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POWERING THE FUTURE: ENERGY RESOURCES IN SCIENCE FICTION AND FANTASY

'This Shining Confluence of Magic and Technology': Solarpunk, Energy Imaginaries, and the Infrastructures of Solarity

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This article will engage in an extended analysis of solarpunk, a richly elaborated speculative solar energy imaginary. It will ask, firstly, what solarpunk suggests about the formal, semiotic, and aesthetic dimensions of existing solar technology, and the kinds of fantasies such technology facilitates. Secondly, it will analyse how imaginary infrastructures figure a variety of social and technological elements necessary to transition, and how fantastical technologies are deployed to facilitate even the most empirical of transition imaginaries. Thirdly, it will ask what solarpunk suggests about the relationship between alternative energy imaginaries, community-building, and agency in the present struggle over energy transition.

In the transition from fossil fuels to renewable energy, solar power is likely to provide the lion's share.¹ Commentators from across the political spectrum, from neoliberal financial advisors and think-tanks (Bloomberg NEF, 2018; Sivaram 2018) to centre-left enthusiasts (Brown, 2015; Scheer, 2004) to full solar communists (Schwartzman, 2013), are bullish about the promise of solar. This broad base of enthusiasm points to how solar power brings with it not just a viable source of energy, but a sense of utopian possibility too. Until fairly recently, solar has been distinguished by its 'perennial status as a future technology' (Johnson, 2015: 6). This 'just over the horizon' quality, combined with its vast generating potential, has made it an ideal vehicle for dreams of an improved future.² But what work do these speculative energy imaginaries do in the struggle over the future of energy transition? How do they deploy the fantastic in order to weave their desirable futures, and what does the fantastic enable? This article will engage in an extended analysis of solarpunk, a richly elaborated speculative solar energy imaginary, in order to address these questions.³ It will ask, firstly, what

¹ Between 2008 and 2013 the price of silicon photovoltaic (PV) panels—the current dominant form of solar technology—plunged 80%, as China began manufacturing silicon panels in earnest (Sivaram, 2018: 28). Concentrated solar power plants (CSP plants—capable of energy storage and timed-release, a major hurdle for PV which can only store and release energy with expensive and relatively low-capacity batteries) in Chile and Australia have, for the first time, become 'competitive with gas-fired power' in terms of dollars per mega-watt hour. This is a major step to make them competitive with this 'cleanest' and most flexible of dirty sources, often touted as a useful just-in-time supplement to the fluctuating energy generation of PV (Deign 2017). In 2016, more investment was poured into solar projects globally than any other power source—some \$ 116 billion (Sivaram 2018: 28). Due mainly to the strong PV market, 'renewables accounted for almost two-thirds of net new power capacity around the world in 2016, with almost 165 gigawatts (GW) coming online', while 'new solar PV capacity around the world grew by 50%, reaching over 74 GW [...] for the first time, solar PV additions rose faster than any other fuel' (IEA 2017). Adding to this is the promise of future developments, such as solar paint or lightweight rolls of PV, transparent and coloured PV, and 'liquid sunlight' (carbon-dense liquids mimicking oil).

² Famously, the amount of power from the sun that strikes the Earth in an hour is more than the entire world consumes in a year (Lewis and Crabtree 2005: ix).

³ Throughout the article I will be using the term 'imaginaries' following Jasanoff's & Kim's notion of 'socio-technical imaginaries' (2015) to mean:

collectively held, institutionally stabilized, and publicly performed visions of desirable futures, animated by shared understandings of forms of social life and social order attainable through, and supportive of, advances in science and technology (4).

solarpunk suggests about the formal, semiotic, and aesthetic dimensions of existing solar technology, and the kinds of fantasies such technology facilitates. Secondly, it will analyse how imaginary infrastructures figure a variety of social and technological elements necessary to transition, and how fantastical technologies are deployed to facilitate even the most empirical of transition imaginaries. Thirdly, it will ask what solarpunk suggests about the relationship between alternative energy imaginaries, community-building, and agency in the present struggle over energy transition.

Infrastructures, Social Relations, Imaginaries

The specifics of speculative energy imaginaries vary depending on the politics of the dreamer. Some are limited to business-as-usual with a generous solar panel icing:

Solar PV isn't just powering glamorous urban buildings or massive industrial plants [...] PV materials are now light enough to be supported by flimsy shanty roofs in the slum outskirts of megacities in the developing world (Sivaram, 2018: 8).

Others envisage solar leading almost inevitably to a more local world. For Hermann Scheer, for example, solar is 'by its very nature, decentralised' (2013: 88) and will occasion the devolution of political power and a more egalitarian and entrepreneurial society, with individual creativity and productivity 'liberated', but remaining within a broadly capitalist economy (2004). While the above futures are market-led, developing from envisaged large-scale private investment in solar (with, in Scheer's case, the state as midwife), others argue that 'capital is not rising to the occasion' (Malm, 2015: 380). From this perspective, only 'transnational political action on a scale not witnessed in human history will do the trick, leading, it is hoped, to a future of global cooperation and, ultimately, communism' (Schwartzman, 2013: 480).

Speaking precisely, we might term solarpunk a speculative imaginary, in so far as it is consciously created in order to explore specific kinds of alternative futures, while imaginaries as such are better understood as types of discourse, collectively but unconsciously held, rather than developed. For both, however, the crucial element is in the collective nature of the fantasies, and the way they provide visions of the future with influence on the present.

Clearly, solar technologies are adaptable to both centralised and distributed models of socio-economic organisation and infrastructure, both neoliberal and communist worlds, and anything in between.

The social and political organisation of a solar future, Darin Barney has noted:

like all energy configurations [...] is going to be a terrain of social contestation and struggle and imagination, and all that is what will determine the outcomes of solarly—not anything that inheres in the technologies themselves (Boyer and Howe, 2018).⁴

Once introduced, 'technology offers a material validation of the social order to which it has been preformed' (Feenberg, 2010: 18)—or, as Andreas Malm argues more broadly, 'productive forces proceed from being effects of relations to something more like causes and props'. From here there is a feedback loop: 'relations become objectified in the productive forces [...] the more such forces there are, the harder to break out of the relations cast in iron' (Malm, 2018: 181). Nonetheless, the social relations in which and for which solar infrastructure is initially formed will determine in the first instance the shape it takes and the social relations it encourages. As Deborah Cowen puts it, 'infrastructure is by definition future oriented; it is assembled in the service of worlds to come' (2017). Hence the dense clustering of opposing visions of the future around energy transition: the necessity of remaking the global energy infrastructure appears to present a rare opportunity for remaking the world in another image, one where utopian visions have material vehicles for their realisation.

