Poetics of Solar Photovoltaics: A Multispecies Storytelling of Solar Energy in Place

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Recibido: 20/03/2024
Aceptado: 13/05/2024

Cómo citar este artículo:
Törnroth, S. (2024) « Poetics of Solar Photovoltaics: A Multispecies Storytelling of Solar Energy in Place». Inmaterial. Diseño, Arte y Sociedad, 9 (17), pp 71-100
DOI 10.46516/inmaterial.v9.203

Abstract

There is a paramount need to explore multispecies experiences with solar photovoltaics (PVs) as these technologies increasingly pervade both human and non-human worlds. This article offers experimental and exploratory insight into the possible relational experiences with PVs beyond the predominantly human-centred and techno-rationalistic lens. Through two rapid autoethnography cases in Singapore, I explore the entangled existence of solar PVs – as they are situated in place – from the human sensorial and embodied perspective. 'Storytelling' is engaged through a poetic first-person perspective, to emotionally connect and communicate the multispecies narrative surrounding solar PVs. The article culminates in a discussion at the nexus between STS, posthumanism and artistic and design research, in which I argue that humans become-with solar through a process of intentional presence in space and by leveraging the privilege of storytelling to centralise narratives surrounding solar "invisibilities"

Keywords:
Solar energy, artistic research, STS, autoethnography, posthumanism

Poéticas de la energía solar fotovoltaica: Un relato multiespecie de energía solar en contexto

Resumen

Existe una necesidad primordial de explorar experiencias multiespecie en relación con la energía solar fotovoltaica (PV), ya que estas tecnologías impregnan cada vez más el mundo humano y no humano. Este artículo ofrece una visión experimental y exploratoria de las posibles experiencias relacionales con la fotovoltaica más allá de la lente predominantemente centrada en el ser humano y tecnorracionalista. A través de dos casos de autoetnografía rápida en Singapur, exploro la existencia entrelazada de las energías solares fotovoltaicas —tal como están situadas en su lugar— desde la perspectiva sensorial y corporal humana. La «narración de historias» se aborda mediante una perspectiva poética en primera persona, para conectar emocionalmente y comunicar la narrativa multiespecie que rodea a la energía solar fotovoltaica. El artículo culmina con una discusión sobre el nexo entre STS, poshumanismo y la investigación artística y de diseño, en donde sostengo que los humanos se vuelven--con la energía solar a través de un proceso de presencia intencional en el espacio y aprovechando el privilegio de la narración para centralizar las narrativas en torno a las «invisibilidades» solares.

Palabras clave:
Energía solar; investigación artística; STS; autoetnografía; poshumanismo

1. Introduction: The "Green" Transition

In a bid to decarbonise and reduce global dependency on fossil energy sources, solar energy technology – particularly solar photovoltaics (PVs) – has been emerging as an anthropogenic beacon of hope, promising to mitigate impending climate change impacts through reducing carbon emissions (Grodsky and Hernandez, 2017). However, its net widespread effects on beings in different habitats and ecosystems remains unclear (e.g. Grodsky and Hernandez, 2017; Moore-O'Leary *et al.*, 2017), which is an urgent concern due to the technology's increasing prevalence. As an example, during a 4-year doctoral research project, I ethnographically traced the negative impacts of a solar PV's life cycle in the context of Swedish consumption and adoption: from mining and production stages at coal-driven industries in China and Germany, to negligible recycling capacities at solar PVs' end-of-life stage (Törnroth, 2023). As a global trend, Tao *et al.* (2020) aptly summarise the reality of solar PV production and use as not being "truly green until they are recycled" (p.1086). Furthermore, the production process of solar PV is highly toxic, as the production of polysilicon and silicon wafers used in solar PV generates particularly dangerous by-products (silicon tetrachloride and hydrofluoric acid), which are often discharged – without treatment – into living environments (Yang, 2014). In 2011, fluoride concentrations in the Mujiaqiao River, a river located near a solar PV production factory in Haining City, eastern China, were found to be ten times higher than permitted by standards. This led to the destruction of a plethora of marine and terrestrial beings, across animal-human binaries (Yang *et al.*, 2014). In a more recent example, Nain and Kumar (2020) discuss the ecological and human health risk posed by metals leached from end-of-life solar photovoltaics. They explain that the estimated soil contamination from PV leachates that lie broken and destroyed in landfills (often exported legally or illegally) is significant with respect to aluminium, silver, cadmium, iron, and lead. Lead presents a high cancer-risk potential for those who come into contact with it; in this case, playing children, through soil contact.

