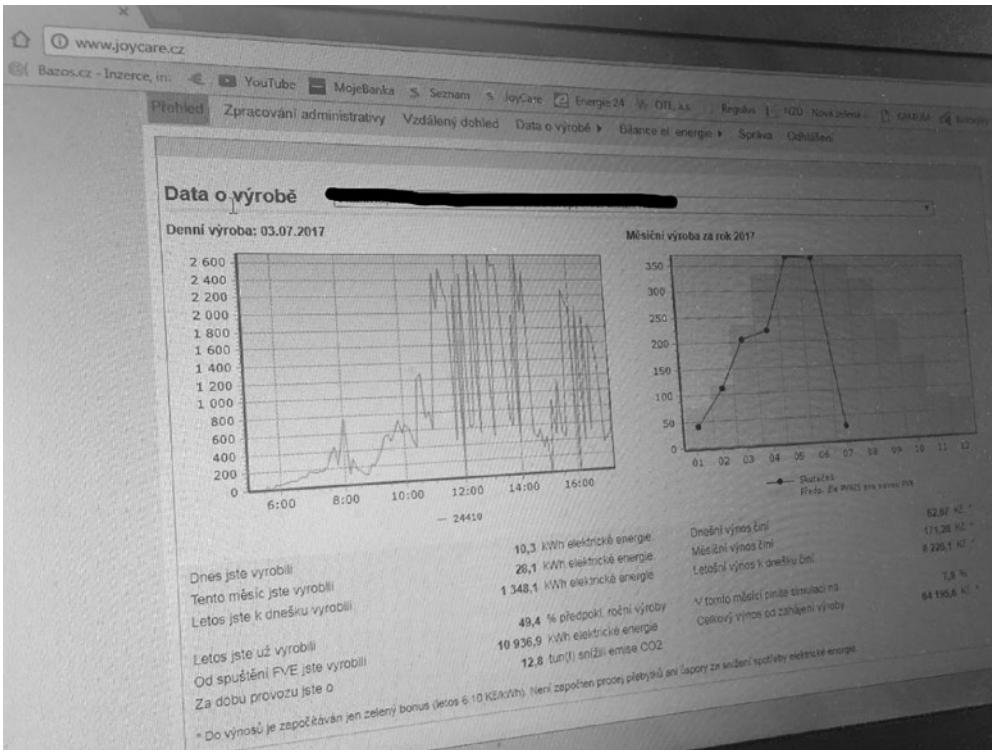
> Karel: Do you have any idea how long you will have food in the stores in Prague when the electricity doesn't work? Retailers have two days' inventory on each level of the supply chain. And I would like to build a place outside civilisation to have a chance to be OK for a week or two (...) The question is not *if* but *when* we can expect a blackout. (…) When you have this helicopter view of society, you definitely have to build something like this, you need to prepare your family for a crisis situation.
>
> Dagmar: And crisis, what could that be?
>
> Karel: It could simply be high winds in northern Germany which can break the electricity network here. (Interview 2018, PV subsidies)

This interview exchange underlines how the acquisition of residential solar was framed as an act of personal foresight and family care, a desire for *un*commoning and *cutting* infrastructural articulations, which at the same time attests to a keen sense of energy as a vital relationality that is electric, digital, climatic, and corporeal. The feeling of bodily vulnerability amongst these middle-class solar householders did not concern the ingestion of infrastructural residues, or energy poverty with its nexus of low income, substandard housing, and diminished health. In conditions of relative affluence, solar householders were sensing the indeterminacy of electricity that "sometimes goes where we send it, and sometimes it chooses its path on the spot, in response to other bodies it encounters and the surprising opportunities for [intra] actions" (Bennett 2010: 28), and were fearing the breakdown of infrastructural logistics, institutional abandonment, and shortages to come. But even where solar island systems were imagined insulating householders from energetic entanglement, micro-generation drew householders into novel material and affective relations.

