Experiments in Excreta to Energy

Sustainability Science and Bio-Necro Collaboration in Urban Ghana

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Abstract

In the quest for alternatives to energy extraversion and carbon-heavy extraction, transformation of waste to energy is growing worldwide. In Ghana's working-class city of Ashaiman, an international NGO converts faecal waste into electricity through a massive biodigester. Fed by public toilets, the power is sold back to residents. Touted as an exemplar of sustainable development, Ashaiman's case demonstrates that when power comes from human waste, the entanglement of energopolitics and biopolitics, but also energopower and necropower – the political uses of death and decay – is undeniable. Premised on such 'bio-necro collaborations' and enabled by sustainability science, these interventions activate state monopolies of waste while assimilating bodily excesses of urban dwellers. Marking the intimate exploitations of internal energy frontiers, an ever-tightening circuitry of energy production and political-economic incorporation results.

Keywords: biogas, decay, energy, necropolitics, science, urban, waste

Introduction: internal energy frontiers and bio-necro collaborations in Ghana's city of Ashaiman

A complex urban metabolism, the heart of Ghana's working-class city of Ashaiman pulses with the rapid movement of bodies, vehicles and goods. Built on sheer energy and ingenuity, residents and transients from across the sub-region work to glean profit from the looming demands of Ghana's national capital, flows of manufactures from the nearby container port, and daily surges of up-country agricultural output.¹ Buildings, bodies and commerce crowd dense neighbourhoods of compound houses, kiosks and wooden shanties at the city's core. Bearing uncertain promise of middle-class lifestyles and livelihoods, they are ringed by newer neighbourhoods and homes in various stages of construction and habitation.

Despite the pace of urban expansion and speculation, green tracts remain at the city's outer edge. One is a former agricultural station earlier used for experimental rice plots. Now repurposed in the prospect of energy harvesting, it is occupied by NGO newcomer, Shaaray, specializing in water, sanitation and hygiene, or WASH, in development-speak. Closing the loop of urban energy needs and expenditures, this is an early step in a larger plan to generate electrical power at urban scale from a massive biodigester filled with the compounded faecal matter of Ashaiman's residents harvested from the city's public toilets. With the blessing of the municipal government and international funders, the power produced is to be sold back to urban consumers at market rates, its sordid origins neutralized via incorporation into the national grid.

Ghana is not new to African energy innovation. The continent's first major hydroelectric scheme was built in 1957 at the dawn of national independence to serve domestic energy needs and supply regional markets (Miescher 2014). Despite intentions of energy self-provisioning, lagging capacity and growing demand paved the way for a long era of energy dependence marked by an ever-erratic power supply and haemorrhaging of national budgets on foreign fuel. While the surprise discovery of offshore oil reserves in 2007 offered the promise of relief, lack of refinery capacity at home rendered Ghana both a fossil fuel exporter and importer as power outages and fuel shortages continued to climb (Chalfin 2015).

Coincident with this much remarked upon story of African energy extraversion (Adunbi 2015; Appel 2012a, 2012b; Leonard 2016) is the rise of new arrangements of internal energy provisioning like Ashaiman's 'excreta to energy' project. What may be called 'internal energy frontiers', they indicate a wider retooling of African energy circuits, from micro-grids and private utilities, to easy-to-assemble solar devices and energy-saving materials explored in this issue. These exercises in auto-extraction include the identification of new energy sources, fabrication of technologies and infrastructures to convert them to usable power, labour and expertise to manage them, systems of regulation and distribution, as well as mobilization of demand, all *in situ*. Yet, the political economy of these internal energy experiments is little examined and not well understood.

Instituting new energy systems is never a simple matter. Alongside inevitable technical challenges of production and distribution are the socio-political challenges of giving durable form to novel arrangements, embedding them in life ways, economies and ecologies, and in cases like Ashaiman's 'excreta to energy' system, intimate bodily functions. As the renaissance of interest in energy across an amalgam of human sciences makes evident, beyond recognizing the importance of energy writ large to human technological development and collateral environmental decline, energy sources and infrastructures exert a powerful influence on political arrangements and struggles worldwide (Barry 2013; Mitchell 2011). Emphasized in a recently reborn anthropology of energy (Boyer 2014; Boyer and Howe 2019; Szeman 2014), within and beyond the operations of modern states, energy systems are, moreover, deeply intertwined with biopolitics – tersely put,

strategies for governing and promoting life through the management of bodies, individuals and populations (Foucault et al. 2008; Rabinow and Rose 2006).