Infrastructures should be understood as both technical systems and 'social networks' (Larkin, 2013: 331). They 'bind people and things into complex

⁴ This is a contemporary iteration of an old Marxist debate concerning the primacy of, on the one hand, technology and infrastructure (the forces of production) or, on the other, the social relations of production that surround them, in determining the shape of society. See Malm (2018) for a contemporary summary of, and intervention into, the debate. See also Sheena Wilson: 'energy itself does not create transformation. It is the valuation of energy sources and the ways in which they are socially, economically, and politically integrated that will be transformative' (2018: 386). 'Solarly' and 'Solarities' are fledgling terms, used in this article and in the energy humanities to refer to the social, political, and economic configurations of possible solar-powered futures. I take this usage from Darin Barney and Imre Szeman. See Boyer and Howe (2018).

heterogeneous systems' and produce 'a kind of mentality and way of living in the world' (Larkin, 2013: 331). They are also constituted by and produce imaginaries: they 'operate on the level of fantasy and desire [...] encode the dreams of individuals and societies and are the vehicles whereby those fantasies are transmitted and made emotionally real' (Larkin, 2013: 333). Some recent work has begun to develop the links between solar energy infrastructures and technologies, social relations, and their associated imaginaries, taking existing infrastructure as a case study. For example, Brennan (2017b) starts with a series of community-owned solar powered streetlights in Highland Park, near the US city of Detroit, brought in to replace central grid lights repossessed by the private utility provider. He describes how the lights emerge from, embed, and encourage more communal social relations, and how they generate speculative visions of radically altered energy futures, characterised by community ownership of energy production. The analysis begins with the reality of the infrastructure and its embedded social relations rather than the associated imaginaries, which function primarily by extrapolation: the local situation scaled up to a neighbourhood, or a city, without much additional detail. While important and useful, this work sheds light primarily on the reciprocal relationship between social context and infrastructure, and less on the imaginary. Its starting point in real infrastructure limits its exploration of the imaginary to its extrapolative function (as opposed to, for example, metaphorical, symbolic, or figurative), which is only one basic element of speculation and fantasy.

The following analysis crosses the bridge from the other side, taking the highly-developed future imaginaries of solarpunk as its starting point.⁵ This approach gives primacy to the affordances of the energy imaginary, and the 'formal dimensions' of infrastructure as 'entextualized forms that have relative autonomy from their technical function' (Larkin, 2013: 329; 335) by exploring them via their literal entextualization in speculative and fantastic narratives. A literary studies approach is best placed to contribute this kind of analysis to the discussion around energy

⁵ Solarpunk is, to my knowledge, the most richly developed imaginary of an alternative solar future (solarity), that we have. Ganzeer's graphic novel *The Solar Grid* (2016) is also well developed, but is incomplete (four issues to date) and is a single-author text rather than a shared community imaginary.

transition, and the contribution is intended to compliment the more ethnographic approach of infrastructure studies.

Solarpunk: An Overview

Solarpunk is an emerging sub-genre of fantasy and science fiction broadly characterised by imagining sustainable futures after energy transition. To date, there are four anthologies of short stories in the canon.⁶ Notably, these are futures in which energy transition is not only a matter of technological innovation but also of changes in social relations and value systems. Alongside the profusion of solar technology, smaller-scale communities or egalitarian eco-city-states are a more common focus than nations, communal ownership is often the norm, and ideals of community, care, and humility—particularly with regards to humanity's relationship to the ecosystem—are prized above economic growth or competition. Solarpunk is not, however, politically homogenous. At one extreme, the early 2012 Brazilian collection, now translated (Orsi, 2018), is more ideologically akin to cyberpunk, set in renewable energy futures dominated by multinational corporations, with an overriding tone of cynicism and a 'deflationary' view of egotistical human nature common to both noir and cyberpunk (cf Freedman, 2009). As the genre has grown, it has developed a strong utopian, activist streak, with the stories much more likely to be optimistic and with the imagined worlds as clear figures of a desire for a socially just and ecologically harmonious social organization (for all the ambiguity of what those terms might mean), though they do not agree on what 'better' looks like. This article takes these latter stories to be of more interest: firstly because they provide visions of a solar future that diverge from cyberpunk's nihilistic 'more of the same' extrapolation, and as such represent efforts to think against the social relations of the present; secondly because the tone of the stories shifts with the emergence of a solarpunk community as they become less single-author works of fiction and more expressions of a shared imaginary; and, thirdly, because as more is published, that

⁶ Arseneault and Pierson (2015); Orsi (2018); Ulibarri (2018); Wagner and Wieland (2017). Two others might be included under the banner: Blue (2017) and Grzyb and Sparks (2017). For websites see 'SOLARPUNKS' (n.d.); jay (2017); and 'Solarpunks Tumblr' (n.d.).

early iteration of solarpunk looks increasingly like a transitional moment—cyberpunk in solarpunk clothing—before the sub-genre found its own sense of identity.

Unusually, the conceptual space named 'solarpunk' emerged prior to the narratives that are now gradually giving it substance, and much of solarpunk happens outside the published stories. The main body of the solarpunk 'megatext' (Broderick, 1995) exists in the numerous blog posts, Tumblr pages, and online discussion groups dedicated to the subgenre, rather than in narrative form.⁷ One early blog post gave it an aesthetic that has proven popular ('very similar to steampunk, but with electronic technology, and an Art Nouveau veneer', Louise, 2014) while manifestos emerged to argue for what it was, before it was really anything at all ('there's an oppositional quality to solarpunk, but it's an opposition that begins with *infrastructure as a form of resistance*', Flynn, 2014, emphasis in original). Solarpunk is a 'world' first and a set of narratives second; one main community hub, the website *solarpunks.net*, describes it as 'at once a vision of the future, a thoughtful provocation, and an achievable lifestyle. In progress.' (SOLARPUNKS, n.d.). The solarpunk imaginary is a collaborative one, a product of the internet's connective and community-building properties, and the narratives emerge from this mood-board of shared discussions and reading-groups, collections of real-world inspirations, and artistic representations.

