A Cosmopolitics of Energy: Diverging Materialities and Hesitating Practices

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Abstract:
Numerous proposals, analyses and strategies now exist for materializing energy in order to influence environmental participation and reduce energy use. This paper asks how specific materialities of energy are articulated across social science and creative practice projects, and how these distinct renderings of materiality perform environmental change. Drawing on Stengers, the paper moves to consider the diverging materialities and speculative practices that might emerge through more cosmopolitical approaches to energy. A range of creative practice projects that materialize energy and perform environmental change in different registers is discussed, with attention given to considering how what counts as materiality, participation and environmental matters of concern shifts within these differently configured engagements. The paper asks how alternative materialities of energy might be generated that work through experimental registers of environmental practice, and that may not always be clearly directed toward instrumental ends. How might environmental practices attend to the speculative qualities of performativity, and engage not just with energy as actuality but also with energy as potentiality?

Keywords: energy, materiality, cosmopolitics, environmental practices, material politics

Introduction: materializing energy

> "What I am interested in is *practice*, the *plurality* and *diverging* character of practices."
> (Stengers 2011b, page 373)

Energy, it seems, animates any number of things, practices and infrastructures, but is scarcely visible itself as a concrete entity or resource. If one were to try to identify where energy is located and what its salient features are, one might find it rather difficult to characterize in what ways energy is material. Would a project of materializing energy examine its extraction in the form of coal mining, fracking or nuclear power generation? Would it address its storing, refinement, and distribution often across multiple continents? Would it attend to the workers, residents and farmers whose labor, dwellings and land are influenced by the locations of energy extraction and production? Would it analyze the specific ways in which it is 'embedded' in any number of products, buildings and infrastructures? Or, would it map its delivery and use within production- and consumption-based activities?

In fact, the practice of making energy visible as a material resource is now a widespread approach and topic of discussion across social science research, environmental policy, and creative practice. These projects articulate how a greater awareness and possible reduction of energy consumption may be achieved by making energy more present as a material resource. The type of materiality most often made evident in these analyses and projects is such that it manifests as a visible (and digital) display at the site of smart meters, energy monitors and other home appliances. By attending to this materialized presence of energy, engagements with energy typically seek to facilitate monitoring practices that influence energy behavior and potentially encourage new consumption practices. This paper takes up the specific ways in which energy is materialized or described in material registers within projects that seek to address, influence or reroute energy use. Crafting a connection between materializations and practices in relation to energy as an environmental matter of concern, this paper asks: in what ways is energy materialized? And how do these approaches to materializing energy make possible distinct practices and engagements with energy and energy-use reduction, and so perform environmental change? What are the material registers, processes and practices that are identified as key sites of engagement and intervention? And what other practices might emerge through experimenting with different and diverging material approaches to energy?

I am compelled to explore these questions related to the materiality of energy since the monitor-based approach to energy demand reduction is at times referred to as a 'failed' project, since while considerable investment has been made in this technology and emerging infrastructure, energy monitors and the practical strategies that they explicitly and implicitly advocate have yet to achieve an appreciable *reduction* in energy use (and may primarily be best placed to "balance" demands on energy grids, rather than achieve overall reductions in energy use as such) (see Darby 2010). This paper is not written to solve the problem of energy monitoring, but is instead interested to question one aspect of how energy technologies perform distinct materialities of energy, and how this strategy is situated within a wider set of practices that address how making energy physically evident as a material resource may lead to energy demand reduction. Rather than make a case for the materialization of energy as a key way to address energy demand, I instead ask in which ways energy is materialized, and how these instantiations are bound up with practices for engaging with energy.

In the first part of this paper, I work through a selection of social science energy analyses and creative practice projects that engage with and articulate specific materialities and materializations of energy, often in relation to raising energy awareness and reducing energy consumption. In this discussion, I consider the ways in which distinct materialities of energy are performed, and the connections made to how energy engagements are practiced or ideally should be practiced. In working across social sciences and design, I am interested to map the ways in which specific modes of energy as visibility or tangibility have stabilized in relation to social science discourse and design practices. In discussing these different fields and approaches to environmental change, my point is not to contrast theoretical and empirical approaches to energy use, but rather to examine how energy is articulated across these conceptual and practical engagements, and how such engagements with energy might give rise to new possibilities for practices. In working across social science and creative practice, my intention is not to flatten the difference between these fields, but to engage with the ways in which a concern with energy can generate similar sets of proposals for reducing energy use. Social sciences are increasingly rethinking its methods through attending to practices; design is increasingly attentive to politics, participation and policy; and environmental policy may even migrate across multiple fields and strategies in a bid to find something that "works."