But before energy systems can be instituted, they must solve the many-sided problem of what we in this issue gloss as ‘capture’,² an amalgam of force, value and property rights, the first part of which is securing access to raw materials. Amidst the frenetic sprawl of Ashaiman, capturing the excremental matters on which Shaaray’s waste to energy pipeline depended was fundamentally tricky. Far from a faeco-politics of scarcity, bodily waste was in abundance in this densely populated urban zone. Yet it was not clear who it belonged to, where and when. In a city largely ‘unplumbed’, some Ashaiman residents pursued free-range options, making use of ‘flying-toilets’, vacant lots and the cover of darkness to relieve themselves. Others, indeed most, relied on what the city’s waste management authorities called ‘private commercial toilets’ (PCT). Each attached to their own makeshift septic system, these are private pay-per-use facilities – both household-based and stand-alone – shared by families, neighbours and passers-by. With close to two hundred such facilities across the city, while the state and municipality had largely renounced its responsibilities for urban excreta, for those operating PCT, the management of bodily evacuation was a source of revenue, even social status (Chalfin 2017). The third option was city-run public toilets. Also pay per use, but cheaper than most private facilities, they were poorly maintained, few in number, and considered sub-prime by officials and residents alike. Alongside the usual ambivalence about human excreta (Van der Geest 1998), the sourcing of bodily waste for Shaaray’s apparatus was tricky indeed. Here, shit was simultaneously abundant and elusive, degraded and desired, asset and liability, private output and public burden.

So composed, Ashaiman’s ‘excreta to energy’ project speaks directly to the theoretical insights of Georges Bataille (1985, 1991). Evident in Allan Stoekl’s (2007) speculative meditation on post-peak oil, this is not the first effort to put Bataille to use to engage energy futures.³ It is the first to do so ethnographically, however. Waste, including excreta – actual and metaphoric – is central to Bataille’s self-proclaimed theory of ‘general economy’ posed as an alternative to a classical economics based on scarcity. Instead of assuming exclusive appropriation and discrete forms of value, Bataille embraces heterogeneity and irreducible value creation, a process he glosses as ‘excretion’ (Bataille 1985: 96). His is a rendering of human material life founded on the incessant productivity of waste (1985: 94). Inspired by the laws of thermodynamics and concern with the material and sensorial excesses of the human body, Bataille contends that all economic activity generates waste or excess of some sort (1991: 23).⁴ Ultimately a form of energy, it may be expended productively or unproductively: fuelling growth, driving exuberant display, and continuing the cycle of destruction.⁵ This is what Bataille (1991) calls ‘*le part maudite*’. Translated as ‘the accursed share’, it is matter ever-present yet resisting full capture in its ongoing change of form. Like the play of human excrement in Ashaiman, there for the taking, but never guaranteed, it is an object of loss but also possibility.

Seen through the lens of Bataille, the accumulation and revalorization of the urban poor's bodily waste – a substance and source otherwise abandoned and debased – by means of bio-energy production prompts a reconsideration of the relationship between energopolitics and biopolitics. Tracing the connection between systems of energy production and the management of 'the basic biological features of the human species' (Szeman 2014: 454, this coupled analytic is certainly relevant to the case of Ashaiman. It is, however, unfinished. Missing from this formulation is the concept of 'necropolitics' (Mbembe 2003). Premised on the claim that power ultimately lies in the right to kill, the necropolitical organizes bodies and populations in relation to death. In Achille Mbembe's words, it is a mode of domination that works by 'subjugat[ing] life to the power of death and decay' (Mbembe 2003: 12, 16). A formulation directly inspired by Bataille (1985), for whom 'death is the very principle of excess' (and thereby sovereign power [Mbembe 2003: 15]), it is critical to understand necropower and energopower as deeply intertwined.

The interdependence of energopower and necropower is no abstraction. Nor is it subtle, as is evident in the deep collateral damage to human lives of carbon-intensive extractivism, from black lung and the poisoned waters of the Niger Delta, to the planetary threat of climate change. Extended beyond the human, necropolitics is even more apparent, not as an after-effect of energy production, but its very condition. Like human waste, peat, coal and crude oil are all the residues of once living things transformed through death and decay into energy sources. The limits of biopower to adequately capture these processes are not lost upon foundational theorists of energopower (Howe 2014; Szeman 2014: 457), who note that 'neither states nor concepts of biopower effectively capture all of life's biodiversity'. Imre Szeman (2014: 458), speaking to the nexus of energopolitics and necropolitics without speaking of it, describes energopower as 'destructive of all life'.