Formal Dimensions of Solar Technologies

Solarpunk narratives create new fictional solar technologies and infrastructures, or embed and elaborate existing ones more fully into the world. In their fabulation and exaggeration they present intriguing insights into the semiotic and aesthetic resonances of solar technologies, and how imaginaries are shaped by them. This section considers three related examples: light; abundance; and transparency.

Solarpunk futures, as we might expect, are often suffused with light. As a crude illustration, the recent *Glass and Gardens* anthology (2018: 292 pages), features the words 'glow', 'bright', 'shine', 'light', and their derivatives 185 times, or roughly three

⁷ This situation is of course true of other contemporary subgenres with dedicated fan communities, particularly the other '-punks', such as steampunk and dieselpunk, but these were named in the first instance to categorize existing examples.

times every five pages. In comparison Cory Doctorow's novel *Walkaway* (2017: 384 pages), a utopian sf (science fiction) novel also concerned with radical responses to climate change, and often claimed by solarpunks as sharing common ground with the subgenre, has only 90 instances, roughly one every five pages. 'Glow' provides the greatest disparity: 60 instances compared to 10. In solarpunk narratives, light, and specifically the production of it, is deployed as a mark of goodness, a shibboleth for communicating a 'solarpunk' sensibility, particularly symbolising the value and practise of communality, both human and ecological. In this, solarpunk is not innovating but rather following in a tradition of literature deploying the poetics and semiotics of light and heat to promote joy and communal work—evident in, say, the famous harvest scene in *Anna Karenina* (2004: 247–54). Solar energy is expressed in these examples as a particular value of 'ambient' energy (Johnson, 2018): modulating, through specific instances of heat and light, the emotional, sensory, and affective substructure of life. In the case of solarpunk, this modulation tends towards a sense of warmth, clarity, safety, and communality that borrows something from the welcoming glow of the hearth, but folds it into a hi-tech setting.

'Riot of the Wind and Sun', from *Glass and Gardens*, opens with a group of female friends talking, listening to music, painting each other's nails, and making beaded jewellery. It is an ordinary, affectionate scene of companionship, in which 'the girls' nails [...] glowed, along with their clothes and the beads' (Rossman, 2018). The ambient warmth of the light produced by the women becomes elided with the emotional warmth of the scene and becomes a visible marker of the ties of affection that bind people together. The story culminates with the entire community working together to make a giant glowing sign in the desert from their finest clothes, in order to communicate their presence to the world. Light becomes a vehicle for uniting and binding communities. Another story from the anthology, 'Cable Town Delivery' closes with a community gathering for a 'Festival of Light' (da Silva, 2018) while in 'Women of White Water' such festivals are 'a celebration of survival [...] community [...] respect for nature' in contrast to 'the old times, when the world was one big village and no one had a sense of home' (Kenwright, 2018). In the more fantastical 'Glow', from *Wings of Renewal*, the community gathers to celebrate 'the solstice, and

all the life the sun gifted them', where the protagonist looks forward to 'mingling with her friends and stuffing her face with sticky, sugary yams', and the centrepiece is a glowing dragon which 'rained sunlight down among the crowd' (Nicoll, 2015). Solarpunk uses light and heat as vehicles for communal feeling and communal relations. It attempts, in its imaginary, to unite solar power with a reinvigoration of communality and responsibility, and a fellow-feeling with non-human nature.

Solar power suggests community and celebration to the imagination partly because of its abundance. For George Bataille, solar energy's abundance demanded a 'social contract to take what is given and to return through expenditure' as Boetzkes summarizes (2017: 317). Festivals have traditionally been a central social mechanism for such expenditure. In solarpunk, they also connect the pragmatic use of solar power to a conscious celebration of it. The poem 'Sunharvest Triptych' (Norja, 2017) captures this celebration of abundance, as well as an awareness of the economy of sunshine in some parts of the world—the need for rhythms of accumulation and storage that hark back to a necessary attunement to agrarian cycles at odds with today's consumer-driven dislocation from seasonal flux:

When the whole land awakens,
when we bless the solar panels
the fieldfuls, the rooftopfuls,
the stained-glass-windowfuls of them
the harvesters of energy
to sustain us in winter's dark months
when the sun barely greets us. (219)

The entanglement of light with community is there both in the festival itself and in the negative sense of the sun's withdrawal, characterized as a diminished 'greeting'. The brimful language here unites with a certain religious reverence, which is another common feature of the solarpunk imaginary, hand in hand with framing their green futures through a nostalgic anti-modernism.

While nostalgia, or the politics of loss, suffered severe censure in politically radical circles after the 19th century, held to be 'backward looking [...] unacceptable,

inadequate, eccentric', it also remained as a 'provocative resource for "counter-cultural" interventions' (Bonnett, 2009 48; 47). The emergence, by the 1960s, of a 'green-tinged [...] localist, folk and libertarian milieu' (Bonnett, 2009: 52) united both conservatives and orthodox Marxists against this new anti-modern sentiment. In the history of the study of the fantastic, this reaction manifests in a strong preference for science fiction over fantasy in the critical theory of the late 20th century, taking up arms against what were perceived as anti-modern, anti-rational forces of mystification in the fantasy genre (with Suvin, 1979, as the key text which set the argument for those that followed). Yet in the contemporary period, the political potential of fantasy is being rehabilitated (see, for example, Miéville, 2002 for an early effort), and more broadly in radical circles 'the shame of nostalgia is fading' as thinkers begin to grapple with the fact that 'the poetry of the future is no longer enough' (Bonnett, 2009: 65). If, as Imre Szeman and Dominic Boyer insist, we must understand 'modernity'—both conservative and radical iterations—as a fossil-fuelled experience, then the affordances of the pre-modern for thinking a break with the current petroculture are clear.

In its efforts to imagine an egalitarian, ecologically harmonious future, the subgenre often turns to figures of pre-modern social structures, much as William Morris did in *News from Nowhere* (1993 [1889]), often claimed as a solarpunk ur-text by the community. One genealogy of solarpunk is to see its technologically facilitated return to nature and natural rhythms as an elaboration on the suggestion of Morris' 'force-vehicles'. Briefly alluded to in *News from Nowhere*, only to have further explanation denied ('I took good care not to ask any questions about them', 1993: 186) these force-vehicles have replaced steam-engines and appear to be the ideal 'green' motive force. There is no comment on noise or effluence from them, and they fit so well into the surrounding agrarian life that they essentially disappear. Yet their presence marks Morris' utopia as future, not past, despite the clear nostalgia for a lost, 'whole' past that grounds the utopian critique. And yet the politics of loss still sits uneasily with radicalism. This article will return later to the difficulty that presents itself when advanced technologies are deployed in a relatively pastoral setting that doesn't seem to allow for the production and distribution of such technologies. This

contradiction between green technologies and their deeply problematic current mode of production is one that solarpunk provides a symbolic resolution for in its utopian figuration, but only by obscuring, like Morris, the necessary means of their production.