Through this article, I investigate in an exploratory manner, the wider entangled worlds of solar PV existence in place, through the posthuman paradigm. Extending from feminist traditions of situated knowledge (Haraway, 1988) and standpoint epistemology (Harding, 1996), is the new materialist ontological perspective of "drawing attention to the primacy of nonhuman influences in formative processes" (Braidotti and Bignall, 2019, p.2). A pivotal concept within this article is multispecies storytelling (Tsing, 2015): the exploration of multiple, potential, and imaginable experiences of multispecies living, expressed through poetic storytelling. Using two cases of rapid autoethnography as a starting point for this is significant for building

a foundation for emotional attunement to the everyday experience, afforded by the first-person human perspective. Such alternative ontological dreaming draws on the concept of *imaginaries* from STS, where values, emotions, and affect take centre stage in the investigation of human situations, alongside questions of epistemological and ontological worlds (McNeil *et al.*, 2017). Jasanoff (2015) further emphasises that dreams, dreamscapes, and imaginaries cater beyond the normative and the aspirational – instead they seek to raise new, different, and peripheral ways of *how life ought to be lived.*

I thus begin this article by exploring the positionality of solar PV – how, beyond its designed physical body, it can be experienced as relational and entangled across multispecies living. After exploring the positionality of solar PV, I then clarify how *rapid* autoethnography could be performed as a method of multispecies storytelling, at two sites with unique and innovative solar PV design, in the context of Singapore. I then continue to offer stories from the two rapid autoethnographical cases as generative potential towards an increased appreciation of alternative and experiential understandings of solar energy, which include both human and non-human narratives. In the discussion, I mention how humans, in our centrality of sensing and storytelling experiences of being in the world, might *become-with* solar to inspire certain ontological dreaming around solar PV. I also discuss privilege and power in being able to do so, and how it links to our *response-ability* (Haraway, 2016) of being in the world. Therefore, the article offers concluding deliberations to a key research question: *How might poetic multispecies storytelling contribute to a posthumanist appreciation of solar PV?*

2. Beyond the Body: Solar PV as Relational

Popular science and contemporary media of solar PV often emphasise interests relating to designed human habitats: the city, for example, through its social, economic, cultural and environmental well-being. Particularly within mainstream discourse of environmental sustainability, there has been a pronounced dualism and an implicit hierarchy of value while looking at such a city-ecology paradigm, corresponding to political-social, human-nature and subject-object divisions set out by Western philosophy (Newalkar and Wheeler, 2017). Posthumanist thinkers have attempted to spearhead and develop necessary and critical enquiry into more complex worldings of solar PV, where these technologies are 'rooted' and collaborate with surrounding soil, stones, grasses and creatures (e.g. Lorenz-Meyer, 2017). Therefore, solar PV

can be understood as a techno-ecological phenomenon – a phenomenon that is indeterminate associations of living and non-living ways of being (Lorenz-Meyer, 2017). Similarly, in the words of Donna Haraway:

> Natures, cultures, subjects, and objects do not pre-exist their intertwined worldings… who is/are to be in/of the world is constituted in intra- and interaction. The partners do not precede the knotting; species of all kinds are consequent upon worldly subject- and object-shaping entanglements. (2016, p.13)

Such a conceptualisation encourages us, as humans, to explore alternative meanings and relations around material entities beyond their physical confines – what solar energy might mean for human and non-human experiences, beyond the PV panel. This may give surprising – yet fluid and evolving – characterisations in time-place situations. This reflects internally in the process of what Bignall and Braidotti (2019) call *becoming-human. Becoming-human* points to the idea that being human is not a static state, but a process that is dynamic and evolving. Suitably, Karen Barad's explanation of *intra-actions* offers an extension to the meaning of the word 'interaction'; towards a co-emergent becoming, or relational evolution between entities. Like Haraway, she explains that individual entities cannot be said to exist as things--in-themselves, but rather, only find meaning or expressions through their co-creative relations with other entities (Barad, 2008). This contributes to the understanding that the experience of solar PV is *situated* – a context-dependent collision of different beings (and their ontological worlds) and different lives (on different timelines) that produce spontaneous yet meaningful worldly entanglements. In this manner, solar PV might take on new meanings and interpretations. As in the words of Natasha Myers in *How to Grow Liveable Worlds:*

> It's time to cast another spell, to call other worlds into being, to conjure other worlds within this world. It is clear that we are at the limits of language, at the edges of imagination. We need art, experiment, and radical disruption to learn other ways to see, feel, and know. (2018, p.53)

Therefore, multispecies storytelling is key to clarifying such worlding processes, where different living beings are explored through interconnected narratives in a complex ecology – requiring us, humans, to "look around rather than ahead," (Tsing, 2015, p.22). By *looking around,* Anna Tsing offers that humans (and humanity) might realise that our identity as humans is fluid and transitional, thereby also posing the difficult and existential question of what it means to be human. This involves a parallel re-articulation of what constitutes solar PV – and how it includes or peripheralizes different meanings and relationships. This article essentially attempts to remove solar energy

technologies as objects of masculine fascination; isolated and purely borne out of technoeconomic engineering principles. I therefore explore solar energy beyond the confines of the PV body, as it is branched into temporal, spatial, and networked intra-actions to create solar worlds (i.e. a context-dependent phenomenon). I do this through the lens of multispecies storytelling and relational thinking, communicated via *rapid* autoethnography, which is described in the following section.

3. Rapid Autoethnography as a Method for Multispecies Storytelling

Autoethnography is a powerful tool for understanding a complex phenomenon, as it enables the researcher to experience the phenomena from a first-hand perspective, as a subject within said phenomena (Chang, 2016). "The body provides us with first-hand, visceral experience of the world" (Hokkanen, 2017, p.25) and thus provides researchers with a rich and embodied understanding of a certain phenomenon. While the scientific community continues to debate the scientific validity of autoethnography, there is much to be said regarding the idea that interpreting and translation processes – inherent to almost all forms of science in one way or another – can be considered social phenomena (Chang, 2016; Hokkanen, 2017). Thus, the inevitable subjective influence of the researcher as a social being on the research process becomes almost impossible to circumvent.