Sensing Articulations with Abundant Solar Radiation and Energy Squandering

Novel sense-abilities were evident in householders' pleasurable practices of immersive observation of electricity generation on their solar applications (Figure 3). On the PC or mobile phone, solar apps track the production of electricity in kilowatt hours by hour, day, month, and year, and thereby put micro-producers "in touch" with the solar radiation.

Figure 3: Arnošt's solar app, 2017. Photograph: Natálie Drtinová



As in other studies (Palm et al. 2018; Strengers 2013), the generation of "free electricity" from abundant solar radiation was often described as "amazing" and joyful. Pleasure was also generated in learning to synchronise the household's electricity use with the availability of the sun.

> Michaela: So Arnošt might say "Today you can't iron because the sun doesn't shine!"
>
> Arnošt: We also say, "Today the sun shines, iron, wash, cook!" (Laughs.) Well, it's good, we learn and then it works. Someone might be interested in night-time electricity; *we are interested in how the weather is*! (Interview 2017, feed-in tariff)

Such load shifting practices also carried ambivalence since they embody collaboration with elemental forces as much as the economising rationality of "Resource Man" (Strengers 2013) that requires a subjugation to a new (weather) regime. Some solar householders, notably women, rejected synchronising housework with the weather. But even where practiced, articulation with solar forces could also entail a pleasurable squandering of home-generated electricity – even among those who benefited from feed-in tariffs and could sell their electricity without limit. Micro-producer Arnošt told us laughingly,

> The pool is 30 degrees (laughs), I probably went over the top with those panels (laughs). But it's nice at night when it's cold, it's splendid, and the water is fantastic!

Such profligate uses of electricity enabled novel sensuous practices – the night-time swim – that point to the generative potentials of abundant electricity, and they unsettle the idea that more energy awareness simply leads to a *reduction* of energy consumption (Palm et al. 2018). Micro-producers in the UK justified seemingly wasteful articulations such as using the clothes dryer when the sun was shining as "saving practices": saving home-generated electricity that otherwise would be "lost" or "just disappears out in the grid and gets wasted" (cited in Turner 2016: 184). Whether arising from an attachment to what Strengers (2013: 145) termed "homegrown energy" or a sense of entitlement to expend this electricity at one's pleasure, refusals to share electricity in the "common" grid controlled by the distribution company put into relief the pleasure of encountering and squandering abundant energy, just as excess electricity for Pavel had activated the impulse to share it horizontally. So why do we not see a higher rate of solar micro-generation?

Noticing Pre-emptive Articulations that Prevent Photovoltaics on Multiple Occupancy Buildings

Above I showed how a focus on technoecological dis/articulation draws attention to what is split off or disentangled from but remains part of solar infrastructural assemblages: the *missing* transmission lines between neighbours or offshore labour. Here I want to extend this sense-ability of determined absences by directing analytical attention to *actual or potential articulations* that have *prevented* the materialisation of PV installations despite extraordinarily favourable conditions. Vojtěch, one of the pioneers in the Czech solar industry, had ironically described the rapid price drops as a hypothetical impediment for rooftop PV: "The price is falling so fast that we should tell our customers, 'Wait! Don't buy solar panels and batteries today because next year the price drop will be *so* significant that you save more money waiting than having them on your roof!'" Whereas the residential sector experienced a backlog of installations due to the shortage of certified electricians, larger solar installations in the field and on the roofs of businesses and prefabricated housing (*paneláky*) typical of postsocialist dwellings did not materialise.[2]

[2] In the business and enterprise sectors, state PV subsidies mandate a public tender. This makes the time-intensive preparation of a PV installation too costly since solar construction firms have no guarantee that they will be awarded the project. For ground-mounted PV power plants, the price declines have made installations just about profitable without subsidies – *if* the solar-generated electricity could be used in proximity without the need to transfer it through the grid. Here the costly transmission charge mandated by the utility companies prevents new installations.