The cover art for the *Sunvault* collection, a solarpunk anthology published in 2017, provides another example of light as a figure for harmonious relationships and plenitude (Wagner and Wieland, 2017). In this image a visibly curving earth holds a city filled with greenery and criss-crossed by water, with the sun dominant above it. The style draws on expressionist techniques reminiscent of Van Gogh's 'The Sower'; the fulsome sun on the *Sunvault* cover radiates light which is picked up and reflected by buildings and water, and bright motes fill the air. Here the sun's light and abundance are presented as a unifying force, touching on and binding together the various elements of the scene, which are a synecdoche for the planet and human civilisation as a whole, suggestive of a total harmony.

While this image of harmony is utopian, it also threatens, as such images do, to totalise. The sun promises and threatens to subsume everyone and everything beneath it, as much a symbol of beneficence as an emblem of tyranny. While solar power lends itself to decentralised structures, it also encourages plans for a world super-grid (Liu, 2015). Finally, sunlight does not fall on everyone in the same way: in some parts of the globe it is something to be warded off, to be escaped, lest it damage land, crops, and biological life, a necessity that will only grow with intensifying global warming.

The ubiquity of light in solarpunk, and its privileging of harmony, belie an accompanying darker social side, in the associated concepts of transparency, tipping into surveillance and discipline. Brennan, in his work on streetlights in Detroit notes the 'long history of light on the street as a racialized tool of state surveillance and policing' (2017b: 167). To reiterate, light does not fall on everyone equally, or with the same consequences. In 'Watch Out, Red Crusher!' (Graves, 2018) the development of 'solar nanites'—a technology implanted into each individual at birth, which essentially turns everyone into a walking solar cell to help power the community of 'Aberdonia'—has the side effect of making everyone's emotions visible

via a colourful glow. In conjunction with a community that idealises harmony, this leads to an oppressive situation, where a red, angry glow leads to exile once the individual becomes an adult, and even a despondent blue is frowned upon. The story is not a simple dystopia, as the values of community and harmony are genuinely celebrated and the praise of the new importance of 'inner beauty' over external trappings is seemingly sincere (Aberdonia is directly and sincerely referred to by the narrator as a 'utopia'). At the same time there runs through it a sense of unease at the new disposition, particularly since the angry young man that is exiled (the 'Red Crusher' of the title) initially claims political disaffection as the cause of his anger (if political disagreement is outlawed, then this is a dystopia indeed). Tellingly, outside the boundaries of the utopia is the 'uncivilized Freeway—home to murderers and thieves'. While this was presumably meant as a *Mad Max*-esque marker of the bad old petrochemical days, the reader—and I suspect the author—can't quite shake a longing for that free-way in the face of stifling Aberdonia. The thoughtful exploration of transparency and harmony this dissonance might have led to, however, is shut down by the narrative disclosure of the Red Crusher's attempted rape. This provides the narrative with an incontrovertible moral front to retroactively justify the value system and its judgement of exile. Solarity's apparently utopian resonance with making visible, and with transparency, here reiterates an old danger of utopia—its totalitarianism, its all-seeing eye—in new form. The reader might wonder, recalling Dostoyevsky's *Underground Man*, whether they will be able to stick their tongue out at this new Crystal Palace.⁸

As well as visible light, solarpunk casts into relief the quality of 'lightness' with which solar power is associated. Images of solar futures from any source, corporate to activist, tend to display solar technologies in a bright, clean, green setting. There

⁸ "You believe in a crystal edifice, forever indestructible; that is, in an edifice at which one can neither put out one's tongue on the sly nor make a fig in the pocket. Well, and perhaps I'm afraid of this edifice precisely because it is crystal and forever indestructible, and it will be impossible to put out one's tongue at it even on the sly." (Dostoyevsky, 2010: 35). Also, to emphasize, despite the ending, or perhaps because of its too-pat resolution, Red Crusher's tensions and dissonances make it one of the most thought-provoking stories in the solarpunk canon.

are obvious pragmatic reasons for this, the main one being that a gloomy solar future wouldn't be very persuasive at either an affective or a technical level. But these images—suggestive of a new dawn, of spring, of fresh beginnings—are both enticing and duplicitous. The poem 'The Sailor-Boys' (Wagner and Wieland, 2017) illustrates the problem:

we is some fresh starts, yes.
We does soar over sighing tragedy,
the heaving high tide of Mama Dlo short of breath,
and laugh, cheer the wind on as we float.
We is some rebels, yes (57).

Solar is so resonant of a 'fresh start' that it slides into ideas of a 'clean slate'. Solar futures are attractive in part because they offer the chance to forget what came before, to absolve us of our own environmentally-damaging history, or at least to shield ourselves from it. Just as utopian representations of the sun elide real underlying contradictions, 'lightness' is a kind of weightlessness that comes with absolution and freedom from responsibility. The lived future, in contrast, will be one heavy with ecological attention and care, and one certainly burdened by the carbonised weight of the past, the responsibility, and the effects unjustly distributed. Here we discover the disjunction between petrocultural encodings of 'freedom' as sheer unencumbered agency on the one hand, classically figured in the ever-unfolding new horizons, the freedom of the automobile, and the endless economic growth of the *Futurama* exhibit at the 1939 New York World's Fair, and the strictures of ecological knowledge on the other. This produces a difficult tension in the question of what a properly agential and joyful, yet responsible and harmonious, ecological subjectivity would look like. Can such lightness come from anything other than forgetting? What does freedom and agency look like in a future where our actions are limited by ecological knowledge and the depleted resources of the earth? The carefree agency of the petrochemical age must here reckon with its external costs, its emissions, and its ecological consequences. The suspension of these two opposing

claims in the solution of solarpunk's imaginary are only resolved by an infrastructural base encoded with an ecologically sound sensibility, facilitating agency in a way that allows us to act without thinking in much the way we do now, but in full knowledge that our actions do not extract an ecological cost.

