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# The Battery is the Message: Media Archaeology as an Energy Art Practice

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#### Abstract

This text is an investigation of battery technologies and planned obsolescence in the context of energy consumption, electronic waste and environmental crisis as brought on by current communication technologies. Tracing the battery's formative histories, the text examines its messy chemistries, entanglements with portable computing to current extraction of constituent minerals of Lithium and Cobalt as bundled into contemporary media devices. Building on Hertz and Parikka's Media Archaeology as an Art Method, the author aims to extend this research and critique into an energy art practice. Here, media archaeology becomes a method to conduct critical and artistic examinations of media technologies as concerned with energy and ecology. The text demonstrates this approach through the study of the Community Power Bank (2016-18), a community-participated energy art project in Helsinki. The project recycled Lithium-ion batteries through Do-It-Yourself (DIY) workshops, hacking and dismantling, and co-constructing power banks amidst discussion about e-waste and ecological concerns among community participants. The project also catalyzed conversations about the political economy of contemporary black-boxed technologies and the intertwined issues of energy, resource depletion and environmental impact.

### Keywords

media archaeology, art, battery, energy, lithium, obsolescence, e-waste, environment

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# The Battery is the Message: Media Archaeology as an Energy Art Practice

#### **Cover Page Footnote**

The thoughts in this article came about during the Community Power Bank (CPB) project workshops at Pixelache Helsinki in 2016-18. The project recycled Lithium 18650 batteries with community participation and re-purposed them to build power banks for handheld media devices. The workshops were conducted at the Museum of Photography and at the Open Knowledge Foundation's OSCE (Open Source Circular Economy) Days 2016-18 in Helsinki, Finland. Further lecture-workshops were held by the author at the University of the Arts Helsinki and also as part of Pixelache's BioSignals 2018 project. The project had no funding and was purely grassroots as organized by the author, volunteers and artist members of Pixelache. All acknowledgements are due to the participants, colleagues and institutions in this project.

#### Introduction

When media explode in your hands, it deserves a description. When it causes airplane evacuations, general panic and hysteria, it warrants an examination. When it quietly dies in your pocket before the end of an eight-hour work day just like the other two billion smartphones, it deserves an explanation. It is reasonable to believe a thermal runaway event is far more spectacular than a quiet smartphone death. Leakages take place, fire and toxic chemicals are involved, possibly leading to personal bodily injury. It can be traumatic. Thermal runaway is today one of the prime modes of battery failure. Chemical reactions within raise its internal temperature, and if not dissipated, the temperature keeps rising that will further accelerate the reactions causing even more heat to be produced, eventually resulting in an explosion. Especially a Lithium-ion cell above a certain temperature, its internal chemical reactions out of control, will explode.

While fast computation and slimmer devices become the norm and Tesla's SpaceX sends a flying robot into space, the battery concealed under the hood of media devices remains a messy and primitive territory. While historically battery development was instrumental in the transformation of modern communication systems such as telegraphy, with the advent of portable computing battery innovation had considerably slowed down. Is it because of the dangerous chemicals and the volatilities of the elements involved? Is it because technological devices themselves are tied to an obsolescence perpetuated by the technology industries that a rechargeable battery lasts only a thousand cycles? Or, is there simply no need to innovate as long as a battery lasts the consumer upgrade cycle (currently at 1-2 years)? While Lithium-ion cells were introduced in the mass market in 1991, battery capacity has only increased 5 to 6% annually. Battery technology has not even come anywhere close to doubling, nor matching the trajectory of the components that it powers, rather grown only eight-fold since the first commercial batteries were introduced in 1854. Despite over decades of research, they remain assemblages of messy chemicals, hazardous, black-boxed and subject to thermal runaways. Batteries are designed today as not meant to be replaced. While scholars and industry stay obsessed with interfaces, software and processor speed, the engine that drives the heart of communications remains an unexplored and dangerous territory.

It is well known that thermal runaway is like a domino effect. One thing leads to the other, until there is no point of return. Samsung blames the explosive incidents to a design flaw in one case and the other to a manufacturing defect.<sup>1</sup> What happens to the 2.5 million smartphones that are being recalled and most likely will get discarded remains unexplained. Martin Farrer writing in *The Guardian* states that "in 2007, the largest battery recall in consumer electronics history took place when Nokia, then the world's top mobile handset maker, offered to replace 46 million phone batteries produced for it by Japanese maker Matsushita Battery."<sup>2</sup> Out of these only two million phones were replaced, the fate of the rest could be considered to the adding tonnage of e-waste. Available data shown by Robinson indicates that the global production of E-waste was at least 13.9 million tons per year in the middle of this decade; and by 2014,<sup>3</sup> 42 million metric tons of e-waste was being generated globally.<sup>4</sup> The recycling of this e-waste has become even more problematic as it is exported to countries in the Global South where dangerous backyard recycling often take place, posing great health risks to the local communities.<sup>5</sup>

In this article, I conduct an excavation of the battery as a key component of communication infrastructures, that not by itself can be considered a medium for dataflows, but without which media cannot operate nor exist. The goal is to direct attention towards the ecological implications of communications technologies, especially the ever-increasing dependence on power and material resources. I argue that the battery under the hood is not merely another media component, a medium without a message. But as a medium within a medium that supports not only societal communication but also channels the matter and energies of the earth. As Thomas Parke Hughes asserts: "the analysis of an incoherent, formative period in the history of energy systems [is] likely to be meaningful to present dilemmas of energy systems and their future growth."<sup>6</sup> Perhaps, considering the proliferation of technological

<sup>&</sup>lt;sup>1</sup> See Josh Horwitz, "Samsung finally explained what caused the Galaxy Note 7 explosions." Quartz, 23 January 2017. Accessed February 23, 2017. https://qz.com/892221/samsung-ssnlf-finally-explained-what-caused-the-galaxy-note-7-explosions.

<sup>&</sup>lt;sup>2</sup> Martin Farrer, "Samsung recalls Galaxy Note 7 phones after battery fires." *The Guardian*, 3 September 2016, accessed February 24, 2017,

http://www.theguardian.com/technology/2016/sep/03/samsung-recalls-galaxy-note-7-phones-after-battery-fires.