Figure 4: *Paneláky* in Orlík's "socially excluded location", 2016. Photograph: Jelena

Given that the majority of Orlík's residents live in flats, as do Czechs in general, installations on prefabricated blocks of flats where inhabitants live as owners or tenants, are particularly crucial for a commoning of solar generated electricity. Here the pre-emptive articulations of state subsidies and regulations by the distribution company combined in ways that underscored how in multiple occupancy buildings the norm of "isolated cells of energy consumption" prevented the shared production and use of solar-generated electricity. As Vojtěch explained,

> If you have a *panelák* with twenty flats and you put solar panels on the house, you cannot distribute the energy between them. It is not possible to put the wire to every flat. In the *panelák* every flat is an isolated cell of energy consumption. So first [the tenants] would need to make an agreement that they will centralise water heating, energy consumption and have their common solar system (…) Everyone will need to cancel their agreement with the distribution company (…) Then we need to do some reconstruction to centralise everything (…). Some people might prefer *not* to because then you have a common bill. What if someone doesn't pay their share? So people are sceptical (…) This *could* be done, no doubt. [But] the distribution company doesn't want this to happen. They put up barriers because centralisation mainly means that [the tenants] save money, for the [electricity] flat rate that would be *much* lower than if they connect every flat on its own (…). We have owners of the *paneláky* coming today, asking: 'What needs to be done to make this happen?' And we say, 'We will see in two years if subsidies are constructed differently so that everything *could* be done *na_klíč* [as turnkey technology]. But now it's not possible' (Interview 2019).

These observations raise doubts about the claim that the current absence of solar cooperatives in the Czech Republic simply results from a lack of tenants' interest due to adverse historical

experiences with collectivisation (Capellán-Pérez et al. 2020) or pervasive institutional distrust – to the contrary. Even though, or rather because, a reduced flat rate would amount to significant electricity savings for prospective tenant-prosumers, electricity commoning is prevented through the utility company's pre-emptive refusal to articulate a PV power plant to more than one metre and electricity account, which harboured liabilities that utilities were finically disincentivised to resolve. Solar industry representatives agreed that more PV plants would be installed *without* current subsidies for renewables.

Technoecological analysis of pre-emptive articulations suggests that expanding PV installations to those historically excluded from energy production requires not separating but multiplying electric connections, which would transform a vertically organised grid (from centralised power plant to individualised consumer) controlled by powerful utility companies into a horizontal network of interconnected households within and between *paneláky* and local PV field installations – an arrangement that would reduce the role of utilities to one of grid maintenance. At present, however, in line with government energy policy, ČEZ plans an expansion of one of its nuclear reactors (ÉRU 2020),

> and if you want to build a big nuclear power plant, you don't want other sources of energy accessing the grid. Because the more sources you allow, the less space there will be for a huge reactor in Dukovany or Temelín. (Vojtěch)

What, then, does the analysis of pre-emptive technoecological dis/articulations of solar infrastructure and the sense-ability of solar abundance and squandering offer for regenerative possibilities of commoning?

Rearticulating the Potential of Electricity Abundance

The foregoing analysis suggests that, enabled by lower PV prices, members of the solar industry could become tenants' allies in devising PV installations and horizontal interconnections beyond the strictures of current state subsidy schemes. At the same time, Vojtěch's apparent acceptance of a singular wiring of a PV plant entails the risk that householders will be removed from participating in solar micro-generation, and that solar commoning even when it benefits disadvantaged communities primarily registers in terms of financial benefits generated from energy savings and/or the selling of excess electricity (Lennon 2017; Milun 2020). While such benefits are no doubt important, technoecological analysis underscores the importance of practical and sensual involvement through solar apps for sensing energetic connection, including electricity's unpredictability (Bennett 2010), and enabling more generative practices afforded by abundant solar radiation.[3]

---

3 This resonates with the digital dashboard and app currently being developed by the Solar Commons Project at the University of Minnesota, which experiments with peer-governance by Black and Native American communities. The dashboard not only tracks the electricity generated but also energy savings and communal wealth funds for reparative community building (solarcommonsproject.org/toolkit).