The Amnesia of Solar Infrastructure

Beyond the site of the newly-ecological subject, the same amnesia of the fresh start plagues solar imaginaries at the level of infrastructure, and raises the same fundamental problem: do solar infrastructures present a genuinely new beginning, from 'root to tip', or are they merely a shiny surface, glossing over the rot within our utopian imaginary? In terms of both their formal and material dimensions, solar energy infrastructures oscillate between visibility and invisibility. This is true of all infrastructures: far from always invisible, as notably claimed by Star (1999), infrastructures can also be 'richly symbolic and vividly present', deployed to generate and 'continually renew political effect' (Larkin, 2013: 336). Solar technologies straddle this line in a particularly vivid way. The 'absolute distributability' (Howe, in Boyer & Howe n.d.) of solar panels and the coloured panels, transparent panels, PV paint, and PV rolls coming downstream will ensure they coat every surface. There are doubtless great aesthetic possibilities in such a world. Solarpunk is full of descriptions of 'towering green and silver spires [and] solar panels colored like jewels' ('Summer Project', Arseneault and Pierson, 2014); 'Solar panels made to resemble old nipah roofs' ('A Field of Sapphires and Sunshine', Ulibarri et al., 2018); and 'solar mosaic walls that mimicked the living flowers and trees all around us' ('Under the Northern Lights', Ulibarri et al., 2018). Yet the sheer intimacy and ubiquity promised by the affordance of aestheticized solar technologies like these causes them to become functionally invisible, whether through transparency or through an aestheticisation that conceals their technical purpose. There may come a time when we cease to notice solar infrastructure as infrastructure in urban areas at all.

The very ubiquity of PV technology, and its near-magical 'surface' quality, recommends it to concealment. Firstly, it conceals itself as something else. Secondly, it conceals the reality of its downstream production—a crucial and hidden appendage of

its energy infrastructure. A key critical emphasis on fossil fuel infrastructure maintains that it is invisible to those in urban, affluent areas, and brutally visible to those at the peripheries, where the resource is extracted and refined. When the latter impinges upon the former, when communities with some political and economic weight are subjected to the realities of the energy infrastructure, there is pushback and political fallout.⁹ There is no persuasive reason solar would be any different. The necessity of bringing solar power production into the very heart of urban and affluent spaces explains the otherwise bafflingly high standards for the aesthetics of solar cells, with entrepreneurs working on aesthetically pleasing PV claiming that 'one of the larger barriers to large-scale adoption of solar power' is 'the intrusive and ugly nature of solar panels' (Lendino, 2015), while an engineering team working on fully transparent cells states 'ultimately we want to make solar harvesting surfaces that you do not even know are there' (Lunt, 2014). The goal is to create invisible infrastructure, the idea of magically generated power, which conceals the process of energy production on-site and, unlike oil and gas which require pipelines and transmission networks, PV's decentralising qualities promise to do away with signs of its off-site production too. By off-site production I mean the actual production of the solar technologies, before they are installed, and the extraction of the resources that go into them, before they are produced. If these relations of production remain the same as at present, PV infrastructure will not present a radical break but rather business as usual.

CSP plants, on the other hand, are enormous, blinding arrays of mirrors and towers, which efficiency dictates be placed in deserts, far from urban centres. These solar power plants fit into the older fossil fuel model of energy production without much adaptation—the energy is produced on the peripheries and imported to the centre. They also replicate the inequalities of those colonial and extractive models. Imagining deserts as 'gold-mines' of sunlight obscures the inequality of the 'solar footprint', under which local communities and ecosystems suffer, and the way that

⁹ Examples are numerous, but include the political resistance in the UK to fracking in the home counties compared to the same practice in the rural USA; the outpouring of anger at the Gulf Oil Spill compared to the regular spills in the Niger Delta; and of course the birth of the Energy Humanities in Alberta, in response to the Canadian Tar Sands.

CSP plants maintain 'the centralisation of profit and electrical infrastructure with large energy utilities and the state' (Brennan, 2017a: 246). The abandoned Desertec Sahara project; the existing Quarzazate solar plant in Morocco; the planned TuNur solar park in Tunisia: all have been criticised as 'Green Grabbing'—appropriating land and resources for purportedly environmental ends (Maroun n.d.; Hamouchene, 2015, 2016a, 2016b, 2017). Using local land (10,000 hectares in the case of TuNur) and draining scarce water reserves for cooling and cleaning the panels, these CSP plants are designed to generate energy at utility scale and send it north, to the UK and Europe, rather than to their own energy-poor populations. The Sahara, in the words of one boosterish journalist, is shaping up to be the 'solar battery for Europe' (Lempriere, 2017). Comparisons with present-day Niger Delta, supplying oil to the world while the local people pay a mark-up for costly diesel for dirty generators, are hard to avoid.

Tying energy production to social justice, Wilson argues that we need:

an energy transition that confronts and comes to terms with the systemic violences of the age of oil [...] the ongoing pillage of natural resources and the exploitation of bodies marked by race, class, and gender around the world.

A true 'world after oil' for Wilson is 'a world whose social systems and cultures are no longer shaped by the relations of petro-capitalism but by alternative configurations of energy and political economy' (2018: 378–9). Yet if this were not reason enough for social shifts to accompany the technical transition, even closing our eyes and ears to global inequality and suffering, even bracketing, in so far as it is possible, the question of political allegiances and ideological perspectives, there remains the brute fact that technical energy transition alone will not cut emissions deeply or swiftly enough to save us.

Infrastructures of Fantasy (1): Business as Usual

All imaginaries or speculations about energy futures are precisely that: imaginary, speculative. Even the most hard-nosed, data-driven, mainstream imaginaries contain pieces of fantasy to make them coherent, to make them work. The key questions are:

'which elements are fantasy?' and 'what job do those elements do?'. What makes imaginaries of energy transition particularly available for analysis in this regard is that they can be pressed between the hard glass of the carbon budget on the one side, and the carbon emissions rate on the other, before being slipped under the microscope.