In the second part of this paper, I then discuss three specific creative energy projects that differently and divergently materialize energy, and in so doing give rise to distinct energy practices. These projects are discussed less as empirical case studies, and more as projects that depart from materialities focused on consumption and reduction to perform other materialities and material engagements. I ask how these creative practice projects that variously harvest, scavenge or generate "alternative" modes of energy suggest additional ways of performing the materialities of energy. These diverging articulations of the materialities of energy arguably articulate an expanded array of practices for engaging with energy. In this space, I draw on Stengers' discussion of "practices of hesitation" in relation to cosmopolitics (2005, 2010), to consider how such practices—rather than offering up final solutions to energy use—interrupt the usual state of affairs and ways of addressing energy use in order to experiment with alternative energy practices as speculative "political fictions" (Stengers 2010, page 26). Based on these projects, I revisit these initial questions about how material instantiations of energy might perform environmental change, or operationalize new arrangements or versions of environmental practice and participation.

My objective in comparing these differing materializations of energy is not to advocate one type of project or practice in favor of another, but rather to ask how distinct materializations of energy variously enroll a range of cosmopolitical actors and give rise to distinct distributions of practice and participation—and possibilities for encountering environmental matters of concern. If there is a growing sense that energy monitors and similar approaches to the making-evident of energy do not deliver substantial energy reductions, then how might it be possible to "design the political scene" (Stengers 2005) of energy such that new "effectuations" (Deleuze and Guattari 1994; Stengers 2011a) of energy proliferate? A cosmopolitics of energy refers to ways in which practices open up through engagement with distinct matters of concern, yet at the same time do not necessarily arrive at a final solution. Instead, hesitation, divergence and creative experimentation within localized energy projects emerge as ways to approach energy not through obvious logics of resolution, but instead as sites of material-political struggle.

Performing the diverging materialities of energy

The process of making energy material and visible is a strategy that is now commonly articulated within sustainable energy research. Social science research oriented toward energy policy has suggested that "rematerializations" of energy through "feedback" gained in the

process of monitoring energy use may be one way to orient efforts to reducing energy use in the home (Burgess and Nye 2008, page 4458). Such an approach attends to how the "visibility" of energy use may influence energy behavior (Hargreaves et al. 2010). As Burgess and Nye (2008) write:

> By its nature, "energy" is an abstract and invisible force that is conceptualized or commonly defined in a number of different ways, for example as a commodity, as a social necessity, as an ecological resource, or as a strategic material (Sheldrick and Macgill, 1988, p. 563). The invisibility and abstract nature of energy is particularly relevant for the domestic sector, in which the effect or extent of energy use is not always readily apparent in the form of chimneys belching smoke or myriads of office windows lit against the night sky (page 4454).

Because neither the material resource nor the residue of energy is especially visible, these authors suggest that a certain disconnect between energy use and its impact results, which may be redressed by "re-materializing energy use patterns" so that the "inconspicuous nature" of energy use may be made more evident and acted upon (ibid., page 4458). By making energy visible and material, individuals may become more reflective, and so change their energy habits out of a concern for the effects that energy resources have on the planet (ibid.).

Making energy visible and evident is a strategy that turns up in energy monitors, as well as appliance labeling and carbon footprint analyses. Describing the ways in which "eco-efficient objects" influence the "materialities of consumption," Kersty Hobson suggests a sort of "embodied 'techno-ethics'" is articulated through the use of eco-objects, where through engagement with material and sustainable devices new "relations with the material world" develop (2006, page 318). Rather than suggest that this is strictly a process of material devices "scripting" behavior, Hobson argues that environmental ethics are articulated through materialized engagements with objects (2006, page 330; see also Slocum 2004), but not in singular or uniform ways. In this way, an eco-teapot that talks to the electricity grid may have the initial objective of signaling individual and collective energy use, but in its materialization in the home and in relation to numerous other actions the teapot may also be intersecting with numerous other effects that are not so easily managed (Marres 2012). While energy is inevitably bound up with everyday material practices, the adoption of explicit strategies of materialization may not actually "solve" the problem of environmental participation in all its complexity—and may even delimit engagement toward potentially ineffectual practices (ibid.).

If social science analyses variously describe the ways in which material objects influence environmental practices and participation, or make suggestions for how materialized and re-materialized energy performances may influence behavior for informing energy policy, then creative practitioners take up these materialities as explicit sites in which to actively materialize energy in order to develop deliberative encounters that may lead to reduced consumption. From electricity meter displays to illuminated power cords, many projects now exist that make energy present as a material resource in order to influence environmental actions. Many of these technologies of display and materialization span from appliances that express levels of energy consumption with ambient light displays (Mazé and Redström 2008), to kinetic energy devices that generate and store "personal" energy (Pierce and Paulos 2010), as well as speculative proposals for blank energy displays that more openly if obliquely respond to the everyday habits of home dwellers (Jeremijenko 2001). These projects often work with a distinct notion of materiality as *tangibility*, where new everyday practices may emerge through the process of encountering the material and visual evidence of consumption.