Rapid autoethnography, as it is referred to within this article, is a take on rapid research methods within different fields of qualitative studies. A recent issue on *Rapid Research in Action: Lessons from the Field* in the journal *Frontiers in Sociology* covered 21 articles on the topic with 177 contributing authors within the social sciences (Deom et al., 2023). More relatedly, rapid ethnography has been explored by Pink and Morgan (2013) as short-term and intense experiences, which could otherwise be more suitable for a specific topic of research than traditional longitudinal ethnographic studies. They take the perspective that short-term ethnography is not a simple "quick and dirty" (p.353) variation of its longer counterpart, but rather:

> … suited to a series of theoretical, methodological, and empirical interests, which converge in the contemporary context in which we are working. These include theoretical turns toward practice, practical activity (what people are actually doing as they move through the world) and the nonrepresentational (the unspoken, unsaid, not seen, but sensory, tacit and known elements of everyday life). (2013, p.353)

Specifically in the field of design research, Millen (2000) utilised rapid ethnography to explore the human-computer interaction (HCI) context, adding that:

> One of the biggest challenges facing HCI ethnographers is the demand to spend time in the field while matching the pace of ever-quickening product development cycles. Traditional ethnography is very time intensive… In most cases, it just isn't possible to spend months or even weeks in the field gathering data, and a similar amount of time understanding the field data. Nevertheless, the benefits of examining field situated user activity remains inviting. (p.280)

Following these lines of thought, I utilise rapid autoethnography for this research on relational solar PVs since it might facilitate short but intense snapshots on the embodied and sensorial experiences following a shared space with PVs on an *everyday* basis. This might also provide a suitable foundation for further research into the topic.

The main idea behind rapid autoethnography within this article is the execution of two site visits in public spaces with innovative solar PV design. These sites were considered as *critical* cases, with the reason being that they have the capacity to facilitate unique and revelatory experiences (Yin, 2014). The embodied and sensorial dimension of autoethnography is emphasised within these two cases, in line with this article's aim to appreciate solar PVs in a relational sense. I see the body not as an object but as a subject, "a necessary precondition for subjectivity, emotion, language, thought, and social interaction" (Niedenthal and Barsalou, 2009, p.140). I thus attune myself to the somatic and affective experiences (or feelings) of the visitations in place, which can be seen as constituents of emotion or affect (e.g. Shweder, 2004; Wetherell, 2012). The *situatedness* of affective experiences is important because emotion can be considered as environmentally determinant; in that beyond the body, socio-material factors of self-appraisal, social appraisal, and pattern of expression come into play (Shweder, 2004). Beyond emotions, another important dimension of the autoethnographical performances is the aspect of *emergence*, also known as an autoethnography "to come" (Gannon, 2018). Gannon (2018) emphasises the openness and fluidity of an emergent autoethnography, in which participants might, "… touch, momentarily, or are repelled, where affect moves and the material things and events of the world bump up against each other in unpredictable ways", (Gannon, 2018, p.21). This unpredictability is essential to this study, as relating to solar PVs in alternative and relational ways, like with all new technologies, requires sensitised thinking of *how it could otherwise be instead of how it is.*

I thereby argue that performing embodied rapid autoethnography from a human lens might afford a heightened awareness, appreciation, and reflection of the expe-

riences of the mind and body in multispecies worlds. Therein lies a possibility of re-casting autoethnography as multispecies storytelling – where embodied human experiences within entangled living worlds might serve as standpoints for possible ontological dreaming. In doing this, it is important to note the role and power of language and storytelling. The expression of stories *(whose stories?)* has the ability to "determine what is real" (Barad, 2008, p.121). This exposes and challenges how power is embedded in language (storytelling), giving it more power than necessary in determining ontologies as compared to other forms of representation (Barad, 2008). In the words of Donna Haraway (2016), "[it] matters which stories tell stories, which concepts think concepts. Mathematically, visually, and narratively, it matters which figures figure figures, which systems systematise systems" (p.101). For that reason, I express the two autoethnographical accounts poetically – that beyond a detailed description of events, they reserve space for ontological dreaming and imagination with multispecies worlds. Furthermore, this is emphasised through the, "think[ing] of a situation together with one's informants; [where] research categories develop with the research, not before it" (Tsing, 2015, p.ix).

4. Experiencing Solar PV in Place: Two Rapid Autoethnographical Cases

Singapore was selected because it provides prime research ground for unique experiences with solar PVs; its seamlessly commutable urban and dense setting is home to multiple innovative and advanced solar design and architecture projects that I could easily access. This is because wide-scale implementation of solar PVs, namely in the form of Building Integrated PV (BIPV), has gained traction in the past decade, due to the country's climatic and meteorological conditions being suitable for harnessing solar energy (Luthor and Reindl, 2013). There are, therefore, multiple sites using solar PV design that could offer opportunities for the deeper exploration of time-place specific multispecies narratives. Crucially, I am also a local citizen, which thus grants me political privileges in terms of my entrance, movement, and experience of the country.

The following two autoethnographical accounts of solar PV are based on (1) a visit to a tourist destination called Gardens by the Bay, the *Super Trees*, developed by Grant Associates, and (2) a visit to a multi-use development called *South Beach*, designed by a global architectural firm, Fosters + Partners.