While we do not know what novel practices of electric commoning could be gestating in housing estates at times of solar abundance, Catherine Fennell's (2011) research with low-income residents in prefabricated housing estates in Chicago, where winter heating can be a matter of life and death, presents some of the sharing practices enabled by abundant (albeit fossil fuel) energy. Before these estates were reconstructed in the 1990s and energy metered and individually billed, housing authorities could provide cheaper energy than utilities through onsite gas power plants that pumped steam through underground pipes into radiators and concrete floors which retained the heat. Given a history of under-supply of energy, African American residents recalled a sense of sensory wellbeing and comfort when heat was unrationed, which enabled the sharing of chores and sociality with family and friends who communed around the free heat. An older resident recalled the pleasure of year-round common socialising that was not limited to humans: "[you could] see the birds along the building, singing, because no snow! Everybody be standing over the pipes, talking, because it's warm, standing out all winter long" (p. 50).

This suggests that the benefits of a rewiring of solar infrastructure to connect residents in Czech *paneláky* could involve more than cost saving or providing an alternative to unsafe practices of "improvising heat" (Fennell 2011) by firing up stoves or devising makeshift connections to neighbours when power is cut off. Coupling existing connections with rooftop PV and (smart) metres is an immanent potential of solar infrastructure, where periodic abundance could afford communal practices of sharing, gifting, and selling excess electricity thereby fostering apprehension of solar generated electricity not as a finite resource that can be owned, but as an abundant flow that connects and can be tapped into. Technoecological analysis shows that any re-articulation of photovoltaics into a more equitable and joyful assemblage is afforded by offshore materials and labour as the "'grounds' of the commons" (Cowen 2014), where current price reductions in the Global North afford the means and responsibility to procure products from credentialed producers – all the while realising that supply chain monitoring remains partial.

Conclusions

Together with scholars and activists who argue that alternative sources of energy alone will not unsettle fossil-fuelled modernity with its constitutive relations of resource extraction and intersecting inequalities on the basis of race, geopolitical location, class and gender (Wilson 2018; Lennon 2017), this article participates in explorations of a possible solar commons (Gibson-Graham et al. 2016; Milun 2020). Yet, rather than starting from solar energy cooperatives or community trust funds, which do not exist in the Czech Republic, the article has examined solar infrastructure on brownfields and residential buildings as an immanent potentiality for solar commoning. Contributing to scholarship on infrastructural assemblages as open-ended gatherings, conduits, and embedding environments (Tsing 2015; Cowan 2014), I have suggested that the new materialist framework of technoecologies with its focus on practices of dis/articulating and sensing infrastructure's spatial and temporal "limits" can become a potent tool for identifying and re-articulating its regenerative potentials for commoning.

Briefly stated, a focus on dis/articulation adds to assemblage theory and commoning by focusing on what is excluded but remains part of the infrastructural arrangements. In my ethnographic analysis of a PV monocultural plantation and residential solar island systems, I have attended to the vestiges of plant and human inhabitants that were displaced by solar arrays and sometimes resided in the edges, as well as the extractive labour that materialised in these panels and was partially remembered in industrial tags and workers' bodies. I have also traced pre-emptive dis/articulations such as mandates by the utility company that *prevented* the materialisation of electric interconnections in housing estates, and solar micro-producers' joyful articulations in synchronising and squandering solar-generated electricity.

In the framework of technoecologies, these traces of dis/articulations make sense-able an enlarged realm of commoning that includes the PV supply chain and multispecies collaboration, and embodies possibilities for regeneration and care. Constituted by and constitutive of this post-military milieu, technoecological sense-ability (Treusch 2017) entails the differential capacity of residents and experts to unfurl "infrastructure" and "environment" into present, past and future conduits and entanglements that are simultaneously economic, chemical, climatic, affective and corporeal. This sense-ability interrupts a prevalent sense of technological sovereignty and ecological balance and is differently crafted by those living nearby and those generating solar energy at home, whether in a desire to insulate themselves from electric infrastructure or to share in the solar assemblage. Contributing to revisceralising the commons (Berlant 2016), technoecological analysis reticulates these sense-abilities, including an openness to the unexpected and indeterminate, for teasing out possibilities for infrastructural transformation.