Locating and amplifying the material traces of energy in the home has been approached as a way to bring energy use not just into a space of greater awareness, but also into a realm of aesthetic engagement. As Ramia Mazé and Johan Redström (2008) from the Interactive Institute write in relation to their Static! energy design program, the goal of their project "was to develop a more profound understanding of energy as a material in design, including its expressive and aesthetic potential" (page 59). The design interventions that these designers undertook involved allowing for the rediscovery of electricity within everyday spaces and ecologies, since the grids, sockets and charges of energy have tended to recede from view. In their project, energy is materialized and made visible as an aesthetic property, something that can inform and animate design outcomes. The Static! project generated a number of energy designs, from illuminated power cords to a solar energy curtain, which through everyday iterative interaction and embodied objects might influence environmental change.

James Pierce and Eric Paulos (2010) similarly note that within creative practice approaches to sustainable energy use, a frequent strategy is to make energy visible or material, often with the purpose of promoting energy awareness. These designers also seek to materialize energy in their design projects, but emphasize modes of tangible energy engagement that might go beyond awareness of one's energy consumption. They suggest that the "abstract and invisible

force" of energy could have any number of possible definitions, from concept to thing and material culture. When asking participants engaged with their energy designs (a lamp, for instance, that through color signaling indicates whether power is derived from coal, solar, wind or human power) to locate the materiality of energy, they found it could be multiply located, including embedded in objects or as the electricity animating devices (2010, page 116). The intangibility and yet constant availability of energy is something that has been designed into modern systems, these authors suggest, where the invisibility of energy is a design strategy that has been so successful it has contributed to unsustainable everyday practices. In this way, design might begin to reorient energy use toward engagements that are "more tangible, more differentiated, and less available" (ibid., page 122). This could include procuring energy from more difficulty sourced, human-powered tactics, or through micro-generation energy strategies that are less centralized but more present as sites of interaction.

These projects across social science and creative practice discussed so far focus on the ways in which the materialities of energy are often primarily accessed and operated upon through technologies of display, where everyday practices and often-individual engagement with the "substance" of energy constitute the distinctive way in which environmental change is materially performed. Energy use is made evident so that its use may be reflected upon and changed. But at what point does energy become demonstrably material; and how does this specific version or enactment of materiality inform energy practices? Materialization here is bound up with a logic of obvious physicality, of that physicality leading to clear actions of reduction, and having a motivating rationale of saving money. Any actions directed toward addressing environmental change are in many ways folded in as an added bonus, where consumers can save money and the environment, and so 'feel good' about their practices. These materializations of energy—as performances of environmental change—also run up against the possibility that such materializations of energy will not engage users sufficiently to reduce their actual energy use, or if they do reduce energy they may spend money or use energy in other ways (otherwise known as the "rebound effect"), since efficiency as a target for reducing CO_2 emissions does not sufficiently address *overall* reduction of energy use or change the mode of energy supply from fossil fuel to alternative energy (Herring 2006). The performativity of energy materialized in these ways may then have counter-performative effects, which may be considered as much a part of how energy materializes (Butler 2010; Callon 2010; Gabrys 2011).

While materializing energy through energy monitors is a process that attempts to enfold users into managing their energy, as is more often the case, users are as likely to ignore devices entirely through disinterest, lack of time, or even puzzlement at what energy monitors are actually displaying and materializing. Most energy displays and meters materialize energy in such a way that it is not necessarily an empirical fact to be acted upon, but rather becomes a hazy source of guilt and confusion, and may eventually be overlooked. How energy could be said to materialize in everyday experiences is not necessarily as straightforward as might be anticipated in energy-device interactions. In this material-politics of energy, performances of environmental change might enact specific material objects to study or toward which to direct policy-led interventions, but these material objects are inevitably in process and unfolding through diverse practices and extended material arrangements. The abstraction of what materiality is and how it ought to operate or propel action is a formative part of the processuality of materiality—the abstraction concresces within the performance of materiality, it becomes with the material operations it is meant to describe (Whitehead 1929).

It may be that there is operating here a sort of eliminative materiality as Stengers (2011a) discusses in relation to scientific practices, which commonly assert that the material facts of phenomena self-evidently provide the rationale for deduction and action. Not limiting her analysis to scientific practices, Stengers suggests that such eliminative modes of materiality present not just "a theory of knowledge" but also strategies of production and destruction of other practices (ibid., page 378). These, too, are performative materialities meant to spur a set of rational and instrumental actions, and arguably the logic of acting on energy is characterized by such an evidence-to-action based understanding of what it means to make the materiality of energy present as the basis for addressing environmental change. Is it possible to open up the performances of materiality to move beyond an approach that strives toward physical evidence as an instrumental basis for environmental action, to ask what other practices might emerge within alternative material concrescences?