4.1. Study 1: Solar as Ecological Liveliness

Figure 1: View along the ground of the Super Trees. There are 18 Super Trees in total within Gardens by the Bay. Source: Author's own image.

Figure 2: View upwards of one of the Super Trees. The solar photovoltaic cells are integrated into the inverted canopy structure at the top of the tree. 11 out of 18 trees have these photovoltaic systems.

Source: Author's own image.

Gardens by the Bay is a 101-hectare garden, housing over 1 million plants in two large greenhouse domes with precisely differing subclimates (Ferguson, 2014). The garden was completed in 2012 and has since been an attraction and destination for locals and tourists alike. Its accessibility and innovative design were the main reasons for it being critically sampled for this autoethnographical case study (Yin, 2014). The Super Tree Grove houses 18 solar tree-like structures (see Figure 1 and 2) that provide ventilation to the greenhouse domes and generate electricity through solar photovoltaic (PV) panels. The solar PV cells are integrated into the inverted canopy structure of the trees (see Figure 2), where they generate electricity to power grey water recycling technology, LED lights for the trees' colourful lighting at night, as well as the general activities at the on-site office.

I conducted the autoethnographical exploration on a wet and rainy afternoon, instantly noticing the heaviness of the humidity in the air – a near misty fog that dampened the sounds of human chatter, of birds singing, and crickets chirping. There was little activity in the space, and I assumed this was due to the rainfall that had recently subsided. Throughout the observation, I made voice recordings of my own reflections to capture the full experience, as well as continuously scribbling field notes to remember the experience. When circumstances allowed (without infringing on individual privacy), I took photographs. I focused on positioning my embodied experiences and reflections as a base for ontological dreaming and multispecies narration. For example, by paying attention to:

Material narratives, such as:

- Forgotten litter ("Are there stray materials living their own narratives in parallel?"),
- The solar PV existence ("In what ways do I perceive and sense solar energy's presence?"),
- Different forms of non(human) living ("What sounds do I hear, what faces and beings do I see, and what ground do I walk on?"),
- Flow and activity ("What movements, behaviour, and (re)actions do I observe? Why?).

Immaterial narratives, such as:

- Embodied experiences ("How is the weather impacting this experience?"),
- Affect in space and place ("What do I feel in this space, what stands out in my experience of this place, and how does moving in this space affect my experience?"),
- Introspective thoughts and reflections ("How does this experience open up access to different and alternative ways of designing solar PVs?").

On arrival, I first noticed my breathing felt heavy and slow – I attributed this to the high humidity in place. As I sat on the rounded benches, the rough stone texture came alive – waterlogged with the rain that had fallen, with visual information artwork magnified unevenly by refracted natural lighting through blobs of collected rainwater. Ants ran to hide, while earthworms escaped their familiar soil homes to bask in the wet and humid conditions. A few pieces of soggy tissues were strewn on the ground, oozing a distasteful pulp when stepped on. The interactive screens installed by the Super Trees flickered continuously with a video on loop, showing interviews and information pertaining to the development of Gardens by the Bay – indifferent and apathetic to the changes in their surroundings. Crickets resonated in the background, together with a soft whirring sound escaping from atop the tree, near the solar PV shading device, where the ventilation hatch joined the sky. The thermal environment underneath the trees was cooling, a soft breeze was constant, and shading from the canopy-like structure meant that any peeking sun rays were blocked – a necessary trait to achieve thermal comfort at ground level in a tropical climate like that of Singapore.

Birds fleeted from tree to tree. They were small and fast, which made it impossible to identify which breeds they were. I looked up to see the colourful and lush vegetation bounce in unison – small water droplets fell like notes of a song, with their bright and vibrant colours seemingly more extraordinary against the grey background of the cloudy sky. The presence of water droplets led to the dampening of acoustics, with the only sounds capable of cutting through the thick, humid air being the birds' high-pitch chirping and the insects' singing. These sounds were particularly meaningful to me in the moment, as they conveyed the immersive perception of being in nature, despite the totality and reality of the engineered aspects of the place. It was clear to me that there was a sense of harmony – any potentially normative boundary delineating nature and the built environment was experientially blurred.

I reflected on the experience provided at every level of the tree – from the stony, wet bench, to the vegetation design on the tree itself, and finally to the solar shading device atop the tree. I looked upwards, and while the experiences were tangible and vivid on the ground, I had to increasingly rely on sight as a main sensorial medium for experiencing the solar PV that reached so far into the sky. There was, undeniably, a noticeable physical and spatial detachment, between myself and the solar PV, but I was connected through the sights and sounds beyond the solar PV's material form – its extended fluid form, if you will – in which its existence and performance extends into surrounding experiential activities: facilitating a cool breeze from its

adjacent ventilating structures, providing home to multispecies narratives, and most consistently yet – existing statically, stoically, and unapologetically, to provide quiet and invisible electrification in support of human activities in the area.