Energy's fundamental connection to human and non-human life and death is incontrovertible, whatever one's theoretical or terminological commitments. I utilize Mbembe's framing to draw attention to the *banality* of necropolitical manoeuvres in the making of late-modern energy frontiers – even those like Ashaiman's posed as sustainable alternatives to carbonization and fossilization. They are banal in three ways. First, they are un-extraordinary. Just as the linking of human and non-human in energy systems is a given, likewise is the play of life and death, development and decay, production and destruction. Second, in the same way that biopower works through mundane tactics that do not appear as political strategy but have political effects on bodies and populations (Foucault 1979), so too does necropower. Thirdly, in the formulation of energopolitical orders, the necro- and biopolitical are co-mingled and co-dependent. This is a process that Jasbir Puar (2009: 163), in a rather different context,⁶ labels 'bio-necro collaboration', where 'bodies and events ... confound attempts to fold easily into and out of the distinctions between living and dying and reflect shifting, capacious, porous, and contradictory parameters of bio and necro politics'.

Distinct from necropolitics popularized elsewhere in urban Africa, where waste and death take on a carnivalesque vitality in the hands of the urban underclass

(De Boeck and Plissart 2004; Mbembe 2001), the bio-necro collaborations on which Ashaiman's excreta to energy pipeline hinged were forged through the experimental practices of urban scientists and technicians. Namely, Shaaray's WASH team used waste science to turn the city into an experimental site for sustainable energy. Through a set of incremental infrastructural exercises regarding the design and testing of the biodigester, Shaaray made the most of bio- and necropolitical entailments of waste in Ashaiman. Reworking them in the production of its unique brand of energopower, the result was a slow-burning capture of urban spaces, bodies and bodily outputs, and with it, municipal authority. Below, the story of Shaaray's scientific endeavours in Ashaiman proceeds in three parts.

Excreta to energy phase 1: public lavatory as private laboratory

Shaaray's alchemy of energy and excremental excess began innocently enough. The Netherlands-based organization offered to partner with the city to build public toilets. Facilitating exclusive purchase on the urban waste stream, the intention was to construct sixty new public facilities that would feed into a centralized sewage system and, from there, a biogas plant. With few properties available in the city's dense residential and commercial core to build, the plan quickly derailed. Shaaray instead turned its sights to building the biodigester and making use of existing waste sources. This was a social, biochemical and economic proposition that hinged on experimentation, from building an experimental apparatus to performing experimental trials.

Although inner-city real estate was unavailable, there was a little-used agricultural station on the outskirts of town where Ashaiman's municipal authority allowed the Shaaray team to set up their workspace. Once reserved for experimental rice plots and celebrated as an engine of food production, Shaaray turned into a site for waste accumulation and harvesting. I first visited in 2012, soon after Shaaray arrived. It was very much a 'laboratory in the field' (Kohler 2002), combining the intentionality of the lab and naturalism of a field site. In pursuit of for-profit outcomes and scientific truths, the facility was devoted to iterative knowledge production and controlled comparison like a laboratory, all the while incorporating the messy realities of real people and places, in the vein of field science.

The site consisted of a fenced two-acre plot, a small office block, a few agricultural beds, fertilizer drying platforms and an underground installation of pipes, chambers, tanks, switches and gages. Most important, there was a bank of public, pay-per-use toilets: two low-water 'pour-flush' toilets and one cistern toilet. At the heart of Shaaray's research station, the toilets fed two mini-biodigesters for production of combustible methane gas. Small in size so Shaaray staff could better monitor the ratio of inputs to outputs in the conduct of their research trials, Chinese dome-style tanks were built by professionals from Ghana's University of Science and Technology. Toilet customers residing near the agricultural station were eager to use the water-closets. Patronized by a hundred people a day for a per-use fee of 10 Ghana *pesewa* (about 3 US cents), they prodded Shaaray managers to expand the

facilities. Unlike commercially driven operations found in Ashaiman's more densely settled neighbourhoods, the Shaaray team resisted the urge to add additional seats. At this early stage, their mission was geared to data collection, not profit.

Socializing at the Shaaray site was mostly an exercise in didactic role-modelling. Ben, the site manager, explained that waiting time was put to use educating customers about proper toilet use, hand washing and water conservation, as well as to collecting their feedback and recommendations. Given the tendency of customers to queue early in the morning, Shaaray staff found this a particularly opportune time to coach them about proper use of the facilities. From Shaaray's perspective, it didn't matter who used the toilet, just that they used it correctly. Driven by Shaaray's ultimate concern with the biochemical conversion of waste to energy through the company's experimental infrastructure, the total 'social' person of users was of much less interest than the volume and composition of their faecal outputs. In crude terms, persons were equal to the waste they produced, and toilets the prime means of capture. Treated as (if) 'cheap nature to be capitalized', following Jason Moore's (2015: 17) formulation, the persons passing through Shaaray's site were not viewed in terms of labour power but as a source of raw material for the production of energy.