Distinct practices of materializing energy are oriented toward developing an awareness of energy, an otherwise seemingly invisible resource, in order to reduce energy use. But inevitably, the modes of materiality and concomitant practices that emerge are much more diverse and diverging than materializing a resource in order to act upon it. Materialities are "diverging," a term that I adopt from Stengers (2010), in that they draw together and connect a diverse range of practices that have the potential to reroute the usual state of affairs.

Stengers discusses "diverging minorities" as a concept that draws on but departs from Deleuze and Guattari's (1987) discussion of minorities. She develops this term as a way to "affirm its relevance for the togetherness" of what she refers to as "'practices,' whose members can be described as 'attached' to something that none of them can appropriate or identify with—a nonhuman—but that causes them to think, feel, and hesitate" (Stengers 2010, page 14). In what I am calling the *diverging materialities* of energy, materiality may articulate not just the possibility for togetherness and attachment, but also the possibility for other connections or practices to emerge. The characteristics of materiality that emerge or are mobilized as points of intervention for rematerializing or encountering energy in order to reduce its use are not just materially articulated for human intervention, however, since energy processes materialize, sediment, and intra-act across nonhuman encounters (Barad 2003).

In this respect, the performativity of materiality as a process enrolls or emphasizes particular relations and capabilities in specific ways when mobilized toward environmental change. In addressing the processual materiality of performativity, I situate this discussion not just in relation to long-standing work by Butler (1993) on "processes of materialization" and performativity, as well as more recent discussions on where the agency and effect of performativity may be located, and how new performativities and political agencies may emerge (Butler 2010); but I also work through Barad's (1998 and 2003) qualification of performativity within a posthumanist and material register, where she seeks to move discussions of processes of materialization into a extra-discursive and more-than-human space. Materializing energy may be a way of performing environmental change, but it is also not just human in its performance of change, since such materialities are articulated across and through multiple participants, which may be variously and differently present as material forces and processes. Distinct materialities of energy might then become more or less evident or viable as environmental action in relation to practices—as well as speculative practices—where the materialities of nonhuman actors are also a key part of how environmental engagements unfold (Hawkins 2010).

The diverging materialities of energy suggest that the practices that might emerge may be opened up into more generative ways of encountering energy—and performing environmental change. The performance of environmental change through the materialization of energy is cosmopolitical in that it enrolls devices, everyday practices, infrastructures, and more as

variously made present as entities where energy materializes, but which inevitably also become actors in these practices of variously substantiating the material resources of energy. Here are multiple ways of understanding what the materialization of energy may involve, which point toward divergences that indicate not necessarily contradictory approaches but rather differently emphasized aspects of energy that attend to the management, ethics or technics of energy engagement. How might a more "hesitating" set of practices, not immediately attuned to the problematic of energy demand reduction but engaged with questions of energy practices, give rise to an expanded set of engagements with energy use? In what ways are these practices bound up with "diverging" materialities, which are not physically evident facts to act upon, but rather materialize energy in multiple other ways? And how do these diverging materialities and hesitating practices present the possibility for rethinking energy not just a problematic of reducing its use, but as a multiply articulated environmental event that we might begin to materialize differently? If performativity is understood in part as a process that variously connects up material actors, devices, situations, infrastructures and more, then what performances and materializations of energy might further be proliferated and developed in order to empower energy experimentation? In this sense, there may be more ways to materialize energy that are less directed toward instrumental objects of management, and more attentive to inventing new arrangements of practices and political possibilities.

Hesitating practices

How can the multiple and diverging materialities of energy expand beyond tactics of awareness to give rise to speculative energy practices? Or, how might it be possible to design a political scene of energy use that creates speculative political fictions and unexpected practices? This may have involve not just asking how environmental change is articulated through social science and creative practice methods, but also considering the generative possibilities that emerge through the cultivation of diverging materialities and hesitating practices. The materialities of energy, as is already evident within the multiple projects and research discussed so far, inevitably unfold operate in a much more expanded and distributed array of materialities in comparison to properties that may be made tangible or visible with meters, products or animated appliances. To materialize or rematerialize energy may not necessarily involve making it visible or tangible or evident as a set of numerical readings or light levels. Instead, materialization or the mattering of energy may even involve understanding what infrastructures, participants and practices ensure its apparent

immateriality. In this way, the materiality of energy may not necessarily show up through necessarily tactile methods, where energy is approachable through sensory modalities *per se*, but rather it may materialize through articulating the complex relations that are part of energy arrangements, and that may become sites for intervening within or rerouting our usual energy practices.

Materials are not just divergent, in this sense, but so too are practices. As Stengers writes, "practices diverge, and their divergence, not to be confused with contradiction, makes them recalcitrant to any consensual definition of a common good that would assign them roles and turn them into functional parts of public order, whatever its claims to excellence" (2010, page 16). Stengers' characterization of the cosmopolitical is that it "refers to the unknown constituted by these multiple, divergent worlds and to the articulations of which they could eventually be capable" (2005, page 995). Cosmopolitics enable "a space of hesitation (ibid.), where hesitation enables modes of practice that call into question "rules or norms" (Stengers 2010, page 16). Practices are not simply scripted, but rather can be approached as an opening, or a challenge in slowing down and disrupting practices "as they are" in order to consider practices "as they may become" (2010, page 26). In this respect, practices engaged in speculative, creative and political fictions may be a way to "empower" experimentation (ibid., page 22).