<sup>&</sup>lt;sup>3</sup> Robinson, Brett H. "E-waste: an assessment of global production and environmental impacts." *Science of the Total Environment* 408, no. 2 (2009): 183-191.

<sup>&</sup>lt;sup>4</sup> Balde et. al., *The Global E-Waste Monitor* 2014, accessed March 20, 2017, https://i.unu.edu/ media/unu.edu/news/52624/UNU-1stGlobal-E-Waste-Monitor-2014-small.pdf.

<sup>&</sup>lt;sup>5</sup> United Nations University, "StEP launches interactive World E-Waste map," accessed February 7, 2017, http://unu.edu/media- relations/releases/step-launches-interactive- world-e-waste-map.html#info.

<sup>&</sup>lt;sup>6</sup> Thomas Parke Hughes, *Networks of Power: Electrification in Western Society, 1880-1930* (Baltimore and London: Johns Hopkins University Press, 1993), 461-465.

media and its energy exploitation of earth elements could help us understand planetary climate change, that in itself is subject to a thermal runaway event. Documenting the ecologies of the battery, from both a historical and a technological perspective is critical to understanding the future of media technologies that is today so intensively based on energy. And, this includes revisiting the energetic entanglements within its formative history, subsequent technological applications, current extraction and fabrication to toxic landfills. My intention here is also to develop an artistic methodology aimed at the energetic ecologies of media, of which Lithium batteries form a significant factor. By recycling Lithium batteries through Do-It-Yourself (DIY) art workshops combined with reflection on energy, e-waste and the environment, I aim to bring the issues of energy and media infrastructures to the foreground.



Fig. 1. Recovered Lithium-ion batteries from discarded laptop battery packs during the Community Power Bank project in Helsinki. Photo Credit: Justin Tyler Tate.

In the following sections, I dig into planned obsolescence of the battery and it's messy chemistries. Further on, I examine why and how hardware came to conceal the battery and how software today merely provides a surface tweak. Here, I draw insights from Matthew N. Eisler's seminal study that explores the dynamics in the co-construction of notebook batteries and computers.<sup>7</sup> Next, I trace the battery's contemporary lifecycle in the energy economy: from mining to extraction to recycling that present formidable challenges to the environment. Data and insights in these sections are collated from literature research, international, institutional and news reports. As a key example of an art method resisting battery obsolescence and waste, I present my own artistic project 'Community Power Bank' conducted in Helsinki, Finland in 2016. The case study demonstrates how artistic projects can extend the lifespan of Lithium batteries, reduce e-waste and mitigate the impacts on the environment. Finally, building on earlier work done by Garnet Hertz and Jussi Parikka in *Zombie Media* (where they argue for a stronger articulation of media archaeology as an art method, addressing not only the past, but also discarded electronic waste<sup>8</sup>) I propose media archaeology as an energy art practice to address technological obsolescence as well as study its effects on the environment.

#### **Planned Obsolescence**

The battery has always been a trivial afterthought in the development and spread of media ecologies. While telecommunications infrastructure designed for longer durations scaled and thrived in a far stable manner with its supporting energy structures, the development of the battery stagnated at the systems level and power density did not correspondingly scale.<sup>9</sup> With the growing demand for slimmer media devices, battery research became focused on thinner, lighter, space- effective and shape-flexible batteries with larger autonomy.<sup>10</sup> Which is at odds with the tremendous volume of data transfer, streaming and mobile computing that has simultaneously placed a great load on energy needs. The current chemistry does not extend the battery lifetime beyond a thousand cycles. Replacing a Lithium battery is a task replete with potential fire hazards. This is inherently tied to how the industry designs portables to discourage users to tinker and with the intention of discard after a few years. Not only batteries are glued within the body of the device, but merely to uncover them from within the bowels of the machine requires expertise

<sup>&</sup>lt;sup>7</sup> See Matthew N. Eisler, "Exploding the Black Box: Personal Computing, the Notebook Battery Crisis, and Postindustrial Systems Thinking," *Technology and Culture* 58, no. 2 (2017), 368-391.

<sup>&</sup>lt;sup>8</sup> Garnet Hertz and Jussi Parikka, "Zombie Media: Circuit Bending Media Archaeology into An Art Method," *Leonardo* 45, no. 5 (2012), 424-430.

<sup>&</sup>lt;sup>9</sup> Eisler says that, "packing more transistors together and increasing chip frequency generated heat, boosting voltage and power consumption, a phenomenon that the semiconductor industry seems to have been aware of as early as the mid- 1990s." See Matthew N. Eisler, "Exploding the Black Box: Personal Computing, the Notebook Battery Crisis, and Postindustrial Systems Thinking," *Technology and Culture* 58, no. 2 (2017), 372.

<sup>&</sup>lt;sup>10</sup> Tarascon and Armand, "Issues and Challenges Facing Rechargeable Lithium Batteries," 359.

and specialized tools. While consumers upgrade, media gets discarded and batteries are thrown away, along with the precious elements extracted from the earth. The embodied energy of extraction, processing, manufacturing and labor is similarly wasted adding to carbon footprints, polluted water and global warming.

Dabbling with dangerous chemicals did not deter turn-of the century media innovators. But with the computing age, the perils of acid burns got concealed away. Makes sense, for a mass consumption product. The less tinkering, the better. Thus, from the easily detachable battery packs in laptops and mobile devices a decade earlier, we are now faced with super-glued batteries within the machines without easy access. This marks the strange and steady inaccessibility of the battery from the machines themselves. To change a battery pack today requires extensive documentation, expertise, special tools and almost *machinic* dexterity of fingers to pick and replace a load of 2 and 3-millimeter screws. One mistake and you end up short-circuiting the electrical connections on the main board and permanently damaging the machine. While there exists a plethora of surface-level fixes on smartphones and laptops on how to save energy and extend battery life, not a lot can be found on battery repair and reuse.