Here the analysis reveals how unexpected plant growth within the plantation points to the possibility of multispecies refuges that transform the electric monoculture, and how electric rewiring could connect PV arrays to households in multiple occupancy buildings in ways that enable new forms of sharing and squandering of electricity in times of abundance. Mobile seedlings, wires, and profligate prosumers become agents that incite more convivial solar arrangements that might already be emerging. Distrust in existing state institutions (Horáková 2020), such as utility companies, here are a necessary ingredient for devising alternative practices and protocols.

Importantly, while these practices can both inform and be informed by solar community wealth funds (Milun 2020) and programmes to install solar power in low-income households (Gibson-Graham 2016), the potentials of solar commoning are not predicated on existing schemes. Minor tweaks can – and in fact already are – re-articulating nodes where relational elements expose their transformative capacity in the present, inviting articulation and solidarity through relational designs and horizontal connection. Yet, this does not imply that technoecologies of solar commoning are devoid of violence and precarity: some dispossession, the analysis shows, cannot be repaired, and current forms of care and regeneration involve deadly disruption events.

Opening up these possibilities of solar commoning is relevant for accelerating climate action. Czech solar industry representatives estimate that at the current rate of solarisation, it will take 800 years to reach climate goals. Larger PV installations on roofs and post-industrial brownfields will be needed to upscale extant infrastructure. While not offering

blueprints, the framework of technoecologies directs attention to situated possibilities and responsibilities of solar energy commoning. In view of new articulations with data centres, mining sites, and low-income households, future research will likely differentiate the modalities of technoecological dis/articulation and sense-ability as these infrastructural assemblages produce novel sensations, thresholds, and exclusions, that take technoecologies into new terrains.

References

Bakke, Gretchen. 2019. "Electricity is Not a Noun." Pp. 25–42 in *Electrifying Anthropology*, edited by Simone Abram, Brit Ross Winthereik, and Thomas Yarrow. London: Bloomsbury.

Bakshi, Bhavik R., Guy Ziv, and Michael Lepech. 2015. "Techno-Ecological Synergy: A Framework for Sustainable Engineering." *Environmental Science and Technology Letters* 49(3): 1752–1760.

Barry, Andrew. 2001. *Political Machines: Governing a Technological Society*. London: Athlone Press.

Bennett, Jane. 2010. *Vibrant Matter*. Durham: Duke University.

Berlant, Lauren. 2016. "The Commons: Infrastructures for Troubling Times." *Environment and Planning D: Society and Space* 34(3): 393–419.

Bollier, David and Silke Helfrich, eds. 2016. *The Wealth of the Commons*. Amherst: Levellers Press.

Cappelan-Perrez, Inigo, Nadia Johanisova, Jasminka Young, and Conrad Kunze. 2020. "Is Community Energy Really Non-Existent in Post-Socialist Europe?" *Energy Research & Social Science* 61: 1–6.

Cowen, Deborah. 2014. *The Deadly Life of Logistics*. Minneapolis: University of Minnesota Press.

Davis, Jeffrey S. 2007. "Military Natures: Militarism and the Environment." *GeoJournal* 69: 131–134.

ERÚ. 2022. "Roční zpráva o provozu elektrizační soustavy České republiky za rok 2021" [Electrical Grid of the Czech Republic, Annual Report 2021]. Retrieved July 7, 2022 (https://www.eru.cz/rocni-zprava-o-provozu-es-cr-pro-rok-2021).

Escobar, Arturo. 2018. *Designs for the Pluriverse.* Durham: Duke University Press.

Fennell, Catherine. 2011. "'Project Heat' and Sensory Politics in Redeveloping Chicago Public Housing." *Ethnography* 12(1): 40–64.

Gibson-Graham, J. K., Jenny Cameron, and Stephen Healy. 2016. "Commoning as a Postcapitalist Politics." Pp. 192–212 in *Releasing the Commons*, edited by Ash Amin and Philipp Howell. New York: Routledge.

Griotitas, Chris, Pedro Nardelli, Vasilis Kostakis, and Arun Narayanan 2020. "From Private to Public Governance: The Case for Reconfiguring Energy Systems as Commons." *Energy Research & Social Science* 70: 1–7.