I observed many tourists – when counting, they made up 23 out of the 32 people observed, identified from a range of social cues: spoken language (e.g. different languages outside the country's ethnic groups), activity and behaviour (e.g. asking for directions at the tourist office), and attire (e.g. dressed for a long day of walking in the warm weather). These tourists appeared to range from working expatriates on business trips, to families on holiday. As I looked around, I noticed several visitors with elderly relatives as well. The seating capacities available in the area appeared particularly useful for this reason – an older lady walked by, only to sit down a couple of metres from me on another rounded bench, gesturing to her family that she was taking a rest. Other visitors were seen pausing and talking, walking at a slow and relaxed pace, engaging in photo-taking, or reading the information boards and the educational interactive screens in the area. From this experience, it was clear to me that the main attraction of this destination was its opportunity for aesthetic experiences, experiences of fascination and awe, as well as learning and education.

From my positioning as an autoethnographical human researcher, I observed that the solar PV canopy existed in material and immaterial entanglements with everyday human and nonhuman living, experienced in multiple – albeit, discreet – ways. This raised possibilities for forms of dreaming beyond the perceived reality, allowing for the imagining of different ontologies and other-ways-of-being within the time-space. For example:

- Through photo-taking by visitors, as a means of capturing and recalling experiences in place, and thereby visually preserving solar PV's situated presence and story,
- Through awareness in embodied weather experiences attributed to solar PV. For example, a soft breeze provided by the solar PV's tree-like canopy and ventilation structures,
- Through the appreciation for the growth and thriving of alternative multispecies living based on solar PV canopy shading. For example, the birds, worms, soil, plants, and more.
- Through the learning experiences facilitated by the interactive screens powered by solar energy,
- Through the other human sensory experiences consequent of the multispecies habitat and living within the Super Tree – a home to the solar PV as well.

These ways of experiencing solar PV in place might seem unimportant and unnoticeable to the naked eye – but it is this very attunement to the intrinsic ways of experiencing that will motivate a more meaningful relationship with solar PV, beyond its commodity value. Therefore, increasing awareness and appreciation for the potential and plural experiences with solar PV, as above, might serve as a way to diversify current techno-rationalistic hegemonic discourse on solar energy technologies, and the "green" transition at large. From the birds that took shelter within the solar PV's tree-like structure, to the elderly lady who rested on a bench – designed opportunities for solar PV with respect to surrounding multispecies worlds facilitate different meaning-makings around solar. This might then foster an increased appreciation for situated experiences (both at the individual and collective level) and any subsequent local interpretations of what a meaningful "green" transition might be.

4.2. Study 2: Solar as Convivial

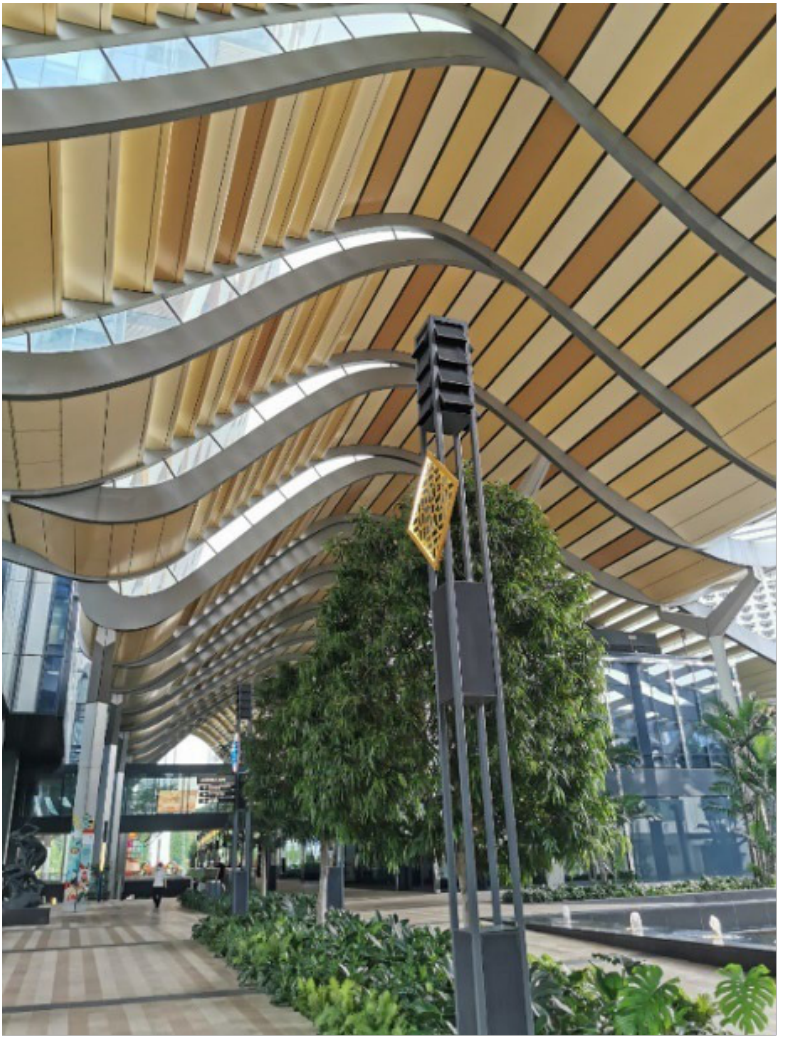

Figure 3: View from the first seated observation area. In the foreground of the image is an orange-coloured, covered walkway with integrated solar cells (known as solar 'canopy-ribbons') joining residences, a hotel, and an office complex. In the background, the walkway continues to join a service node: the underground metro service, a commercial services area (F&B establishments), a play area, and a rest area.

Source: Author's own image.