The most mainstream, widespread, and influential imaginaries are those employed by the Intergovernmental Panel on Climate Change (IPCC). Most of the integrated assessment models for holding the planet to 1.5C above pre-industrial temperatures in the 2014 IPCC report, and all four pathways in the recent, significantly more overtly alarming 2018 report 'rely heavily on CDR [Carbon Dioxide Removal] technologies such as BECCS [Bioenergy with Carbon Capture and Storage]' (Hickman, 2016).¹⁰ Yet these are 'currently undetermined and contentious technologies', where 'demonstration at a commercial scale has not yet been achieved', and in which, many argue 'land-use change and life-cycle emissions are not thoroughly considered' (Stavrakas, Spyridaki, and Flamos, 2018: 2). These technologies are given a reality in the IPCC reports—reports which have great influence over actions taken in the present—that they are not close to having. The thoroughly 'realistic' official pathways to energy transition thus include a piece of actual fantasy in order to make them work. For Kevin Anderson and Glen Peters (2016), the reason they are in the reports is clear:

The allure of BECCS and other negative-emission technologies stems from their promise of much-reduced political and economic challenges today, compensated by anticipated technological advances tomorrow [...] The promise of future and cost-optimal negative-emission technologies is more politically appealing than the prospect of developing policies to deliver rapid and deep mitigation now.¹¹

¹⁰ See also Bloomberg NEF's report that states that in the most bullish scenarios, with coal completely removed from the global energy mix by 2035, this 'still would not get us to 2 degrees'. In fact, 'it's not nearly close enough. To do that, we require new zero-carbon technologies that can decarbonize gas at scale or supplant its role in the system' (2018).

¹¹ See also Vuuren et al. (2017).

In the mainstream IPCC imaginaries, and in all business-as-usual imaginaries which envisage energy transition as a technical rather than a radical social change (e.g. Sivaram, 2018; Bloomberg, NEF 2018; IEA, 2017), these technologies function as pieces of fantasy to make them coherent in the face of the hard reality of the carbon budget coupled with the present course of action and rising emissions. They are there to square the circle, to make the equations come out right, without the necessity of drastic social and political change.

The business-as-usual imaginary is populated by BECCS technologies, liquid sunlight, and geo-engineering, and these should be understood as infrastructural desires—the desire of the current disposition to perpetuate itself. The need to move away from fossil fuels on the one hand, and a reluctance for that shift to occasion changes in the quality and style of life on the other, produces a hard statistical vacuum which demands the creation of these technologies. They emerge in the imaginary first and foremost, as wish-fulfilment fantasies denying the necessity for social change. They provide, alternately: a simple subtraction of the cause of the problem (BECCS, stripping out the carbon being put in); a total retooling of the production side, to maintain the same consumption side style of life (liquid sunlight);¹² or blunt intervention into the immensely entangled and complex boundary conditions of the problem (the hubristic Hail-Mary fantasy of geo-engineering), akin to children trying to change the rules of a game when they are losing (cf 'The Hidden Dangers of Geoengineering', n.d.). All this effort and all this fantasy are required to 'transition' without transitioning.

The other option is radical social change, on the order of global planning and deep, swift cutbacks in consumption and certain types of production, with resources reallocated to the production of necessary technologies and infrastructures—what Kevin Anderson and Alice Bows describe as 'planned economic recession' (2008: 3880). While the business-as-usual imaginary points to its limits by the fantasies it uses to conceal or mitigate them—'with climate change [...] we are dealing with a

¹² Sivaram calls liquid sunlight 'the ultimate holy grail: 100 percent clean, drop-in replacements for fossil fuels' (2018: 183).

world of very large changes, outside the realm of standard market theory' (Anderson, 2012: 28), we turn to imaginaries like solarpunk to outline the opposite—the social and infrastructural changes necessary. They are there, figured in science-fictional terms, in fantastic terms, and in the elided utopian breaks that separate these worlds from ours. Since the mainstream responses to climate change are separated from the hard-nosed realities of necessary mitigation by a chasm that yawns daily wider, the demand made by solarpunk's fantastical worlds is a truthful and welcome one.

Infrastructures of Fantasy (2): Solarpunk

Let me tell you a story. Rashida, a young girl, lives in a village in the midst of beautiful countryside. The community is small and close-knit, and like most places in this solarpunk future, the values of care, community, and ecological balance are paramount. The village is organised along the lines of a semi-medieval guild system, but, like Marx's communists, their time is their own outside the rhythmic demands of the seasons, and, like Morris's utopians, their non-alienated labour is a pleasure to them. The village runs on solar power, which is generated from treated dragon scales, shed by passing dragons on their long migrations, and collected by the villagers. In much the same way the scales provide energy to the dragons, they can, with a bit of crafting and installation, be used to generate power for the community. The scales are mounted on the roofs of the houses, and right now there's a need for more. A recent influx of Wanderers looking to settle down and start their own families has required the building of more homes, which means more energy demand. Rashida's father, a handy man to have around, has even prepared the molten salt batteries they'll need to store power for the nights and gloomy winter days. But they need those scales for the roofs, and there just isn't a dragon in sight.

In 'Dragon's Oath' (Mitchell, 2015), we are confronted by a basic fact of solar technology that is often passed over in silence in radical energy imaginaries, including solarpunk. Beyond its green credentials, beyond its decentralising capacities, beyond its utopian promise, the technology needs to be manufactured and distributed in the first place. The means of its production is required for any solar future to exist or, as Rashida says, 'to get dragon scales, you needed dragons' (Mitchell, 2015: 191).

In taking solar infrastructure as given and using it as a jumping-off point for its own imaginative ends, the majority of solarpunk is arguably an imaginary of consumption first and foremost. In contrast, the mainstream imaginary could be understood as an imaginary of production. Which is to say that the means of production—the research, funding, production, procurement, distribution, and installation of solar technologies, the mines, laboratories, factories, and finances; everything that goes into producing solar technologies as useful and useable realities on the global and urgent scale necessary—is already present, like a coiled spring. The imaginaries that accompany this system of production inevitably envisage its continuation, and perhaps not without justification, since its continuation is also the continuation of the current mode of production of solar technology as such. Even a strident Marxist like Malm acknowledges that waiting for a socialist revolution before combating climate change is 'untenable' (2015: 383). Any experiment in alternative or radical solarities, short of revolution, seems destined to develop parasitically upon the present, or not at all.

A better way to think about energy transition, then, is as a stepping stone—a solar future needs to be parasitic on the fossil-fuel present for a time, and a socially just future must initially be parasitic on the neo-colonial, capitalist present.¹³ Like First Nations gaining energy sovereignty through the installation of solar panels, or Brennan's community-owned streetlights, energy sovereignties are reliant for their emergence upon the very relations of production from which they are striving to break away. Solar technology provides energy autonomy, but only for as long as the product works, only for the lifespan of a solar cell, before the question of production arises again. A genuine transition requires a transition of the means of production—a socially just means of solar technology production.