This deliberate obsolescence as Hertz and Parikka argue: "takes place on a micro-political level of design: difficult-to-replace batteries in personal MP3 audio players, proprietary cables and chargers that are only manufactured for a short period of time, discontinued customer support or plastic enclosures that are glued shut and break if opened."<sup>11</sup> As such, the lithium battery no longer works after approximately 2-3 years or 1000 cycles and the media device will require professional service or will be discarded. Smartphone and laptop batteries are not easily removable. The battery degrades, and the replacement of the battery becomes expensive as it cannot be undertaken by the average user. This early obsolescence of the device due to the lifetime of the battery might be an intention of the manufacturers who favor high-powered batteries with long run-time, and, therefore the most volatile chemistries.

Various types of obsolescence rule batteries. And since batteries and media devices are conjoined twins, the effects of obsolescence flow into one another. Material obsolescence, or the deficient capability of materials and components leads to fast aging or a Thermal Runaway event. Functional obsolescence, or the fast changing technical and functional requirements of media devices leads to a perpetual iterations of battery form factors. A subjective ageing could take place due

<sup>&</sup>lt;sup>11</sup> Garnet Hertz and Jussi Parikka, "Zombie Media: Circuit Bending Media Archaeology into an Art Method," *Leonardo* 45, no. 5 (2012), 426.

to fashion, technical trends and consumption patterns. A loss of functionality could also occur due to high prices for consumables, maintenance and repair as well as comparable low costs for new products. But of all these, Planned Obsolescence, or an unstated deliberate shortening of the product lifetime by the manufacturer perhaps plays an important role in today's battery dilemmas.<sup>12</sup> "Guided by the principle of planned obsolescence, manufacturers assumed that consumers would throw away and replace old handheld devices long before aging batteries became a problem.

Accordingly, they devoted hardly any research to battery reliability and safety."<sup>13</sup> Manufacturers have argued that the cost of resources, production cycles and marketing strategies cannot be ignored and that they release the most 'optimal' product. As such, materials and components of inexpensive-quality are used "which statistically achieve a "sufficient" lifetime from manufacturer's perspective."<sup>14</sup> This illustrates how corporations producing these technologies are eager for consumption to speed up rather than slow down, deploying a combination of perceived and planned obsolescence in order to reduce product lifespans, which increases ecological costs but also raises short-term profitability.<sup>15</sup>

Throwing away obsolete batteries is nothing new. The portable Columbia dry cells of 1890s were meant to be discarded as consumer goods. It was chemically efficient and economical to produce in mass quantities.<sup>16</sup> Maintenance-free, durable, non-spilling and cheap, the 1.5-volt Columbia was so good it remained the most used and discarded battery for the next six decades, filling the landfills with toxic waste. Eveready in 1950s introduced the now ubiquitous cylindrical alkaline battery, that is today the most common disposable battery. These last two to four months and then have to be thrown away. Made of cheap materials, the economic costs of recycling are high and as such these batteries have constantly been part of mainstream solid waste. Today rechargeable Lithium batteries are replacing alkaline batteries to a

<sup>&</sup>lt;sup>12</sup> Proske et al., "Obsolescence of electronics-the example of smartphones," *Electronics Goes Green* 2016+(EGG) (2016): 1-8

<sup>&</sup>lt;sup>13</sup> Eisler, "Exploding the Black Box," 383.

<sup>&</sup>lt;sup>14</sup> Proske et al., "Obsolescence of electronics-the example of smartphones," 1-8.

<sup>&</sup>lt;sup>15</sup> See Sy Taffel, "Escaping Attention: Digital Media Hardware, Materiality and Ecological Cost." *Culture Machine* 13 (2012): 1-28.

<sup>&</sup>lt;sup>16</sup> Judah Ginsberg, "The Columbia Dry Cell Battery," Washington DC: American Chemical Society, 2005, accessed April 5, 2017,

https://www.acs.org/content/dam/acsorg/education/whatischemistry/landmarks/drycellbattery/col umbia-dry-cell- battery-historical-resource.pdf

certain extent. But these too are guided by increasing miniaturization,<sup>17</sup> manufacturer priorities of cost, cycles of production, bottom lines and even pricefixing.<sup>18</sup> A "Science for Environment Policy" study by the European Union in 2012 says that Lithium-ion batteries are the most energy consuming technologies using the equivalent of 1.6 kg of oil per kg of battery produced.<sup>19</sup> They also ranked the worst in greenhouse gas emissions with up to 12.5 kg of CO<sub>2</sub> equivalent emitted per kg of battery. Yet, after a thousand cycles, Lithium ends up in the recycling sorting station awaiting an expensive extraction process or dumped in landfills.

#### From Life-Giver to Disposable

It is widely held that batteries helped transform modern media. Not only did its development facilitate the emergence of telegraphy, but also acted as a driving force for electrical telecommunications at the turn of the nineteenth century. In its meteoric history, the battery was both seen as a life-giver, an 'instrument of life' that infuses 'a spark' to Dr. Frankenstein's monster,<sup>20</sup> and also as a facilitator of death and destruction. It was a chemical catalyst for conveying messages through the wires, during war, during peace, under the sea through the Trans-Atlantic cables, harbinger of celebratory news, and a messenger of stock market crashes. But with the emergence of electrification, telegraphy moved away to the stable supply of direct current.<sup>21</sup> Batteries remained as messy chemical experiments, undependable, releasing poisonous fumes, hard to handle and refill.

Richard Maxwell and Toby Miller in *Greening the Media* note that sulfuric and nitric acid were used in each revision of battery technology in the nineteenth century.<sup>22</sup> The chemical reactions dissolved the zinc, copper, mercury and other elements, toxic gases such as nitric oxide were produced. "In addition to inhaling the

<sup>&</sup>lt;sup>17</sup> Jean-Marie Tarascon and Michel Armand, "Issues and Challenges Facing Rechargeable Lithium Batteries," *Nature* 414, no. 6861 (2001), 359.

<sup>&</sup>lt;sup>18</sup> See article "EU slaps €166 million fine on Sony, Sanyo, Panasonic battery units over price cartel," accessed March 13, 2018, http://www.japantimes.co.jp/news/2016/12/13/business/corporatebusiness/eu-slaps-e166-million-fine-sony-sanyo-panasonic-battery-units-pricecartel/#.WQxrK1KB2qA.