To investigate such experimentation in relation to energy, I now turn to consider the increasing number of creative practice projects, spanning art, design, digital media and architecture, which have taken up energy as a topic for research and practice. A whole host of creative practice projects have now worked to reroute the ecologies and economies of energy toward more distributed and participatory engagements, from Amy Balkin's "Public Smog" (2007) which attempts to create an atmospheric park by redirecting a carbon market to a carbon commons; to the art-and-activism organization Platform's, "And While London Burns" (2006) an operatic sound walk which navigates the complex relationships of oil, money and geopolitics within the City of London; as well as Superflex's "Supergas" (1996) a project that develops a participatory methane-energy technology for developing-world contexts. Working in a similar vein are projects such as "Active Energy" (2010) a collaboration between the artist Loraine Leeson and SPACE studios, which develops a context where old and young people (a Geezer's Club and an inner-city group of boys) collaborate with renewable energy engineers to learn about tidal and wind energy, and to

create a tidal-powered sign emblazoned with the words, “Geezer Power,” In another way, the “Energy and Co-Designing Communities” (2011-13) project employs “ludic” action research and interactive technologies to engage communities in new ways of thinking about energy reduction through data scraping and harvesting the multiple forms of “babble” that surround energy discourse and practices.

These participatory approaches to energy might be seen to differently *materialize* energy: as atmospheric residue, geopolitical tour, DIY production site, or community-radio experiment. Within this context and in the remaining space of this paper, I address in more detail three creative practice projects that are situated at the intersection of energy and materiality in order to consider the questions raised so far in relation to the how materialities of energy assemble within distinct cosmopolitical arrangements of participation and practice. These three projects, HeHe’s “Nuage Vert,” YoHa’s “Coal-Fired Computers,” and Neighborhood Satellite’s “Energy Harvests” work in different ways across relationships between energy and materiality in order to generate alternative energy practices. These projects raise the question of how materiality might be encountered in more transformative registers (cf. Serres 1982; 2000 [1977]). And they further point to the ways in which energy as material process and transformation may inform new cosmopolitical arrangements and practices.

Nuage Vert

“Nuage Vert” (2008c) is a relatively well-known and prize-winning electronic art installation developed by HeHe, a collaboration between Helen Evans and Heiko Hansen. In its first version and installation in 2008, this project mapped the emissions from Salmisaari, an urban power plant in Helsinki, with the aim of alerting urban dwellers to the correlation between the at-times visible clouds of heat vapor and exhaust (as well as invisible CO_2 emissions) that emanate from the chimney, and the amount of electricity consumption by residents. Salmisaari is a combined heat and power plant (CHP) that supplies Helsinki with power, and in the process consumes on average 600,000 tons of coal per year to produce 700 gigawatt hours (GWh) of electricity and 1500 GWh of heat (2008b).

Taking place during the course of a week in late February, the project deployed a green laser light beamed to make the power plant exhaust visible as an iconic reminder of energy consumption. The invisibility of electricity consumption is “materialized” by identifying and tracing energy emissions that can be read in the data of yearly increasing energy use in

Helsinki. The laser tracings mapped over the power plant cloud demonstrate local energy consumption, with the lowest energy consumption represented by the largest green cloud, so that residents may collectively have an effect on the size of the cloud if they consume less electricity. On the final night of the installation, the project hosted an "Unplug" event, where residents and companies located in Helsinki were asked to unplug their appliances between 7-8 pm and "admire the growing Nuage Vert laser projection" (Huuskonen 2008) During the time of the unplug event, a decrease in energy consumption was measured equivalent to 800 kilovolt amperes (kVa).

But even more significant than the energy reduction observed (since often unplug events can lead to an eventual surge in power use once normal usage resumes), is the aspect of this event that led to public experimentation and "monitoring of the collective consumption within a local area" (2008a). Since energy use is typically individualized, making power consumption "public and visible" from within "an invisible digital infrastructure" is a way to articulate energy relationships across resources, institutions, everyday practices, urban spaces, and within new and imagined forms of environmental citizenship. HeHe suggests these material articulations could provide openings for creating "a new type of citizenship and the transformation of a city" (Evans 2008). Beyond the invisibility of energy, and the "abstractions" presented by most sustainability measures in the form of carbon calculating, this project proposes to "materiali[ze] environmental issues" with the objective of making them "a subject within our collective daily lives" (ibid.)