However, all waste was not equal. In Shaaray's research balance sheet, human excrement was a central though not singular input in a larger recipe for energy production. A defining innovation of Shaaray's transaction of waste to energy and back again was the combination of different types of organic excess: human waste, fruit and vegetable waste from the city's food market, and offal from the city's main slaughterhouse. In the apparatus of the biodigester, these varied inputs would together form an intermediary essence generative of energy and, in turn, profit through its sale to power companies and eventually consumers.

In the transformation of different types of waste into energy, a large part of the work of Shaaray managers and technicians involved determining the best combinations and conditions to maximize energy production. Shaaray's site manager, Ben, held a degree in Environmental Science. He and his assistants carefully monitored inputs, checking volumes, temperatures, gas pressure and flow meters, inspecting the different elements of the experimental system at regular intervals each day. With two small biogas generators they could run two experiments at the same time. I observed two test trials. One involved mixing slaughterhouse waste with human excrement. The other involved mixing food waste with human waste. These were small-batch experiments. The first included 15 kilos of animal waste, 150 litres of toilet waste and 10 litres of water. The other required 12 kilos of food waste and 100 litres of toilet waste.

Getting the proportions right was one reason Shaaray staff were so exacting, actively monitoring and advising toilet customers. It was critical that each user flush their waste with a 2.5 litre measure of water so the mix would be the proper volume and consistency for biodigestion. In another twist on the worksite's dual use as laboratory and field site, impinging upon the operations of the apparatus as well as the persons whose waste it contained, customers were effectively enrolled in

the Shaaray project as laboratory technicians in their own right. Likewise bringing together biopolitics and necropolitics in the pursuit of energopower, the power of decay extended beyond the *bios*, giving agency to no-longer human yet still bio-active things.

Requiring ongoing adjustment of inputs, outputs and configurations of the experimental apparatus, this was a self-conscious endeavour. Not entirely different from experiments in urban sustainability science in the UK (Evans and Karvonen 2014), these interventions employed the epistemes of science to 'empiricize the urban landscape' and thereby instrumentalize it. Creating a controlled, bounded environment that relied on measurement, expertise, and the staging and restaging of simplified versions of much more complex social realities, it turned infrastructure into scientific instrument and scientific instrument into infrastructure. The research team documented each step in their research logs. More so, to keep their experimental prototype going, it was necessary to burn or release the methane produced. Seeking to incorporate the off-take into daily practice, the Shaaray staff reminded nearby residents and toilet customers to come and use the gas. Shifting from instrument to infrastructure, they conveniently routed it to a pipe and brazier near the entrance to the work site.

With the liquid effluents of biodigestion allowed to run off, the solid by-products were being tested as an organic fertilizer. Spreading it to dry on raised beds, the Shaaray site manager talked with pride about the efficiency of the firm's 'waste to value' chain. A fly in the ointment of experiment, the city waste management official accompanying me to the site was not so easily impressed. Employing a more conventional species of waste-based knowledge, he reminded the staff to be aware of flies on the fertilizer drying beds, warning that flies were the source of maggots in the toilet chamber and an indication of poorly maintained facilities. Ben quickly countered that flies were a welcome by-product of food waste and deliberately put to use to accelerate decomposition in the waste chamber. With two different 'micro-biopolitics' (Paxson 2008) in mind, one attuned to decay and the other hewing to high modernist ideals of a firm line between human, non-human species and waste, the exchange revealed competing understandings of sanitation and an emerging impasse over control of the project.

There were other sorts of energopolitics at play. In a location coded as 'state lands', the government had a benign, largely background presence that marked Shaaray's activities as official. Though not a fully public realm, the toilets came across as a public service attentive to local needs and users – like the pregnant and elderly customers who requested and received cistern rather than squat toilets. Though likewise making claims on waste, the facility was nothing like Ashaiman's squalid government-run public toilets. Also public spaces, there state authority was made known through the toilets' degrading conditions, subjecting users to waste, rather than turning them into active subjects of waste science.

Bringing this in line with Bataille's theory of 'conspicuous waste', it is relevant to ask when and which wastes are made conspicuous and which are not. Just as Susan Leigh Star (1999) alerts us to the relationship between infrastructure's visibility

and invisibility, might conspicuous waste serve to cover up the inconspicuous? At the Shaaray site, the toilets were promoted and publicized while the biodigester, underground and newly built, was off-limits and largely invisible. That is, although waste was doubly present, biopolitics prevailed over both necropolitics and energopolitics in this early stage. The digester's diminutive scale was out of proportion with its eventual impact.

Excreta to energy phase 2: seeing like a biodigester

When I returned to Ashaiman a year later to look into the urban waste stream elsewhere in the city, I was surprised to find myself running into Shaaray staff far from their research site. Instead they were out and about in town. Resetting the social, territorial and institutional boundaries of experimentation, the new research phase dramatically altered the political cast of their project. Both empiricizing the city and instrumentalizing municipal waste management anew, in this next phase the city itself shifted from a site of experimentation to the object of experiment. A move from building an energopolitics around persons to populations, in contrast to the direct relationship between Shaaray staff and individual sanitary subjects within the research station, there was now an indirect relation between the company and urban residents *en masse* mediated by municipal authorities by means of waste.