<sup>&</sup>lt;sup>19</sup> European Union, "Environmental Impacts of Batteries for Low Carbon Technologies Compared."

<sup>&</sup>lt;sup>20</sup> See Richard C. Sha, "Volta's Battery, Animal Electricity, and Frankenstein," *European Romantic Review* 23, no. 1 (2012): 21-41.

<sup>&</sup>lt;sup>21</sup> Except during the world wars, when telegraphic equipment and flashlights would depend on storage batteries. Larger 50-volt nickel-iron batteries would power electronics of the deadly German VI (the flying bomb) and V2 rockets.

<sup>&</sup>lt;sup>22</sup> Richard Maxwell and Toby Miller, *Greening the Media* (Oxford And New York: Oxford University Press, 2012), 53.

fumes, which could damage lung and mucous membranes, contact with the battery acids harmed the skin and caused deep lining of hands (palmar fissures) into which other workplace filth became lodged." These chemicals would continue to be present even in the dry cell batteries as paste. "Servicing these batteries involved either replacing worn lead plates and posts and cracked jars or removing any remaining oil or spent battery acid solution, which would have been dumped into a containment sump or directly into the ground. Workers were exposed to acids, acid vapor, and lead, and overflows from the sump entered the sewage system and waterways or soaked into the land under the buildings."<sup>23</sup>

Batteries kept causing unending and insurmountable problems.<sup>24</sup> With the onset of centralized electrification in the last decades of the nineteenth century that provided a large-scale stable source of electricity, the need for innovation in storage batteries declined. Edison would rather build more generators, engines and boilers to supply extra direct current than invest in clumsy and inefficient storage batteries.<sup>25</sup> Lighting system battery installations and battery-operated trolley cars also failed (due to rapid degeneration of battery plates added to the long-term costs), and as such a strong opposition (by the direct-current interests) dominated the electricity market. Additionally, commercial interests due to continuous patent litigation, small companies without capital to influence the evolution of the technology (vs Edison) slowed down battery development. The abundant supplies of cheap coal also drove down the cost of energy infrastructure and generation. This is how alternating current transmission also started displacing direct current and storage batteries used in power supply.26 Therefore, "the halting and distributed nature of the research, development, and production of advanced power sources could be considered a legacy of what Richard Schallenberg characterized as the inertia that gripped the field of electrochemistry in the wake of the disappearance of electric vehicles from U.S. public roads and of large-scale use of batteries in electric utility systems by the 1920s."27

<sup>&</sup>lt;sup>23</sup> Maxwell and Miller, *Greening the Media*, 53; John W. Snyder, "Historic Preservation and Hazardous Waste: A Legacy of the Industrial Past," *The Journal of Preservation Technology* 24, no. 1/2 (1992), 70.

<sup>&</sup>lt;sup>24</sup> Richard H. Schallenberg, "The Anomalous Storage Battery: An American Lag in Early Electrical Engineering," *Technology and Culture* 22, no. 4 (1981): 725-752.

<sup>&</sup>lt;sup>25</sup> According to Schallenberg (1982), during the 'battle of the systems' alternating current systems without batteries would eventually dominate direct current systems with batteries. See Richard H. Schallenberg, *Bottled Energy. Electrical Engineering and the Evolution of Chemical Energy Storage*, Philadelphia, PA: American Philosophical Society, 1982.

<sup>&</sup>lt;sup>26</sup> Hughes, Networks of Power, 461-465.

<sup>&</sup>lt;sup>27</sup> Eisler, "Exploding the Black Box," 370.

The slump in battery usage continued with the lack of proper control equipment, and the failure to develop maintenance and operation procedures. It pushed batteries towards other smaller applications where it was not feasible nor practical to draw power from the electrical grid, where the chemical reactions could be contained in smaller secure packets. Thus, batteries available as domestic sources of power led to the introduction of electric doorbells, burglar alarms, electric sewing machines, and incandescent lights, including the battery-powered flashlight.<sup>28</sup> While innovation in battery chemistry crawled through the war years, with a move toward miniaturization and portability, the battery got packaged into standardized sizes.<sup>29</sup> From glass jars to wooden containers to cardboard enclosures, driven by the economics of manufacturing and consumption, for the next sixty years the battery became disposable. Thus, "for much of the postwar era, most manufacturers of commercial batteries contented themselves with a handful of proven, prosaic, and profitable electrochemical couples (nickel-iron, carbon-zinc, lead-acid, and nickelcadmium)."30 By the time Eveready introduced the portable cylindrical alkaline batteries in 1959, the messy chemistry was sealed away from view, and obsolescence coded into the design.

#### **From Chemicals to Portables**

Lithium came to batteries via several unrelated scientific routes none of which were related to energy storage. Its applications ranged from medical treatment of gout to mania, to greases for aircraft engines, lithium soaps, to the production of nuclear weapons during the Cold War.<sup>37</sup> While the alkaline battery flooded the markets and homes, it was the need for a better chemistry that drove research to lithium. It took well over twenty years to commercial production. Meanwhile portable computing had emerged, that had to rely on the older generation of non-lithium batteries. Industry could not agree to common laptop batteries, and diverse battery solutions followed. Individual lithium-ion cells were grouped into packs, concealed into separate containers within laptops while lithium pouch cells made their way into mobile handsets, and later on to ultra-thin portables. Today, their narrow form

<sup>&</sup>lt;sup>28</sup> Ginsberg, "The Columbia Dry Cell Battery."

<sup>&</sup>lt;sup>29</sup> The National Institute of Standards and Technology formalized the alphabet nomenclature that is still used today in around 1917. See Isidor Buchmann, "A Look at Cell Formats and how to Build a good Battery."

<sup>&</sup>lt;sup>30</sup> Eisler, "Exploding the Black Box," 374.