Yet in many ways, this project is most interesting for the ways in which it materializes energy by developing an energy commons from the imagined and speculative residue of energy. The urban skies over Helsinki become a space for materializing local and combined energy consumption activities. At the same time, in developing a correlation between the amount of energy consumption and the scale of the green cloud, HeHe collaborated with Helsingin Energia to gain access to energy data, and in the process the company began to make available online more real-time data about energy consumption in Helsinki, thereby creating an energy-information commons as a resource for other energy projects. The green laser cloud is a captivating and intentionally ambiguous mutable image, and while the possible linkage of this visual display to energy reduction may instrumentalize the cloud, HeHe stresses that there are multiple possible interpretations of the green cloud: does it portend a toxic event, or is it a sign of collective energy reduction? The cloud is a flickering and even fictionalized medium

for addressing a whole host of issues related to energy citizenship—it visualizes the materialities and relations of energy in the form of CO_2, exhaust, heat and more, and connects collective energy consumption to the atmospheric commons. Given this cosmopolitical array of participants in this energy commons and material event, this project generates an open-ended question about what other energy practices, besides momentarily unplugging, might emerge from these material imaginaries.

Coal Fired Computers

Another project that addresses coal power, yet focuses on materializing this energy source in relation to computers, is "Coal Fired Computers," which premiered in Newcastle, United Kingdom, for the AV Festival in spring 2010. This project materializes energy by making evident the waste of energy—both in terms of coal and the power relations that support coal infrastructures—used to power computers. Graham Harwood and Matsuko Yokokohi (YoHa), together with Jean Denmars, developed this project to make evident the considerable amount of coal that continues to be burned to provide the electricity that contributes to the production and firing of computers. The project consists of a 35-ton steam-powered engine connected to a dynamo to produce electricity, and fueled by 1.5 tons of coal. The artists worked with miner activists during the exhibition, and the engine connects to a computer that displays records from a database of miner's lung disease. The ongoing emergence of these records are the spark to inflate a pair of black lungs on display, to underscore the correlation between "300,000,000 computers and 318,000 black lungs," the subtitle of the project.

While electronics may seem to be invisible and resource-light machines, the use of coal not just to power electronics but also to contribute to their production, ensures that these machines are resource intensive and "dirty." The connection that YoHa makes across computation and coal draws together the effects of machines upon the bodies of miners, as well as the displacement of coal production to seemingly invisible geographies in India and China. Coal dust gets in the lungs of miners; and the burning of coal as a main fossil fuel source contributes to air pollution. The materiality and dirt of machines informs the materiality of bodies, which transform (and decay) through ongoing exposure to the energy sources that fuel machines, setting in place an ongoing corporeality that is constituted through the waste of energy.

Energy is more than fuel in this context; it becomes evident as *power*. The materialization of coal as a power source for computers makes evident and performs the material politics that distribute and allocate resources and bodies to support these infrastructures. YoHa traces the correlation between information and power back to the 19th Century, when the steam and rail networks developed together with telegraphic communication. Information networks are sites of power as well, a fact that has migrated from telegraphic to digital exchanges. While information networks today appear to be relatively invisible and immaterial, the 1.5 tons of coal used to power an inefficient computer installation inverts these usual immaterialities.

In an interview with Matthew Fuller, Graham Harwood indicates that he was interested to "burn as much coal as possible" through the device in order to "see what it felt like to be completely wasteful" (Fuller and Harwood 2010). In contrast to projects that seek to make energy use more efficient, "Coal Fired Computers" materializes the relationships that enable the wastefulness of energy. Rather than rendering energy as a display to manage, YoHa render the material politics of electronics-fuelling energy through waste, disease, hard labor, and computational devices that enable material abstractions. Deliberately inefficient, the coal-fired device makes translations and transformations across coal, bodies, electricity, heat, and data. These relations are prone to "leaks," which, different from models of sustainable and efficient energy use that would clean up any wayward uses of energy (however dirty the power source), become the basis for alternative material imaginings. Rather than performing environmental change through developing an awareness of a materiality of energy to engage with through efficiency, here is an apparently idiotic way of encountering energy (Michael 2012; Stengers 2005), which departs from the usual way of addressing energy use. The materiality of energy is not a performance of economizing, but rather of materializing in order to make present the political arrangements that sustain energy extraction and use.

The energy use on "display" here is less concerned with reductions or efficiencies, and more attentive to looking at the power sources of energy. As long is coal is a primary substance powering and producing computers, we are bound into distinct material-political relationships that emerge through this material. In this sense, the ecological consequences of electronics, as YoHa suggests, can be such that the "relentless conceptual machines of software cultures" are able to "monitor crisis as they create it" (YoHa 2010b). A question emerges in this project as to how electronics that monitor environmental distress may contribute to those same problems. Does displaying or materializing the facts of electricity consumption without

connection to the expanded material ecologies that make energy (and electronics) possible necessarily inform or change the material politics of electronic energy? Here, the diverging materialities of a coal-fired computer might cause a hesitation in energy practices, thereby prompting the question: what are the environmental impacts of the devices with which we would materialize and act upon energy use?