Once Shaaray's team analysed the results of their work at the research station to determine the most energy-efficient stew of human, plant and animal waste, their next goal was to ascertain the composition of urban organic discards in real terms. This would allow calculation of the waste actually available for the biodigester. If they knew how much plant and animal waste could be amassed in a given time frame, Shaaray could then determine how much human waste they would need to harvest to maximize energy production.

Because the problem had to be approached on an urban scale, it required not just the tacit approval of urban authorities but their active participation. With the express permission of the reigning District Chief Executive, this next phase of experimentation was staged in an urban public space very different from the closed commons of the peri-urban agricultural outpost: Ashaiman's Waste Transfer Station. Located on the fringes of Ashaiman's commercial core and overseen by the municipal administration's waste management department, all solid waste from the city was to be deposited here. Theoretically open to all by dint of law, the site was primarily accessed by a mix of formal and informal private waste workers and municipal employees who would deposit, sort, repack, and eventually send the waste to the city's more distant dump after removing more desirable discards for recycling (Chalfin 2019).

Akin to other forms of sanctioned surplus extraction, making official what might be posed as states' tacit 'monopoly of waste',⁷ according to Ghana's 1999 Environmental Sanitation Policy, Municipal and District Assemblies hold ultimate authority over the disposal and handling of waste, both solid (trash) and liquid (excreta):

ENVIRONMENTAL SANITATION POLICY: 1999.

6. ENVIRONMENTAL MANAGEMENT AND PROTECTION

6.1 Control and Ownership of Wastes

All waste deposited in the public domain shall be the property of the District Assembly. The District Assembly may also direct generators of waste to dispose of or surrender such waste to the District Assembly in a manner and at such times and places as may be approved by the District Assembly.

Operating under this statutory licence by proxy, Shaaray simultaneously employed and reworked the terms of municipal accountability for urban waste matters. Along with seeking free access to the waste materials within the municipality's aegis, Shaaray essentially put the municipality to work on its behalf. Here we see a double dynamic at play that draws on the privilege afforded to scientific investigation and the kind of moral recognition that comes with the voluntary treatment of waste for public good, pace Bataille (1991: 64), who sees waste as a perverse form of sacrifice.⁸

More so, making use of urban spatial hierarchies, Shaaray used its new perch at Ashaiman's transfer station as a gateway to other public areas under city control. Abiding by Shaaray's requests, city representatives instructed site managers to have their crews sort the waste brought to the dump from Ashaiman's several open-air produce markets. This was different from the usual separation of resalable and recyclable materials from the municipal garbage heap (Chalfin 2019). Under the supervision of Shaaray staff, labourers at the waste transfer site were directed to differentiate organic and non-organic waste. Making waste conspicuous was an arduous task, with the work of disciplining decay a mix of necro- and biopolitical toil.⁹ It involved laying out tarps, dumping a truck load of refuse, hand-sorting organic and non-organic items, loading them into separate bins and hauling them to weigh. Shaaray supervisors recorded results, comparing the findings across the different markets to get a sense of normal outputs. Over a few weeks, the work crew had made their way through three dumpsters' worth of refuse.

In the *de facto* diarchy of Shaaray and municipal waste management, it was not exactly clear which organization was in command and which was in control. Evident, however, in Shaaray's urban science experiment was the capacity of a private agency working for its own profit and public good to simultaneously activate and take advantage of the municipality's statutory monopoly of waste. With Shaaray's forays into urban science encroaching on municipal authority and turning the government's implicit rights to waste to new ends via the banal necropolitics of waste-sorting, the city's organic discards became a form of urban property. Straddling the human and the non-human, they were partible and aggregatable and subject to separate rights of access, use and disposal, and even the right to calculate.

Combining the extraction of labour with scientific research methods, Shaaray representatives called this process of separation and classification a 'training exercise'. The waste workers pressed into service, using the popular slang for waste jokingly called it '*bola* learning', and 'garbage university', poking fun at the seriousness of young urban waste professionals directing the sorting efforts.

Surprisingly relevant to Shaaray's urban experiments turning waste to energy in Ashaiman, Bataille (1991: 73) remarks:

While the resources man controls are reducible to quantities of energy, he is not always able to set them aside for a growth ... He must waste the excess, but he remains eager to acquire even when he does the opposite. And so he makes waste itself an object of acquisition. Once the resources are dissipated, there remains the prestige acquired by the one who wastes.