Guattari, Félix. 2000 [1989]. *The Three Ecologies.* London: The Athlone Press.

Haines, Christian and Peter Hitchcock. 2019. "Introduction: No Place for the Commons." *Minnesota Review* 93: 55–61.

Haraway, Donna. 1992. "The Promises of Monsters." Pp. 295–337 in *Cultural Studies*, edited by Lawrence Grossberg, Cary Nelson, and Paula Teichler. New York: Routledge.

Haraway, Donna. 2003. *The Companion Species Manifesto*. Chicago: Prickly Paradigm Press.

Haraway, Donna. 2015. "Anthropocene, Capitalocene, Plantionocene, Chthulucene: Making Kin." *Environmental Humanities* 6: 159–165.

Haraway, Donna, Noboru Ishikawa, Scott Gilbert, Kenneth Olwig, Anna Tsing, and Nils Bubandt. 2016. "Anthropologists are Talking – about the Anthropocene." *Ethnos* 81(3): 535–564.

Hess, Karl. 1979. *Community Technology*. New York: Harper & Row.

Hernandez, Rebecca R. et al. 2019. "Techno-Ecological Synergies of Solar Energy for Global Sustainability." *Nature Sustainability* 2(7): 560–568.

Horáková, Nicole. 2020. "A Mistrustful Society? The Lack of Trust in Government Institutions in the Czech Republic." *International Journal of Social Quality* 19(2): 51–72.

Klímová, Jana. 2020. "Zázrak, nebo tunel? Jak solární baron dosáhl na miliardy [A Miracle or a Fraud? How a Solar Baron Was Entitled to Billions]." ParlamentníListy.cz, January 6, 2020.

Klusáček, Petr, Marek Havlíček, Petr Dvořák, Josef Kunc, Stanislav Martinát, and Petr Tonev. 2014. "From Wasted Land to Megawatts: How to Convert Brownfields into Solar Power Plants." *ACTAUN* 62(3): 517–528.

LaDuke, Winona and Deborah Cowen. 2020. "Beyond Wiindigo Infrastructure." *The South Atlantic Quarterly* 119(2): 243–268.

Lennon, Myles. 2017. "Decolonizing Energy." *Energy Research & Social Science* 38: 18–27.

Lorenz-Meyer, Dagmar. 2017 "Becoming Responsible with Solar Power? Extending Feminist Imaginings of Community, Participation and Care." *Australian Feminist Studies* 32(94): 427–444.

Lorenz-Meyer, Dagmar, Pat Treusch, and Xin Liu. 2019. *Feminist Technoecologies: Reimagining Matters of Care and Sustainability.* London, New York: Routledge.

Mah, Deborah N. 2019. "Community Solar Energy Initiatives in Urban Energy Transitions." *Energy Research & Social Science* 50: 129–141.

Marhoul, Pavel and Jaroslav Zámečník. 2012. "Abandoned Military Areas." Pp. 111–114 in *Ecological Restauration in the Czech Republic*, edited by Ivana Jongepierova et al. Prague: Nature Conservation Agency of the Czech Republic.

McGregor, Deborah. 2021. "Indigenous Environmental Justice and Sustainability." Pp. 58–71 in *The Cambridge Handbook of Environmental Justice and Sustainable Development*, edited by Sumudu Atapattu, Carmen Gonzalez, and Sara Seck. Cambridge: Cambridge University Press.

Melville, Emilia, Ian Christie, Kate Burningham, Celia Way, and Phil Hampshire. 2017. "The Electric Commons: A Qualitative Study of Community Accountability." *Energy Policy* 106: 12–21.

Milun, Kathryn. 2020. "Solar Commons: A 'Commons Option' for the 21st Century." *American Journal of Economics and Sociology* 79(3): 1023–1057.

Moore-O'Leary, Kara A. et al. 2017. "Sustainability of Utility-scale Solar Energy: Critical Ecological Concepts." *Frontiers in Ecology and the Environment* 15(7): 385–394.

Mulvaney, Dustin. 2019. *Solar Power*. Oakland: University of California Press.