<sup>&</sup>lt;sup>31</sup> Lithium was discovered in the early 1800's by a Swedish scientist Johan August Arfwedson in Petalite, a lithium bearing ore.

factor, flexibility and high energy density allows for slimmer devices. Yet the chemistry does not extend the battery lifetime beyond a thousand cycles despite all sorts of surface-level software tweaking. Fortunately, this disadvantage fits right into the industry's hopes of a short consumer upgrade cycle. After two to three years, the battery's chemicals are exhausted, and so does the life of the device.

Lithium is a highly reactive element (it can explode upon contact with water), as such a lot of energy can be stored in its atomic bonds. The advantage of using lithium was demonstrated already in the 1970s with the assembly of primary cells. According to Tarascon and Armand, "owing to their high capacity and variable discharge rate, they rapidly found applications as power sources for watches, calculators or for implantable medical devices."<sup>32</sup> However, it soon encountered irregular lithium growth as the metal got replated during each subsequent discharge–recharge cycle which led to explosion hazards. Thus, two separate development paths looking for alternatives took place: first, toward the cylindrical shape with liquid electrolyte and the second, toward a smaller dry paste-based lithium pouch. Both paths were delayed due to lack of suitable negative electrode materials, electrolytes and failures to meet safety standards. Performance and costs also hampered their progress. Thus, "battery technoscience languished for most of the twentieth century until the late 1980s and early 1990s."<sup>33</sup>

Meanwhile, portable computing had to rely on a variety of power alternatives, none of which were perfected. For example, nickel metal hydride batteries were the initial workhorse for early media devices such as computers and cell phones.<sup>34</sup> However, this "research and development of batteries [...] occurred at a great social and intellectual distance from research and development of consumer devices, especially mobile computers."<sup>35</sup> By late eighties, the vast majority of laptops relied exclusively on proprietary nickel-cadmium batteries, that usually lasted two to three hours. The *Mac Portable* even resorted to a lead-acid battery.<sup>36</sup> User frustration with short battery life led some manufacturers to design machines that could also operate with off-the-shelf alkaline cells.<sup>37</sup> Already, earlier, The *TRS-80 Model 100* laptop, introduced in 1983 used four alkaline batteries for up to 16-20 hours before

<sup>&</sup>lt;sup>32</sup> Tarascon and Armand, "Issues and Challenges Facing Rechargeable Lithium Batteries," 359-367.

<sup>&</sup>lt;sup>33</sup> Eisler, "Exploding the Black Box," 369.

<sup>&</sup>lt;sup>34</sup> M. Stanley Whittingham, "Materials Challenges Facing Electrical Energy Storage," *MRS Bulletin* 33, no. 4 (2008), 412.

<sup>&</sup>lt;sup>35</sup> Eisler, "Exploding the Black Box," 369.

<sup>&</sup>lt;sup>36</sup> LEM Staff, "Mac Portable," *Low End Mac*, 10 September 1989, accessed February 22, 2017, http://lowendmac.com/1989/mac-portable.

<sup>&</sup>lt;sup>37</sup> Krohn, Nico, "Portable PC Users want Cheaper Batteries: Laptop Vendors are Adapting their Designs," *Infoworld*, 17 December 1990., 21

they were discarded.<sup>38</sup> The *Poqet PC* was powered by two AA-size batteries that lasted anywhere between three to twelve hours. However, the majority of manufacturers could not agree to standardize laptop batteries and stuck to nickel cadmium and the nickel metal hydride batteries despite their high costs and low power storage.<sup>39</sup> These remained preferred in laptops manufactured throughout the late eighties to early nineties.

Sony Corporation in June 1991 commercialized the secondary Lithium-ion cell, "having a potential exceeding 3.6 V (three times that of alkaline systems) and gravimetric energy densities as high as 120–150 Whkg-1 (two to three times those of usual Ni-Cd batteries) found in most of today's high-performance portable electronic devices."40 This was also the result of sustained experimentation by Goodenough and Whittingham in the lithium-ion cobalt system and the intercalation method of lithium.41 These resulted in the now popularly known as '18650' cell, that actually follows the dimensions (18 x 65 mm) of the cylindrical packaging. Soon, 18650s were bundled into battery packs, with battery management systems. Toshiba T3400CT was the first ultraportable to have a Lithium-ion battery pack. Individual lithium-ion cells were grouped into packs (the metals are themselves folded and rolled within), concealed into separate containers within laptops while lithium pouch cells made their way into mobile handsets. By late 1999, the drive toward slimmer systems pushed portables toward the second development path of the rectangular lithium-polymer pouch cell.<sup>42</sup> This thin film battery type due to its versatility, flexibility and lightness has driven the continuing trend towards slimness and miniaturization of media devices.43 In today's ultra-slim notebooks, these pouches can be easily jammed into small spaces (like in the MacBook Air) and spread across the insides of a laptop.

<sup>&</sup>lt;sup>38</sup> Kdulcimer, "Old Computers," *PCLinuxOSMagazine*, accessed February 22, 2017, http://pclosmag.com/html/Issues/200610/page04.html.

<sup>&</sup>lt;sup>39</sup> According to Eisler, "the notebook computer battery crisis emerged at a time when electronics engineers were struggling to understand the implications of microprocessor scaling (miniaturization) on the operation of mobile computing systems, especially power demand." Eisler, "Exploding the Black Box," 370.

<sup>&</sup>lt;sup>40</sup> Tarascon and Armand, "Issues and Challenges Facing Rechargeable Lithium Batteries," 359. WhKg = Watt Hour per Kilogram.

<sup>&</sup>lt;sup>41</sup> Charles J. Scuilla, "The Commercialization of Lithium Battery Technology." *Proceedings of Battcon*, 16 (2007): 1-9.

<sup>&</sup>lt;sup>42</sup> Lithium polymer electrolyte (LPE) battery also called plastic Li-ion (PLiON).