Demonstrating and complicating Bataille's core insights, under the umbrella of Shaaray's experimental quest to amass the necessary types and quantities of organic materials, waste was indeed an avid object of acquisition. Transferable and containing the seeds of multiple forms of value, it was not a commodity, but a type of gift or urban booty. Freely given by the state, its transfer made evident the municipal government's privileged status as both free to take and free to waste. Yet, freely accepted by Shaaray (pace Mauss [1954] 2002), waste's transaction enabled its transformation back into use value via waste science. In short, as Shaaray mobilized the municipality's statutory rights, Ashaiman's wastes – human and non-human – became objects of municipal command and company control. Here again, despite its abundance, like the 'four cheap' characterizing the late-modern capitalization of nature described by Moore (2015), waste is not free for the taking. Rather, in the case of conversion of waste to energy, it is accessed by privilege and proxy and the back-door strategies of necropolitics. Pursued for the ostensible purpose of urban improvement, this is one bio-necro collaboration among many marking the Shaaray project.

Excreta to energy phase 3: pipe dreams and disappointments

By the end of the next year, Shaaray's 'excreta to energy' pipe dream was on its way to becoming a reality. The organization secured a million euros from the African Development Bank's 'African Water Facility'. This was a grant scheme inspired by the UN Millennium Development Goals (2000) promoting 'sustainable access to improved water and sanitation'. With financing in hand, Shaaray's plan for a large-scale biodigester could finally go ahead. When connected to a generator, the methane produced within the biodigester would be converted into electricity and sold to the Accra Electric Company at a preferential tariff and then purchased by the Electricity Corporation of Ghana to be sold to consumers. A near-perfect loop demonstrating the promise of green capitalism, as Shaaray saw it, the useless would be made useful, cost transformed into profit, and a noxious pollutant would become a source of pleasure and productivity. From laboratory experiment to field training exercise, Shaaray had become a *bona fide* business enterprise.

Moving from development agent to commercial entity, Shaaray's work took on a strongly proprietary cast. The municipal government, deemed a partner on paper, was in practice reduced to one stakeholder among many. Although the agricultural

station was adequate for the small-scale prototypes, a much larger space was required for the actual biogas plant. The city had earlier promised Shaaray access to a tract zoned many decades earlier for sewage settling ponds that were never built. This is where Shaaray sited its plant. The installation was a couple of football fields in size and included a massive biodigester, multiple waste storage tanks, drying beds, effluent run-off fields, pumps, siphons, generators, transformers and power lines. Once construction was under way, the head of the city's environmental health department, previously worried about flies on the drying beds, now found himself unwelcome. The site was surrounded by a barbed fence, with a security gate and security guards, and he was only permitted to visit by appointment. This was all fine according to the agreement signed by Shaaray and Ashaiman's Chief Executive. Essentially a Build, Own, Operate and Transfer agreement, or BOOT, the municipality was due to inherit the power plant within eighteen years. This was so despite the fine-print of the ADB project contract noting 'waste treatment equipment is expected to have a useful life of 15 years' (African Development Bank 2013).

Despite the exclusion experienced by public officials, the installation had an assured public presence. There had been considerable deliberation around what sort of biodigester to build. Departing from the miniaturized Chinese dome of the experimental works, an entirely different system was selected. Known as an ECO-bag, it essentially consisted of a pit sealed with an expandable, airtight PVC tarp. The volume and height depend on the amount of waste fed into the digester and the amount of methane produced. It was considered relatively easy to install and much less expensive than the cost of bricks, mortar and reinforced steel for a more conventional spherical tank. Most bag-style digesters were built to smaller specifications; at 1000 cubic metres, the supplier expressed concern about the large size. However, with the tropics again a laboratory for experimentation and innovation (Kohler 2002), the exception was deemed workable given the favourably high ambient air temperature in Ashaiman.

Shaaray representatives considered the long shallow shape of the ECO-bag a perfect fit for the unbuilt sewage treatment ponds. This time turning a business proposition into an unexpected science experiment, once the installation was under way the contractor ran into problems despite earlier on-site testing. The problem was not the bag, but the pit. The area had quickly turned muddy. The site had to be re-engineered with a sub-reservoir and three-metre high cement platform. Blowing the budget, the adjustment also blew the project's cover. The expansive green dome of the ECO-bag was now highly visible. Large, looming and remote, it was a symbol of a capacious if distant authority.

The assistant manager, Thomas, whom I had met a few years earlier during the waste-sorting exercise, showed me around. He talked with pride about the complex operations, mentioning how far they had come since the early experiments at the rice fields. Under his supervision, the workers had primed the digester with manure and market waste, and power production was already under way. At the far edge of the whole installation, away from the muck of the drying beds and effluent ponds, were the two electrical generators, one low voltage, the other high, leading into the

electricity company's high-tension electricity lines on the other side of the fence. Thomas pointed out the components and explained the operations.