Energy Harvests

Beyond approaches to display and materialize the politics and infrastructures of energy use, other projects tap into the wasted energy all around us in order to make this a common resource. "Energy Harvests" (2009) a Neighborhood Satellites project by Hanspeter Kadel and Myriel Milicevic, makes a point not just to visualize or materialize otherwise overlooked connections within energy consumption, but also to develop tools for harvesting forms of wasted or surplus energy in the city. From sound waves to vibration and excess heat, the energy harvesting devices that Neighborhood Satellites develops map and mine the many sources of energy that animate our everyday landscapes, but that are typically seen as superfluous to the usual economies of energy.

The "Energy Harvests" project includes windmills installed in the Metro in Berlin, energy workshops for developing individual light harvesters and discussing energy leaks and utopias, DIY kits for participants to make their own energy harvesters, as well as "Portable Harvesters," which may be transported through urban landscapes for opportunistic energy harvesting. The "Portable Harvesters" mobile prototypes operate as excess energy collectors. The five harvesters are intended to "be carried along for the everyday energy harvesting in the city" (Kadel and Milicevic n.d.). Navigators of excess urban energy may deploy harvesters for light pollution (and sunlight); harvesters that use piezoelectric technology to collect excess vibrations from urban transport or construction sites; harvester speakers that transform loud sounds such as sirens into energy; harvester windmills that gather currents from ventilation systems and transport; and harvesters for gathering wasted heat from any number of buildings and machines.

The notion of energy "leaks" emerges again with the "Energy Harvests" project. Although different from the "Coal Fired Computers" approach to leaks, which works with the material-political relations of energy waste while also developing a superfluous device for capturing and transforming those material-political relations, "Energy Harvests" proposes that energy

leaks may be captured to make available new types of energy commons from the "dirt" of wasted energy. The "Energy Harvests" project objective is about "claiming energy leaks as resource," where the "structural leakages" of cities may provide "a multitude of free power outlets for anyone wishing to collect them" (ibid.). The leaks and spills and excesses of energy become a resource for transforming energy relations and practices. Here, different forms of energy commons could be seen to emerge, where free decentralized energy is available for anyone who is able to tap into and harvest this resource. Energy commons emerge from the wasted energy of cities, and from the surplus energy of our everyday practices and productions and consumptions. To materialize energy in this sense involves making tools not just to visualize but also to *harvest* excess energy and so *transform* the possibilities for its use and misuse. Such an approach involves not necessarily technologies of display for indicating energy consumption and so pointing toward ways of reducing energy or changing energy behaviors; but rather requires rethinking and rerouting energy ecologies and practices to generative and opportunistic engagements.

A cosmopolitics of energy

Environmental change is typically rendered in an instrumental register, as a pursuit of often quite specific environmental targets. But if as a cosmopolitical method of diverging materialities suggests that departing from the usual state of affairs is also a process of transformation, then *change* in this sense present a shift in the register of how energy as an environmental matter of concern might be encountered. Here, energy may not necessarily be materialized as something upon which we can obviously act as the physical evidence of consumption, but rather as a political scene to be designed across human and nonhuman registers. Designing a political scene may be about forming capabilities, possibilities for experimentation, and political engagement all as registers of environmental change—even more than solutions that meet certain hoped-for ends (cf. Lane et al. 2011). In this sense, a cosmopolitical engagement with energy could also be a way to perform environmental change not as an enactment or framing, but as an opening that slows down thought, and potentially generates new political possibilities. The practices at play here might then understood not necessarily as methods enacting objects and realities, but rather as speculative and cosmopolitical arrangements that experiment with new political possibilities. Another way of saying this might be that this is a constructivism that opens out toward invention, rather than closing in to dwell on a description of found objects.

In this way, I have drawn on Stengers suggestion that it is more interesting to work in a speculative register and attend to the generative and yet-to-be-known capacities of practices, rather than make a catalog of all the ways in which energy practices (for instance) fail to achieve their stated aims. Projects that work to materialize energy in these more speculative registers could be seen as providing openings for thinking about how diverse ways of materializing energy might give rise to a range of practices for encountering energy differently. Taking a cue from Whitehead (1929), this could be a way to address the concrete occasions of energy in order to speculate about what potential energy practices might emerge through materializations of energy that span across a broader cosmopolitical array of engagements with energy as resource, infrastructure, and more.

The initial questions presented in this discussion ask how an expanded understanding of the material arrangements of energy might point to ways of unsettling and rematerializing energy practices, not necessarily through visualizing energy as an object of display or reduction, but as an opportunity to make new energy configurations. Within Stengers' articulation of cosmopolitics, she at once suggests that more-than-humans be taken seriously as participants in material-political issues, while also calling for an attention to the specific ways in which politics are mobilized in relation to concrete events. This specificity has the effect of directing politics not toward abstract notions of the common good, but rather of attending to the concrescences of material-political events as they happen and in their concrete situations (see also Whitehead 1929; Gabrys, Hawkins and Michael 2013).