<sup>&</sup>lt;sup>43</sup> The precedent for this can be found in the 6-volt *Polapulse* battery in Polaroid cameras that consisted of four wafer-thin *Leclanche* cells. See Lateral Science:

http://lateralscience.blogspot.de/2015/02/the-polapulse-battery.html

While Lithium-ion batteries disappeared into battery packs, "manufacturers tended to undersize battery cavities for the expected performance or otherwise mismatched them with power source form factors."44 Faster processors were introduced, "that generated more heat and required more power and battery designers increased energy density by thinning separators to make room for more reactive material, creating thermal management problems and narrowed margins of safety."45 Then, to solve these issues, Battery Management Systems (BMS) came into being, as a way to monitor each and individual battery within a set.<sup>46</sup> Consisting of hardware and software, the BMS is the only way one can keep in check rogue cells and ensure there are no thermal runaways. This is stark reminder that every individual lithium-ion battery is unique in terms of content and chemistry. Even in the case of pouch formats, the chemical compositions vary from plate to plate from paste to paste, always adding a degree of uncertainty to the perceived performance of the battery. Interface-level fixes can hardly address the deep chemical issues within a Lithium-ion battery. In the case of smartphones, a plethora of energy saving applications exist. These throttle applications that run in the background, reducing the power needs, but do not directly address issues within the battery. In this way the battery inside a smartphone or laptop is usually out of reach both at the software and hardware levels. Thus, the consumer has merely the illusion of being in control of the battery and energy needs of her media device.

#### The Stained Earth

"It is the earth that provides for media and enables it," Jussi Parikka writes in *Geology of Media*, "the minerals, materials of(f) the ground, the affordances of its geophysical reality that make technical media happen."<sup>47</sup> Elements such as Lithium dug out of the earth today form the energetic backbone of handheld and portable media, including over a billion smart phones. Not only Lithium, but also the supporting minerals of the energy industry such as Cobalt, Nickel, Manganese or Graphite are all extracted at a considerable price to the environment. This

<sup>&</sup>lt;sup>44</sup> Eisler, "Exploding the Black Box," 379; Ralph J. Brodd, Factors Affecting US Production Decisions: Why Are There No Volume Lithium-Ion Battery Manufacturers in the United States? Gaithersburg, MD: National Institute of Standards and Technology, 2005: 24-29.

<sup>&</sup>lt;sup>45</sup> Eisler, "Exploding the Black Box," 379; Michael, Kanellos, "Can Anything Tame the Battery Flames?" CNET News, 15 August 2006, accessed February 5, 2017, http://news.cnet.com/Can-anything-tamethe-bat- tery-flames/2100-11398\_3-6105924.html.

<sup>&</sup>lt;sup>46</sup> Usually six to nine batteries fit into a laptop battery pack in various combinations to provide 19 volts.

<sup>&</sup>lt;sup>47</sup> Jussi Parikka, A Geology of Media. Minneapolis: University of Minnesota Press, 2015. Kindle Edition.

extraction is energy-intensive, not to mention the billions of gallons of precious water used in the refinement processes. The manufacturing processes of both Lithium and Cobalt present huge environmental and health hazards. Recycling technologies are yet to catch up. Recycling batteries, especially re-extracting the prized minerals remain a vexing problem. Although, lithium-ion batteries have the largest impact on metal depletion, its recycling remains complicated.<sup>48</sup>

Due to its highly reactive nature, Lithium does not freely exist on earth. It is a rare element, rarer than Cobalt, Neodymium and Nickel, metals linked with electric mobility,<sup>49</sup> and as such only occurs in pegmatites and brine deposits in low concentrations. With the demand rising for lithium-ion batteries, attention has thus shifted to brine extraction in Chile, Argentina and Bolivia. The Lithium triangle between these nations is the center of world's lithium extraction.<sup>50</sup> Lithium is also mined in Australia and China but extracted from rock. In the *Salar de Altacama* desert, brine is pumped out from under the desert and then evaporated in artificial pools that stretch for hundreds of kilometers.<sup>51</sup> The concentrated brine is then transported to processing plants in coastal Chile, where they are refined into powder. The powder finally is shipped to the various battery manufacturers based around the globe.

The mining of Lithium consumes large amounts of water, almost 65 percent of water resources and is energy-intensive.<sup>52</sup> The electric energy consumption of producing a ton of Lithium Carbonate is 1.8 mmbtu (British Thermal Unit), and this resource comes from over 60 percent fossil fuels.<sup>53</sup> Only 40 percent of the Lithium

<sup>&</sup>lt;sup>48</sup> European Union, "Environmental Impacts of Batteries for Low Carbon Technologies Compared."

<sup>&</sup>lt;sup>49</sup> Saskia Ziemann, Marcel Weil, and Liselotte Schebek, "Tracing the Fate of lithium——The Development of a Material Flow Model," *Resources, Conservation and Recycling* 63 (2012): 26-34.

 <sup>&</sup>lt;sup>50</sup> Henry Sanderson, "Lithium: Chile's Buried Treasure," *The Financial Times*, July 8, 2016, accessed February 7, 2017, https://www.ft.com/content/cde8f984-43c7-11e6-b22f-79eb4891c97d.

<sup>&</sup>lt;sup>51</sup> According to the Credit Suisse Global Equity and Credit Research team, lithium carbonate demand will rise from about 200 kilotons (kt) today to over 500 kt in 2025. Global storage capacity currently stands at about 250 MW and is expected to grow to 14,000 MW by 2023. Given the rapid rise in battery demand, a shortage in the supply for lithium, graphite and cobalt is expected. We can imagine that by another decade the *Salar* would become one mega supra-national extraction zone. Available at: https://www.credit-suisse.com/articles/news-and-expertise/2016/11/en/beneficiaries-of-the-electric-vehicle-boom.html

<sup>&</sup>lt;sup>52</sup> Sean Cubitt, Finite Media: Environmental Implications of Digital Technology. Durham, NC: Duke University Press, 2016; William Tahil, "The Trouble with Lithium." Implications of Future PHEV Production for Lithium Demand. Martainville: Meridian International Research, 2007.