As he showed me the electricity meter ticking off the energy produced by the digester before moving out of the Shaaray compound to the power company's lines, I sensed a mix of pride and a wistfulness that took me by surprise. Perhaps dealing with his own sense of alienated efforts, he said it was 'unfortunate that consumers couldn't see or know that they were part of the process', implying that they were somehow present in this all-powerful substance of electricity, yet left unaware. It was as if all of the work, the knowledge, the careful chemistry of faeces, cow dung and market waste, the admixture of water, the timing of release and so on had been reduced to an anonymous force condensed within a vast grid, with no name, no mark, no smell.

With the ECO-bag and surrounding bio-waste industrial site looming large but out of bounds, the expansive but largely unmarked energopower of the grid effectively masked the bio-necro collaborations on which it was predicated. It was a moment reminiscent of Antina Von Schnitzler's (2016) discussion of the recasting of electricity meters in South Africa's townships, but this time coming from someone at the top of the energy-value chain. In this brief moment, the capital 'P' power of government authority had been displaced by the small 'p' power of electricity delivery, coercive capacity cancelled out by consumer demand.

But it was power nonetheless. Upon closer inspection, it became evident that the electrical lines and looming ECO-bag were only part of the story: another case of conspicuous infrastructure obscuring the insidious as at Shaaray's first experimental site. The company's final Memorandum of Understanding with Ashaiman authorities permitted Shaaray to collect all the faecal matter and solid waste it needed from city premises. With human waste the preferred input for the ECO-bag digester, Shaaray cut a deal to utilize excrement from the city's numerous public toilets. In return, Shaaray committed to building a few new toilets and renovating several others.

Justifying an intrusive yet largely veiled public presence, Shaaray's research findings in Ashaiman indicated the importance of obtaining what it called 'high-quality faecal materials'. According to Thomas, the project foreman, it had to be fresh, that is, less than two weeks old, and absolutely free of chemicals. Instrumentalizing urban bodies and bodily waste as at the initial research site, but this time as a cog in a wider industrial process, public toilet users were expected to be at once conduit, producer and anonymous arbiter of faecal outputs. Project documents proposed using the public toilets for 'hygienic behaviour change campaigns', 'training public toilet operators' and 'incentivizing suppliers' in pursuit of 'acceptable sanitary conditions' and 'outputs' (African Development Bank 2013).

A case of necropower subsuming biopower in the service of energopower, one wonders about the implications of these qualifications and quantifications for the waste-producing body. Here Bataille's insights regarding waste as a source of rank are relevant anew. Are Ashaiman's public toilet users to be divided into high- and low-quality and -quantity waste producers? Will those who waste more and those

who waste best earn social prestige? Would certain public toilets and those who patronize them be accorded status and recognition due to the quality of their faecal matter? Or is the matter at issue, following Stoekl's (2007: 56) reading of Bataille, Shaaray's evaluation of bodily waste in terms of profit and utility versus the intimate expenditures of evacuation for Ashaiman residents that renders them part of a human collective without recourse to individual gain?

Perhaps it is a Marxian optic that offers a deeper grasp of the stakes of this scenario. Bataille (1985: 32) quotes Marx: 'In history as in nature, decay is the laboratory of life.' Updating this insight, is decay here not the laboratory of capital? Is the urban underclass in this equation reduced to faecal suppliers, a privilege they pay for when they use a public toilet and pay again when they purchase energy produced from their very own excrement? Is waste harvesting, like organ harvesting discussed by Nancy Scheper-Hughes (2001, one of the few productive outlets available to them? A perverse *mise en valeur*, according to this waste to energy logic, the productive potential of Ashaiman's urban poor was to be gaged not on their labour power or capacity to do work, but on their merits as waste producers and energy consumers. Likewise, the outsourcing and upgrading of urban public services by means of sustainability science as a way to gain a grip on urban citizens and test the *de facto* limits of *de jure* authority via investment in energy introversion alters the means of urban governance, reviving it and chipping away at its promise. Revising Marx once again, here 'decay is the laboratory of energopower'.

Conclusion. From sustainability science to bio-necro collaboration.

The long path between initiation and implementation of Ashaiman's excreta to energy project reveals much about the intimate and emplaced actualities of sustainable energy alternatives designed to stave off the dependencies of energy extraversion. With energy production a process of elemental transubstantiation – a hard fact implicit in Bataille's heady theory formulated in the shadow of the atomic bomb – the first lesson learned is the heavy load borne by waste, especially human and other bio-active organic waste matters. As Bataille makes clear, waste, always laden with residues of past lives and future possibilities, is never free for the taking, no matter how seemingly extraneous or inutile. Excrement, one form of Bataille's (1991) 'living matter', is not a pristine reservoir: it comes at a price. Like other energy sources, it must be claimed and cleansed of prior entanglements. While it appears on the surface to be cheap (see Moore 2015), its political exploitability is a hard one, as capture gives way to loss and the heterogeneous markings of human life and death dissolve in the ether of transmission.