Newman, Erica A. 2019. "Disturbance Ecology in the Anthropocene." *Frontiers in Ecology and Evolution* 7: 1–6.

Palm, Jenny, Maria Eidenskog, and Rasmus Luthander. 2017. "Sufficiency, Change, and Flexibility: Critically Examining the Energy Consumption Profiles of Solar Prosumers in Sweden." *Energy Research & Social Science* 39: 12–18.

Papadopulis, Dimitris. 2021. "Chemicals, Ecology, and Reparative Justice." Pp 34–69 in *Reactivating Elements*, edited by Dimitris Papadopoulos, Maria Puig de la Bellacasa, and Natasha Myers. Durham: Duke University Press.

Scheer, Hermann. 2001. *A Solar Manifesto*. 2nd edition. London: James & James.

Smith, Adrian A. and Dayna N. Scott. 2021. "Energy without Injustice? Indigenous Participation in Renewable Energy Generation." Pp. 383–397 in *The Cambridge Handbook of Environmental Justice and Sustainable Development*, edited by Sumudu Atapattu, Carmen Gonzalez, and Sara Seck. Cambridge: Cambridge University Press.

Šoltés, Adam. 2018. *Obchod so solárnymi panelmi medzi Áziou a EÚ* [*Trade with Solar Modules between Asia and the EU*]. MA Thesis. Prague: VŠE.

Sovacool, Benjamin K., Saleem Ali, Morgan Bazilian, Ben Radkley, Behoit Nemery, Julia Okatz, and Dustin Mulvaney. 2020. "Sustainable Minerals and Metals for a Low-Carbon Future." *Science* 367(6473): 30–33.

Stengers, Isabelle. 2005. "The Cosmopolitical Proposal." Pp. 994–1003 in *Making Things Public,* edited by Peter Weibel and Bruno Latour. Cambridge: MIT Press.

Strengers, Yolande. 2013. *Smart Energy Technologies in Everyday Life.* New York: Palgrave Macmillan.

Szeman, Imre and Darin Barney. 2021. "Introduction: From Solar to Solarity." *South Atlantic Quarterly* 120(1): 1–11.

Treusch, Pat. 2017. "Re-reading ELIZA: Human-machine Interaction as Cognitive Sense-ability." *Australian Feminist Studies* 32(94): 411–426.

Tsing, Anna. 2015. *The Mushroom at the End of the World*. Princeton: Princeton University Press.

Tsing, Anna. 2016. "Earth Stalked by Man." *The Cambridge Journal of Anthropology* 34(1): 2–16.

Tsing, Anna and Jesse Bazzul. 2022. "A Feral Atlas for the Anthropocene." Pp. 309–320 in *Reimaging Science Education in the Anthropocene*, edited by Maria F. G. Wallace, Jesse Bazzul, Marc Higgins, and Sara Tolbert. Palgrave Macmillan.

Turner, Britta. 2016. *Assemblages of Solar Electricity*. Dissertation. Durham: Durham University/ Department of Geography.

Weber, Lindsay G. 2018. "The Commons." Pp. 83–86 in *Posthuman Glossary*, edited by Rosi Braidotti and Maria Hlavajova. London: Bloomsbury.

Wilson, Sheena. 2018. "Energy Imaginaries." Pp. 377–411 in *Materialism and the Critique of Energy*, edited by Brent R. Bellamy and Jeff Diamanti. Chicago: MCM.

Wynter, Sylvia. 1971. "Novel and History, Plot and Plantation." *Savacou* 5: 95–102.

Author

Dagmar Lorenz-Meyer is Assistant Professor of gender studies in the Department of Sociology at the Faculty of Humanities, Charles University. Her research emerges at the intersection of corporeal feminisms, technoscience studies and neo-materialism, currently in relation to participatory photography, solar energy, and stress in the neoliberal university. She recently co-edited *Feminist Technoecologies: Reimagining Matters of Care and Sustainability* (Routledge 2019), curated Roma snapshot photography, and serves as section co-editor of the journal *Matter: Journal of New Materialist Research*.
Contact: d.lorenz-meyer@fhs.cuni.cz