<sup>&</sup>lt;sup>53</sup> Dunn et al., "Material and Energy Flows in the Materials Production, Assembly, and End-of-Life Stages of the Automotive Lithium-Ion Battery Life Cycle," Argonne National Laboratory, U. S. Department of Energy, accessed March 20, 2017, http:// www.osti.gov/scitech/servlets/purl/1177517.

resource is recovered, and the rest is re-injected back into the *Salar*. Cubitt discusses how this has led to "angry disputes with local communities whose wells run dry, and whose crops are afflicted by runoff from the ponds of saline solution..."<sup>54</sup> Not only water contamination, but also depletion results in less water available for local flora and fauna. Toxic chemicals are used for leaching purposes that require waste treatment amid improper handling and spills. Cubitt says there are already:

...signs that the two southern lakes of the lithium triangle are heading for depletion at the accelerated demand driven by the new desire for batteries. The possible function of solar reflection of the desert, the dispensing of vast quantities of chlorine, and the massive amounts of corrosive salt water that seeps into the surrounding landscape has yet to be scientifically investigated. Mining has driven off a local species of Flamingos that has led to an increase of cyanobacteria that is lethal to humans, plants and animals. The abuse of water management has also increased the environmental risks of PCBs from polyethylene used in the drying tanks. <sup>55</sup>

Meanwhile, Cobalt the other primary element of the Lithium-ion battery has seen demand tripled in the last five years and is projected to double by 2020. Cobalt mining in Congo supplies over 60 percent of the world's cobalt supplies.

Here, "the world's soaring demand for cobalt is at times met by workers, including children, who labor in harsh and dangerous conditions... What is so called 'artisanal mining', an estimated 100,000 cobalt miners in Congo use hand tools to dig hundreds of feet underground with little oversight and few safety measures... Deaths and injuries are common. And the mining activity exposes local communities to levels of toxic metals that appear to be linked to ailments that include breathing problems and birth defects..." <sup>56</sup>

These mines have also affected the health of the local population through the pollution of surface water, and concentrations of cobalt remain high in the local community. A large percentage of this artisanally-mined Cobalt goes into the Lithium-ion battery for smartphones, 20 percent in the case of Apple's iPhones. The refined Cobalt in the lithium-ion battery can be as much as 5 - 10 grams in a

<sup>&</sup>lt;sup>54</sup> Cubitt, *Finite Media*, 63-150; Albrecht Bodo, "How "Green" is Lithium?" accessed March 22, 2017, http://www.kitco.com/ind/Albrecht/2014-12-16-How-Green-is- Lithium.html.

<sup>&</sup>lt;sup>55</sup> Cubitt, *Finite Media*, 63-150; Thomas Cherico Wanger, "The Lithium Future—resources, Recycling, and the Environment." *Conservation Letters* 4, no. 3 (2011): 202-206.

<sup>&</sup>lt;sup>56</sup> Frankel, "The Cobalt Pipeline."

smartphone, 28 grams in a laptop and up to 15 000 grams in an electric car.<sup>57</sup> According to a US EPA Report of 2013, batteries that use nickel and cobalt cathodes and solvent-based electrode processing demonstrate a high potential for environmental and human health impacts. The environmental impacts include resource depletion, global warming, and ecological toxicity those that primarily result from the production, processing and use of cobalt and nickel metal compounds. These can cause adverse respiratory, pulmonary and neurological effects in those exposed.

What happens to all the minerals that go into a Lithium battery, once the battery dies? Usually, smartphone and laptop manufacturers such as Apple pass the buck to recycling third-party vendors or to local authorities' recycling programs. According to Valenzuela and Böhm, they demonstrate 'zero-waste' optimization strategies, by saying that their laptop batteries last up to five years on one hand, that supposedly saves on buying new batteries, producing less waste, but on the other hand allowing these devices to go obsolete by the death of the battery.<sup>58</sup> Beyond the recycling page of Apple's website, one stumbles into a confusing dark abyss of vendor offers, municipal laws, and government regulations. The manufacturer washes its hands off. Thus, the recovery rate of lithium-ion batteries, even in first world countries, is in the single digit percent range,<sup>59</sup> and more so since lithium content in each individual battery is around only two percent which makes recovery economically inefficient.

Existing recycling processes for spent portable rechargeable batteries from consumer products currently concentrate on valuable cathode materials, such as cobalt and nickel, and do not focus on lithium recovery.<sup>60</sup> Technologies of recycling lithium back to battery production still remains undeveloped. The only possible recycling done converts battery waste into slags that are used in making concrete, or as most re-enter the environment through landfills. Thus, battery waste is considerable, amounting to millions of tons a year, since only a fraction gets recycled. When the battery dies, much of media also die and end up on the shores of Ghana. Rechargeable battery waste clocks in at fourteen thousand tons in the United States alone. The recycling of dead batteries by corporations are at best meant to maintain a superficial image of the so-called circular economy rather than any commitment to environment and humanity.

<sup>&</sup>lt;sup>57</sup> Ibid.

<sup>&</sup>lt;sup>58</sup> Valenzuela, Francisco, and Steffen Böhm. "Against Wasted Politics: A Critique of the Circular Economy." Ephemera: Theory & Politics in Organization 17, no. 1 (2017): 23-60.

<sup>&</sup>lt;sup>59</sup> Bodo, "How "Green" is Lithium?"

<sup>&</sup>lt;sup>60</sup> Ziemann, Weil, and Schebek, "Tracing the Fate of Lithium, 26-34

## Repurposing Obsolescence through Energy Art: The Community Power Bank

Despite Planned Obsolescence and the apparent indifference of manufacturers, the amateur recycling and repurposing of laptop and smartphone lithium batteries is widespread. From powering e-bikes to solar power storage to fake Tesla Powerwalls, there exist a considerable amount of experimentation with building energy storage systems from recovered Lithium cells. These can be found from online DIY communities with detailed instructional videos on websites and streaming services. These practices draw their energies from home-made tools, networked communities, off-the-shelf parts and dumpster diving of obsolete media. However, these remain in the realm of amateur makers, hackers and DIY enthusiasts. Attempts to bring these practices to a wider audience have precipitated litigation by the major media companies for patent violations and safety. For one, it can be extremely complex and hazardous to open up Lithium battery packs without professional guidance and tools. Even more complicated is assembling a new battery pack from recycled batteries without the necessary technical knowhow and permissions. But, once these issues are addressed, it could open up recycling practices to the general public. To tinker with blackboxed technologies such as Lithium batteries is not only a provocation against consumer practices and technology companies but also carries the potential to lead to new knowledge and understandings of media and the environment.