These three projects demonstrate how the materialities of energy emerge within distinct cosmopolitical arrangements that are generative of distinct types of participants and publics. The materialities of energy extend from home electricity use to airborne emissions, as well as coal mining, power plants, energy leaks, and carbon sinks and climate change. In these differently articulated energy arrangements, diverging materialities emerge that perform but do not readily point toward a clear pathway of environmental change. In this sense, they assemble a cosmopolitical array of participants and design political scenes that slow down thinking about what the performance of environmental change in relation to energy may involve. These variously assembled materialities of energy present renewed opportunities for developing speculative and interventionist practices in relation to the cosmopolitics of energy. The projects discussed here might also be seen to imagine new types of energy citizens who emerge, not as paragons of efficiency or energy reduction, necessarily, but as opportunists and

contraption artists capable of rerouting the centralized networks of energy through decentralized distributions and commons made through surplus or alternative resources.

The materialities of energy that concresce in these three projects suggest modes of participation that are not exclusively consumption-oriented, and which reposition energy participation from practices of individual management to collective becomings. An atmospheric disturbance in an urban area is a much different type of "display" and material rendering of energy use than an individual electronic meter in a utility cupboard, with much different effectuations for how energy might be attended to as a distributed urban, industrial, municipal and citizenly project. Similarly, a project that materializes the labor, industrial disease and energy requirements of electronic devices themselves as part of an energy engagement arranges energy relations that are attentive to the sourcing of energy, and the bodies through which the residues of energy extraction and use travels. Hesitating practices oriented toward energy here might be concerned with rethinking the source and supply of energy as much as "saving" energy as currently delivered. And finally, by reworking the sites of energy production and rethinking the "waste" of energy, alternative participatory practices emerge at the local level, such that energy use is as much a question of energy production where participation is not relegated scripted consumer behaviors but is opened up into new modes of making energy supplies available and possible. These cosmopolitical ways of materializing—and ontologizing—energy point the ways in which the actual complexity of energy practices may be a resource, provocation and site of invention for doing energy differently.

Conclusion

While the materiality of energy has often been focused and located within devices, this paper has considered the different ontologies of materiality that are mobilized and located both within and beyond devices. I have asked in relation to these projects: What characterizes these particular materializations of energy, how do they cohere and what practices do they facilitate? In other words, how is energy materialized in order to enable or engender practices and performances for realizing environmental change? This paper has sought to build upon discussion that connect the materiality and material politics of environmental participation (Hawkins 2010), by asking in what ways is energy materially articulated, and how do these versions and distinct types of materialization coincide with distinct practices and modalities of environmental participation in energy issues?

While attention to materiality may at times work through a more general or assumed register of that which counts as material—in other words, things or stuff—this paper has sought to articulate the ways in which distinct arrangements, relations and processes of materiality cohere or are mobilized as strategies for performing environmental change. In this sense, materiality is arguably more than objects, things, or evidently tangible material, but also include relations, processes and infrastructures (Gabrys 2011), which exceed the participatory space of the consumer-citizen who might judiciously act on energy use. These different materializations may be more or less effectuated in the performative abstractions and practices that unfold in relation to environmental change. In his recent study on "carbon democracy," Timothy Mitchell (2011) draws a relationship between energy and democracy, and suggests that current forms of democracy are concomitant with the forms of energy they use. Indeed, different modalities of "publics" are even mobilized in relation to projects for micro-generation or renewable energy (Walker et al. 2010). Publics are now emerging that "occupy" rooftops to install solar energy, and which stage ongoing micro-generation energy experiments. The articulation of different approaches to the cosmopolitics of energy and its publics requires an attention to the changing energy relationships that emerge through these material politics of energy use and distribution.

The projects discussed here involve thinking through distinct processes of materialization and political possibilities in relation to energy. This is a way of attending to the speculative qualities of performing environmental change, which engage not just with energy as actuality but also with energy as potentiality (cf. Butler 2010; Whitehead 1929). Within these multiple projects, proposals are put forward for *alternative* energy, and do not just supplant a supply source—whether solar or wind or tidal for fossil fuels—but also rethink the technologies and practices and distributions of energy, so that the "alternative" in alternative energy involves attending to different modes and topologies of energy relations and materialities. They address not just how energy and its devices might be less resource-intensive and draw energy from less polluting sources such as coal, but also how new configurations and practices of energy use, distribution and resourcing might emerge. While they do not offer final solutions to our collective energy crises, they do suggest ways for developing speculative inquiries into the material politics of energy. In this way, the diverging materialities of energy may be directed toward making new energy engagements, collectives and politics possible—as hesitating practices.

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