Shedding light on energopolitical orders in the making well beyond the single case of urban Ghana, Shaaray parlayes field science into energopolitical strategy. Imposing order and making claims on bodies, populations and no-longer human materials, the organization's experimental endeavours exceed the technopolitical, though they are likewise formulaic, bureaucratic and rule-bound (Barry 2013). Shaaray's techno-scientific practice also exceeds the biochemical and biophysical

transformations of energy production, whether the miniaturized Chinese dome or mega ECO-bag. Riding on a combination of scientific legitimacy and the discretionary freedoms of field science, these efforts manage and expropriate human lives and bodies through the collective orchestration of decay. The firm melds necropolitics and biopolitics to cultivate self-regulating subjects who are both sources and consumers of excess energy.

Also at stake in Shaaray's excreta to energy project are the necropolitical potentials of the state, easy to claim but dicey to delegate as waste harvesting devolves into urban capture. This too is a multi-sided process involving the successive assimilation of unused space, discarded things, wasteful bodies and the latent entitlements of municipal government. At once enlivening and usurping unrealized premises of state authority, for whom gain is predicated on loss, the dynamic is re-inscribed in the promised transfer of the BOOT biogas plant, *le part maudite*, already spent.

The ends of power transmission via the national electrical grid, as the Shaaray foreman rightly recognizes, obscures these multi-layered entanglements on which waste to energy production is predicated. An effort to make visible and understand the banal means through which they are made invisible, the drawn-out threads of peripatetic ethnographic observation bring to light a more complex energopolitical backstory. This is a scenario considerably different from better understood conditions of African energy extroversion, where systems' inside and outside are more boldly demarcated despite their necessary interdependencies (Appel 2012a, 2012b). In the case of internal energy fronts such as those found in Ashaiman, the levers of transformation hide in plain sight. Energopolitical capture here is predicated not on expropriation but the soft predations of domestication and bio-necro collaboration.

Of relevance to anthropological investigations of energy and other infrastructures in formation elsewhere, here sustainability science operates as a mode of intervention and legitimation in tacit alliance with state authority. Melding expropriation and radical self-reliance anew, these localized formulations of energy and consumer capture magnify the meagre surpluses available *in situ*. Although waste's excesses dazzle with possibility, as Bataille (1991) well notes, the slippery topography of necropolitical output eludes assimilation (Stoekl 2007: 31), prone to its own brand of indiscipline. It is these processes of bio- to necropolitical transubstantiation that Ashaiman's novel waste to energy infrastructures seek to harness and erase. Despite efforts to convert the excesses of nature to a singular utility, it is evident that the technopolitics of energy production (pace Boyer 2014; Mitchell 2011; Szeman 2014) can never fully subdue the unruly forces of life or decay.

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Notes

1. Ashaiman, population 200,000 (2010 census), is located twenty miles from Ghana's national capital and grew from an informal settlement serving the nearby port city of Tema. In 2008 it was designated an autonomous municipality with the responsibilities of self-government, including provision of basic utilities to residents.
2. Speaking to the 'rule of capture', Hannah Appel, Arthur Mason and Micheal Watts (2015: 36) mention the ambiguity of property rights as the greatest obstacle and biggest lure to energy resource prospecting.
3. Stoekl (2007) offers a provocative if unorthodox reading of Bataille's idea of excess to propose a theory of ecological sustainability premised on acceptance of the limits of utility and individual gain.
4. The first law of thermodynamics states that energy can neither be created nor destroyed; it can only change forms. In any process, the total energy of the universe remains the same.
5. Although some attribute it to his obsession with the sun (Bakke 2019:36), it is notable that Bataille's theorizations of energy emerged at a moment when nuclear power had become a historical reality.
6. Puar (2009) develops the term to understand the orchestration of affect in the context of disability rights.
7. If state authority is tied to monopolization of excess, such as taxation and violence, the assertion of exclusive claims to waste are on par with other sanctioned forms of surplus extraction.
8. Catherine Alexander and Josh Reno (2014) similarly point to the assessment of waste to energy transactions in the UK as a type of 'gift-giving'.
9. Rosalind Fredericks (2018) describes similar routines of discipline and decay among waste workers in Dakar, Senegal, referring to the "intersecting precarities" of human bodies, trash infrastructures and waste materials. This mix of what Kathleen Millar (2018) calls "forms of life" and 'forms of death' are also evident in the waste dumps of Ashaiman (Chalfin 2019).

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