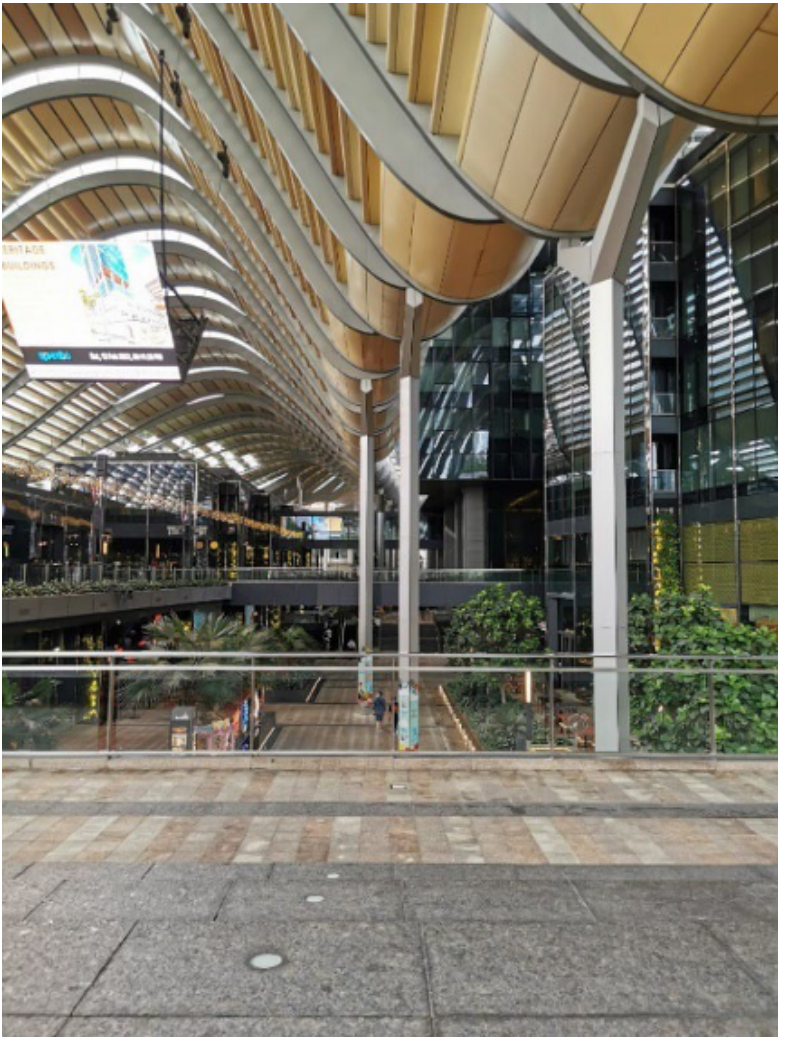

Figure 4: View from the second seated observation area. In the foreground is a series of wide and flat steps, overlooking the level below that comprises commercial services, the entrance to the underground metro, and a play area.

Source: Author's own image.

The South Beach multi-use development was completed in 2016, located in downtown Singapore. The development was designed by the global architecture and planning firm Fosters + Partners as part of a larger thematic project on restoring pre-existing cultural heritage buildings nearby. Here, solar PV presents itself as a characteristic visual trait within the development: the winding 'canopy-ribbons', pictured in Figures 3 and 4. The canopy-ribbons shelter a wide walkway that extends lengthwise, across the entire development. The canopy-ribbons comprise Building Integrated Photovoltaics (BIPV), providing light-filled spaces whilst generating electricity from the sun. The unique visual and functional characteristics of solar PVs in this development were the main reasons why the case was critically sampled (Yin, 2014). The canopy also reduces heat loads in the area and shelters pedestrian traffic from the extremes of a tropical climate like that of Singapore (Aranda-Mena and Tan, 2020).

I conducted the autoethnographical study on a warm and humid afternoon, beginning with a seated observation as seen in Figure 3. Similar to the previous study, I scribbled field notes, captured voice recordings and, where possible, took photographs. My immediate first impression of the environment was the sensation of a strong and constant breeze – I felt it hit me from the right, sweeping across my body and leaving downwind on my left. I observed the landscaping around me sway aggressively in protest – plants that stayed rooted in soil while leaves and branches danced in panic. I experienced some goosebumps, resulting from the quick cooling of sticky sweat on my skin. Cleanliness in the area was immaculate – not a piece of litter in sight – and the plants were manicured on what appeared to be a frequent basis. Noticing their deep green colour and luscious growth, it was clear that they thrived in this light-filled space and warmth – perhaps providing a successful picture of what an indoor-outdoor design could be.

The atmosphere of the area was spacious, light and peaceful, and I automatically sensed that this was a space intended for relaxed human experiences, such as calm and private discussions and leisurely walks. However, it appeared the extensively engineered environment left minimal room for alternative living beings beyond soil, plants, and humans – few insects and no animals were in view (or could be heard), which was a stark contrast to the previous case. For example, on looking closely, the movement of ants was rampant, in both synchronous and nonsynchronous forms. I looked at a rubbish bin close by, and it appeared as if someone had decorated its rim with melted ice cream. A trail of ants eagerly formed, hoisting little globules of ice

cream on their backs, before modestly making their way back to the planter behind me. I was aware that perhaps beyond what is visible – beyond the prying human eye – there are more critters, protected and comfortable.