Other difficult truths follow hard on the heels of these. The small-scale utopias of solarpunk must necessarily exist within a wider system that includes large-scale industrial production. It is possible to make homemade solar panels, but the process

¹³ Another iteration of the same parasitic relation is the solarpunk community's emergence via and continued reliance on the energy-hungry internet.

requires the purchase of technically advanced parts, made in sterile conditions, like the ultra-pure and thin silicon cells. Going a step deeper into the process, it is possible to make the cells domestically, but again, the process requires ingredients ranging from (depending on the process) titanium dioxide—produced from limonite, rutile, or titanium slag through an involved series of stages that in turn require things like chloride or sulphate, and equipment such as hydrolysers— iodine; plastic; thin glass; and graphite, and that's just for a single small cell.¹⁴ It's possible to buy all of this, but that is fundamentally the same as buying the fully-made solar panels if the aim is to move away from large-scale industrial production. And this is without even taking into consideration the efficiency and longevity of the cells (homemade cells come in significantly below current industry-produced panels in efficiency, the latter hovering around the 20%–26% mark; the longevity of home-made cells is also poor, and the current industrial standard is at around 25 years guaranteed, more in some cases), the difficult and dirty processes of extraction of the raw materials, and the scale of manufacture required for global energy transition. If the world had to rely on a decentralised, cottage industry of solar cells, were that even possible, the social changes required to bring energy consumption down to the level that could be met by such an industry would be, at this point, post-apocalyptic.

The utopian imaginary of 'Dragon's Oath' oscillates between figuring a parasitic enclave, dependent on relations of production that are alien to it but which exist in our present (industrial capital); and figuring a fully-transformed future, with relations of production that do not yet exist. The dragon encodes both possibilities, in a kind of superposition, and so also suggests the transition between them. The dragon condenses into itself everything we currently understand as required for solar technology to exist, from mining minerals to transportation to precision-construction of the cells, to financing and distribution. But in containing all that within itself, it also allows them to be transformed—the figure imparts its own formal and technical dimensions upon them, which become indistinguishable from the 'relations of production' of the non-human world, suggestive of a mode of production somehow

¹⁴ 'How to Make Solar Cell in Home' (2018).

without external cost to natural resources and the ecology. This is an impossible image of an ecological ideal, a mode of production that is indistinguishable from 'natural' processes, seamlessly integrated. As such it acts as a marker for the kind of transition that must happen in the present. In its unattainability, the dragon-as-mode of production makes plain that the simple switch to solar technologies, without regard for the specifics of their construction, and the very real problems with their disposal, is insufficient—something amply demonstrated by the ecological damage and harsh labour conditions of the Chinese PV boom and its rapidly escalating solar waste problem (see Shellenberger, 2018; Yang, Lim, and Yoo, 2017). Something similar occurs in the story 'Lost and Found' (Pierson, 2015), where dragons appear as:

avatars of nature [...] so in sync with the planet some scientists claim they don't qualify as animals. They worked to create an environment conducive to everyone and everything, maintaining the synergy of life and death in perfect balance [...] They'd shown us how to work with the planet to benefit everyone.

Dragons in both stories are fantastical placeholders: vehicles and keystones for a radical social transition that has not happened but must in order to achieve the kind of world envisaged by solarpunk. They provide the break with reality that is required to elaborate a different future, and in doing so create a resonant figure for the kind of values and desires that such a break needs to satisfy and be led by. In the more science-fictional solarpunk stories, a similar function is fulfilled by what Fredric Jameson would call a utopian 'rupture' (2005: 229), namely the war, cataclysm, or revolution that always predates the narrative and brings about its conditions. This rupture is necessarily devoid of content—it is pure negation, a void between Now and Then. The dragon, on the other hand, is a way of giving the rupture presence. Rather than a featureless negation the dragon provides an imaginative means to give shape and expression to the desires and values that precede and perhaps give rise to a new world, and to the formal dimensions of the infrastructure which would be required to sustain it. Earlier I argued that the only way to reconcile a joyous

and carefree agency with the demands of our growing ecological awareness was through an infrastructural base encoded with an ecologically sound sensibility. This is the utopian demand encoded in the figure of the solarpunk dragon—relations of production and their infrastructural concretisation that secures an ecological foundation for community, individual agency, and joy.

Solarpunk in the Community

In this article I have considered what the solarpunk imaginary reveals about the formal dimensions of existing solar technologies and explored its figurations of future subjectivities and infrastructures, and the necessities of transition. To close, I will turn to solarpunk's relation to the prime mover of transition: social relations and political action in the present.

The productive relationship between practices of speculation on the one hand, and political activism and social change on the other, is increasingly recognised in the critical literature, and deployed by professional activists.¹⁵ Around the question of a just energy transition alone there are a number of active groups engaging with imaginaries of the future as part of their strategy.¹⁶ Solarpunk, as indicated at the beginning of this article, is as much a growing community, and an expression of political desires, as it is a subgenre. It is a community-forming imaginary: the websites, tumblr pages, aesthetics, and stories provide a 'scratch in the glass' for the coalescence of an emergent identity and set of desires for the future to which increasing numbers of people are drawn, and to which they can contribute. The solarpunk imaginary can then provide a conceptual coherence to an already-mobilised political activity, provide a community of like-minded people, and provide a space for new activity. A group that identifies as solarpunk is currently building a peer-to-peer, open source social media network called 'scuttlebutt', which it sees as

¹⁵ See Haran (2017); Hassler-Forest (2016); Imarisha and Brown (2015); Rieder (2017); Streeby (2018).

¹⁶ For example, 'How might we organize around energy transition in order to imagine and create more liveable futures for all?' is the central question of the Just Powers research group (Just Powers n.d.). The Transition Network facilitates 'utopian visioning' sessions for its participants to encourage team bonding and to inspire ('Transition Network' n.d.). *Stir* mixes articles on issues of social justice and climate change with pieces exploring the radical potential of science fiction (Stir to Action n.d.)

embodying the solarpunk ethos in a digital social platform.¹⁷ A Goodreads solarpunk reading group has been set up, which reads not only fiction but books on sustainable living and permaculture, and which hosts discussions on ways to implement change at a local level.¹⁸ The not-for-profit advocacy and policy group Shared Assets, which 'provide[s] advice, support and training, undertake research, and advocate for [...] new models of common good land use', recently published an article stating that they were 'taking some of the first steps and helping sow some of the seeds of a solarpunk future' (Swade, 2018). Complimentary to the way that Brennan identified 'visionary infrastructure' as 'convening community and imagining alternatives' (2017b: 170), the solarpunk imaginary both convenes a community and imagines alternative infrastructures, which are then concretised in real-world interventions.