My focus on the ants was interrupted by a party of approximately 14 wedding guests that spilled out into the foyer from the doors of the hotel, filling the place with murmured chatter. They stayed, chatting, for approximately 20 minutes underneath the breezy and shaded walkway, before going their own ways. Further away, I observed a smaller group of 2-3 children playing in the playground (designed with swing sets and a water fountain), while their parents gathered at a restaurant close by. Passers-by along the main walkway varied from rushed office workers to families with young children and the elderly walking at a leisurely pace.

As I moved to my second observation point (see Figure 4), I noticed that the wide, grey steps provided a popular gathering spot for people to sit, talk, and relax. Several smaller social groups, ranging from 2-4 people, had spread out across the steps, spaced out rather evenly, as if to secure privacy for themselves and their conversations. I noticed that the service personnel from the nearby restaurants were on their smoke break, nestled in discreet and quiet corners – with one explanation for this being that smoking in most public areas invites big fines in Singapore. There was a clear difference between the pace of activity within the area – most activity was concentrated in the public spaces (areas allowing the freedom to exist without needing to pay for a service) as opposed to the capitalised, private areas (areas of service provision that require some sort of payment for use, e.g. restaurants, the underground metro, shops, and so on). All in all, I observed approximately 67 persons that afternoon.

What I found particularly significant within this study were the experiences offered by solar PV's presence:

- A constant breeziness that permitted several human activities and behaviour (e.g. leisurely walking, long periods of rest and conviviality, frequent pausing and lingering),
- A form of sensory dampening (i.e. a place to relax, unpack, and unwind, away from the hectic ways of life),
- An affective experience of allowing one to take space for one's self – an inviting atmosphere of openness, lightness, and airiness affords some personal space, into which multispecies living beings could retreat,
- Liveliness of soil and plants (i.e. movement, vibrancy, flourishing within a cared-for environment).

The breeziness, significantly influenced by the solar PV canopy, offered a relational way in which human engagement to solar energy could be felt through an embodied experience of the wind. Symbolically speaking, solar energy could be felt, as much as it could be seen, through its PV panel form. This implicitly motivated human behaviour and activity – even without seemingly direct, tangible correlations. But its immaterial narrative and connection is nevertheless robust. Resonating with existing research, solar PV technology appears to have reached a point in innovation where it can be a part of (or at least contribute to) everyday experiences (e.g. Backlund et al., 2007; Gumińska, 2019; Sánchez-Pantoja et al., 2018b, 2018a), whether bounded within its form or relational in its ecological narratives.

5. Discussion: Attuning to Solar (In)Visibilities

The autoethnographical explorations give insight into how solar energy experiences may manifest in multiple different forms in everyday lives – a facilitated breeze, swaying leaves, bird song, insects chirping, leisurely strolls, and more. This, in turn, offers opportunities for plural ontological explorations. In this section, I return to the research question introduced at the beginning of the article: *How might poetic multispecies storytelling contribute to a posthumanist appreciation of solar PV?* Through deliberating this research question, I offer ways of relational thinking with solar PV that might provide meaning and appreciation beyond detached and decontextualised anthropo-techno ways of understanding solar PV (Wilhite and Wallenborn, 2013).

The fleeting form of solar PV emphasises the temporality (or rather, the temporariness) of solar PVs existence on a landscape – where, after their 20 to 30-year lifespans, they may cease to exist, or be replaced with newer and even more desirable technologies (Chowdhury et al., 2020). Fundamentally, this points to the fact that while their material existence may be short, the processes informing the conception of their lives (through designing and decision-making) are not. Processes such as designing and decision-making around renewables are often similar to those applied to the "green" transition – in other words, linear, short-term and extractive. As such, recent research has shown that resistance, critique, and alternative movements towards the adoption of renewables – and the "green" transition in general – signals a need for a more just and diversified understanding and application of renewables (e.g. Knuth *et al.*, 2022; Sovacool, 2021). According to Donna Haraway's notion of *response-ability*, being human means, "to become worldly and to respond" (Haraway, 2016, p.41). Exploring alternative ontological worlds with solar PV is thus based on engaging and enriching our human ability to respond to others. Responding to others does not necessarily rely on the verbal or visible, as the two cases show. It is about sensing what might

be latent, implicit, or tacit – specifically, what might be invisible. The solar PV panel is visible, yet appreciating solar PV's behaviour with its many ecological relations requires *attunement*, which might only be possible with introspection following undisturbed *presence in place.*

Presence in place is the *intentional* curation of headspace for introspection, heightened awareness, and situated immersion in place, which would allow one to pick up on miniscule, less visible, and seemingly mundane details and happenings in that place. To be present in a place consequently refers to being intentionally open and aware of the different cognitive, affective, and interpretative aspects derived from the surrounding environment (Thombre and Kapshe, 2021). To be clear, the key takeaway here is being intentional. This is a further deliberation surrounding Tsing's art of *noticing* (Tsing, 2015), in that beyond noticing, one must also be intentional in what they are noticing and ready to curate a headspace for undisturbed immersion. Thus, being humanly present in place – and by refining the skills associated with being perceptive and having a heightened awareness of possible alternative material and immaterial narratives, offers an important bridge between ontological worlds. The dreaming of the (non)human from the standpoint and existence of the human might therefore open up other ways of understanding solar PV technology and provide a crucial source for informing meaningful design.

However, this means recognising that a political dimension is embedded into living – across human and nonhuman living. This begs the question then of *who* or *what* can afford a privileged, unreserved *looking around* (Tsing, 2015)? Looking around refers to the capacity to appreciate seemingly mundane yet significant details of the multiple narratives that exist, collide, and inform ecologies within a place. At the time of the two cases, the human – myself – had the privilege (i.e. power) of looking around, which facilitates a subjective positioning on the experience in place. With that said, an ontological exploration or dreaming surrounding an experience can differ widely in approach, performance, and analysis. In a photo essay called *Edenic Apocalypse: Singapore's End-of-Time Botanical Tourism*, by Natasha Myers (2015), she explains:

> Gardens by the Bay has engineered an ambivalent affective ecology, one that simultaneously elates with the allure of vital simulations, and throws visitors into what Donna Haraway calls the "slew of despond." … It is in this simulation of an already lost world that we can see how capital continues to profit from the very extinctions that it drives, here in the guise of entertainment for climate-change Education. (p.31)

This offers a different version of *looking around* at the Gardens by the Bay site, thereby contributing to an alternative sense-making behind the ecological worlds that exist

there. Such nuanced differences provide for a lively and dynamic discourse about more-than-human technologies in feminist technoscience fields, since *intra-actions* between the human mind and body and the multispecies living is ultimately personal.

At the juncture of becoming-humans ourselves (Braidotti and Bignall, 2019), a posthumanist understanding of solar PV is thus, the poetic narration of *becoming-with* solar PV in complex worlding processes. This means that the human reflection and introspection process, situated in place, might serve as an opportunity and platform for a certain dreaming of different ontologies. The two cases explore how multispecies poetic narration within a situated context might offer a way forward for solar PV knowledge as part of entangled worlds – where a socio-technical transition borne largely from the Anthropocene might develop further nuanced sensibilities. Meaning that its transcending affects into atmospheres, environments and multispecies living does not stop (nor start) at the PV's physical conception, but rather, through embodied, experiential knowledge intrinsic to ways of being with manifestations of solar PV. The studies do not mean to certainly nor statically depict, through quantitative measures, what these ontologies are – for instance, they do not provide a comprehensive list of nomenclature nor a scientific account of the metabolic systems in place across the multispecies living. However, they do, through personable poetic storytelling, instil a sense of alternative imagining and worlding possibilities. Telecommunication lines that carry electricity; warmth in the summer months; the changing of seasons; deaths in marine life through pollution with by-products from solar PV production; poisoned soils at solar PV landfill sites; cattle grazing pastures under rows of solar PV panels in solar parks. Such poetic experimentation with language is powerful in giving space to multispecies agency as a forefront to anthropogenic technologies, contributing to a growing discourse on artful and artistic feminist technoscience.

6. Conclusion

Through two autoethnographical studies, I have offered some posthuman insight into *becoming-with* solar PV. From describing "*feeling*" solar PV (as in through the breeze in Study 2) to narrating the embodied experiences derived from the shading from solar PV (Study 1), I argue that these ways of appreciating and storytelling around solar PV are alternative and nuanced to the dominant perspective (that is often perhaps visual and monolithic). Through repetitive practice of such noticing, I argue that one might hone the skill of picking up on such miniscule details that facilitate a multispecies and relational learning of solar PV (i.e. to *become-with* solar PV) eventually leading to more ecological adoption and designing of renewables.

Multispecies storytelling through immaterial and material narratives offers a way of shifting traditional design perspectives from the human to more relational intra-actions in space – where solar PV, although a product of the Anthropocene, manifests different meanings within entangled multispecies worlds. As such, knowledge from this article could contribute to new ways of understanding and designing solar PV worlds that are not only anthropo-techno centric, but relish in multispecies *response-ability* and flourish. This means the decentralisation of a human-centred value system and adoption of these technologies, towards a more ecologically sustainable acceptance of these systems. Systems that are integrated in their situated ecologies beyond their sole purpose of generating electricity; but offering new habitats; facilitating biological processes; a meeting ground for active discourse and deliberation.

These two explorations of rapid autoethnography offer a proposed experimental and approachable way forward in multispecies experience and narration. Particularly in the field of artistic and design research, rapid autoethnography might serve as a useful method for those who are seeking to centralise the multispecies perspective based on a sensitisation to human sensorial and embodied experiences in place. These cases comprise preliminary research into broader multispecies appreciation in the designing of solar PV systems in place, which would require lengthier spans of immersion, observation and data collection (i.e. full-scale ethnography practice).

I reflect upon my autoethnographical experience in Study 2, during a moment of quiet immersion. As the wind blew, the hairs on my neck began to stand. A cloud of cigarette smoke wafted by me, and as I looked around, a man in uniform threw his cigarette on the ground and grinded it to a pulp. He glanced my way carelessly, and then walked away. I stared at the remains of warm glowing ashes on the ground. Black, white, and gold; once a full chemical body. Another gust of wind blew, and the

ashes, with a burst of energy, swirled and flew away in a hasty escape. Ashes, weighing on me like the significance of human remains, spread out into the world, partaking in the stories of others. I looked up at the glistening gold canopy-ribbons. Solar PV was a part of this story.

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