The stories themselves are images of desired future states, images of post-oil futures, images of community, of kin, of friendship and care, and of strife overcome by communal striving. By producing these images of desire, the solarpunk imaginary expands itself by drawing others in, by providing a frame and an identity to their desires. The effect can be understood as what Terence Turner described as the 'pivot' in ritual practice: the narratives embody altered social relations within their frame; this figuration serves as a 'pivot':

transmitting the internal force of the ritual performance to the external frame of object relations [...] The 'pivoting' effected [...] implies an extension of the ritual frame, through the projection of the effect of ritual action beyond its original limits to encompass the projection of its efficacy (2006: 237–8).

Which is to say that the efficacy of solarpunk's imaginary in building community and inspiring action beyond the frame of its narratives operates through this transmission of its imaginary—the presentation of altered social relations and alternative figurations of desire—into the external world through the agency of those it enrolls. The imaginary aims to perform a realignment of behaviour through

¹⁷ King (2018).

¹⁸ Solarpunk Goodreads (n.d.).

figuration of a desired state, and many of its stories contain reflections of this core aim within themselves.

The most thorough example is the story 'Midsummer Night's Heist' (Commando Jugendstil, et. al. 2018), which narrates an imaginary political intervention into the present, real world. Set in Italy, a group of activists intend to halt a planned far-right anti-immigration demonstration in a public square, due to take place the following day. Over the course of the night, the activists engage the help of a large number of artistic and creative individuals, from dancers to actors to Live-Action Role-Players, who 'perform' across the city, causing widespread disruption and drawing the attention of the police. Under the cover of this distraction, a core group transforms the public square in question, so that the following morning, as dawn breaks, the baffled police, far-right protestors, and members of the public are faced with a magical, solarpunk scene, which is worth quoting at length:

The Sun pays them no heed and continues to rise, painting the sky with a thousand shades of crimson, vermilion, and gold, and as it climbs upwards through the heavens, waking up birds, trees, and all manners of creatures, its rays start to hit the stelae. Photons bounce through the solar concentrators like steel balls in a pinball machine and finally hit the high-efficiency, multilayer, mini solar panels hidden in the joins between the concentrators. Photoelectrons cascade between the different layers, amplified at each step, like an avalanche gaining speed as it rolls. Electricity courses through the cables laid out in the garden, flowing towards the Raspberry Pis, the hard drives, and the speakers. Music starts to play, a jaunty electro-swing song, filling the air with its lively rhythm and the defiant sound of trumpets [...] Piazza della Scala has turned into a garden overnight, as if by magic. Grass grows soft and inviting where the flagstones should have been, and flowers fill their senses with a riot of colours and smells. *Please, step on the grass*, a small placard says, penned in an ornate, elegant script, but the officers don't dare. *If you step in the land of faeries, you might never come back...* one of them thinks. (italics in original)

Despite being set in the ostensible 'real' world, this is an exceedingly rich figuration of the solarpunk imaginary. It articulates the breaking dawn of a fresh, changed world, altered by direct intervention in the present, and drawing on artistic, technological, and ecological knowledge in equal measure (the garden is designed and planted by a permaculturist). The sun's rays bring the scene to life, revealing a richness of colour, and the light's uniting and linking of the scene and its inhabitants—human and non-human—is emphasised. The most up-to-date technology is deployed in a thoroughly DIY fashion, the Raspberry Pi being a symbol of coding as an activity of the people, rather than a professional caste, and is brought together with pre-modern and religious symbolism (the stelae most obviously).

Beyond this, there is the sense of magic to the garden, occasioned by such a sudden and total transformation. The garden is a piece of visionary infrastructure, embedding and encouraging new social relations, and mobilising a particularly 'solarpunk' affect. The intervention is a success, the far-right demonstration cancelled, and the garden attracts global attention, spreading its message across the world. Locally, the public gathers to enjoy the scene, the transformed square creating a new community space that in turn creates a new community. The intervention here is a synecdoche for solarpunk's narratives, its figuration of an alternative world, structured by alternative infrastructures, and mobilising new forms of subjectivity and community within its bounds, and working against the creation and reproduction of others (the far-right demonstration). In Turner's words, the 'pivot' of the garden extends the efficacy of the performance beyond the frame of the ritual, both locally and globally, transforming the world outside itself in its own image. The policeman is quite right: if you step in the land of the faeries, you might never come back.

Conclusion

In engaging critically with the struggle over energy transition the relationship between three things is crucial: infrastructure; social relations; and future energy imaginaries. Each of these partakes of the other: infrastructures embed and sustain social relations, and are productive of future imaginaries; social relations seek to instantiate or prolong themselves through infrastructural means, and the

elaboration of persuasive future imaginaries; and future imaginaries consist of, and are productive of, social relations and infrastructural elements. Current engagement with the question of energy transition, emerging from critical social sciences and infrastructure studies, tends to engage more with existing infrastructure and social relations, dealing with imaginaries only in so far as they extend from these primary objects of analysis. This article has sought to redress that balance and demonstrate the value of extended analysis of richly elaborated energy imaginaries in engaging the question of achieving a fully social and cultural energy transition. In doing so, it has also aimed to claim and model a proactive role for literary studies in the larger marshalling of critical forces towards tackling this era-defining challenge. In the face of calls 'to think differently, to achieve greater clarity, to foster a greater imagination' (Anderson, 2012: 39), literary analysis—specifically, tools drawn from the disciplines of science fiction and fantasy studies—can be employed to demonstrate that certain modes of imagination have different affordances in the real-life struggle over energy transition; that different types of fabulation do different things and have different effects. Pursuing this, the article has sought to draw out the connections between the types of imaginaries and their social conditions of production, in particular through the extended analysis of solarpunk, and to show the agency that imaginaries can have with regards to forming communities, mobilising affect, and extending themselves into the world in the form of social relations and infrastructure. If energy transition is to be a battle of hearts and minds as much as PV panels and lithium batteries, a serious engagement with energy imaginaries is the means to understanding and marshalling them.

Competing Interests

The author has no competing interests to declare.

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