In 2016, in collaboration with Pixelache, I initiated an energy art project 'Community Power Bank' (CPB) to develop portable power storage systems based on discarded Lithium batteries.<sup>61</sup> The aim was to build a community 'power bank' by recycling Lithium batteries, building portable battery packs, DIY power generators and networking them into a community micro-grid. In various DIY workshops participants were guided to safely dismantle batteries, test, identify and recover functional cells. They learned how to design various cell arrangements to create variable voltage power banks used for charging media devices and other USB charged technologies. Through hands-on DIY workshops and then by deployment, the project aimed to create a dialogue about e-waste and environmental concerns among community participants. Within the peer-group, individuals recycled and worked together in the co-creation of the power bank. This included both co-constructing and understanding of methodologies to build open battery systems. These workshops aimed to foster a community discussion around recycling Lithium

<sup>&</sup>lt;sup>61</sup> Open Knowledge Finland. OSCE Days 2016, https://fi.okfn.org/2016/06/30/osce-days-2016-helsinkireport/

batteries, towards a DIY energy network while at the same time teaching applicable skills and enabling an alternative power grid.



Fig. 2. *Left*, dismantling of discarded laptop battery packs during a Community Power Bank workshop at the Museum of Photography Helsinki; *right*, testing of individual Lithium-Ion batteries for voltage. Photo Credits: Justin Tyler Tate.

The workshops held at the Museum of Photography and at the Open Source Circular Economy (OSCE) Days in Helsinki,<sup>62</sup> literally involved the physical breaking of the black box of discarded Lithium laptop battery packs. The workshops were conducted in three parts with three groups of community participants. The first group were instructed to break open the PVC housing enclosure of the packs using pliers and screwdrivers. The second group were guided to extricate the associated components (circuit board, wires, solders) and separate them into two parts: batteries and components. It was the third group that was then instructed to co-construct new power banks. Previously the project went on 'e-waste expeditions' to search and recover laptop battery packs from waste containers, dumpsters and shops with battery recycling bins. It also sought out technology companies in the region that discarded old laptops along with the battery packs. From these expeditions, the project was able to gather a significant amount of discarded lithium

<sup>&</sup>lt;sup>62</sup> Open Knowledge Finland. "OSCE Days 2016."

packs, none of which promised to contain functioning recoverable 18650 lithium cells. The only way to know was to break them open.

Dismantling Lithium battery packs is not only an unknown area of expertise but also a hazardous task. A punctured 18650 can be extremely volatile. The CPB project created its own procedure for dismantling battery packs (since there are no certified instruction manuals) from experimenting. For the workshops, tools such as screwdrivers, pliers, soldering iron, hot glue guns, knives and assorted small tools were used. A fire extinguisher was placed nearby along with sand and thermal blankets. The battery packs are solidly glued along the edges with no visible metal screws. The only way in is to insert the flat edge of a Phillips screwdriver and then struggle to open a gap. Along the same crack, another screwdriver is inserted to enlarge the gap, and so on, until the gap becomes big enough and the enclosure cracks open. As a precaution it is wise not to insert the screwdriver too deep or too fast into the battery pack or else such action might puncture a cell causing fire or even an explosion. Once the enclosure has come off, the battery management circuit board and connecting wires can be pulled off and the 18650s can be safely separated from their locations. Normally a laptop pack would contain up to nine lithium-ion cells, and after power testing half of them would have to be permanently discarded. Nearly 50% of all Lithium batteries recovered during the CPB project had to abandoned due to lack of sufficient voltage.



Fig. 3. *Left*, soldering of circuit for a power bank during a battery workshop; *right*, a power bank constructed during a workshop. Photo Credits: Justin Tyler Tate.

Artistic repurposing of the lithium batteries from their original home in a laptop pack to a mini power bank was the final step of the CPB project. From the brute force of cracking open the black box of a laptop pack, the next step of fighting obsolescence is delicate and precise soldering of circuits. The third group of participants of the CPB were guided to co-construct such mini power banks, and that included arranging components based on a circuit diagram, soldering them to each other and finally placing them all into an enclosure. A power bank module consists of a Lithium-ion battery, off-the-shelf purchased protection circuit boards, micro-USB and/or a USB sockets, switches all soldered and placed within an enclosure. Typically, a single Lithium-ion cell with 3.7 Volts and around 2200 mAh (milli-Ampere-hour) is enough to recharge a mobile phone at 0% charge to full capacity. The outcome is not necessarily an aesthetically placing looking device, but one that is functional, and more so, a result of community participation.<sup>63</sup>

#### Media Archaeology as an Energy Art Practice

Artistic repurposing could be considered similar to the media archaeological approach of reverse-engineering. For Wolfgang Ernst, such a media archaeology starts from examining a media assemblage, an operational device. It then reverse-engineers the assemblage to extract the epistemological learnings from the nature of the physical media, its processes and durations. His way of approaching objects is "as an amateur engineer who opens, checks physically, tests, and experiments to learn how media function." This methodology according to Ernst is non-discursive and based on precise case studies.<sup>64</sup> This is also an approach undertaken by artists, especially "many media archaeological artists, such as DeMarinis, Gebhard Sengmüller and a more recent wave of young artists such as *Institute for Algorhythmics* who are interested in concrete sonic archaeologies of contemporary media."<sup>65</sup>

In *Zombie Media*, Hertz and Parikka, argue that media archaeology has presented itself as "a methodology of lost ideas, unusual machines and re-emerging desires and discourses searching for elements that set it apart from mainstream technological excitement and hype, but not always connecting such ideas to political

<sup>&</sup>lt;sup>63</sup> The Community Power Bank project in 2018 continued with lectures and workshops at various venues including the University of the Arts, Pixelache BioSignals project and other local arts venues. In these events, the methodology applied followed from previously documented workshops in the dismantling of batteries combined with reflection on energy, e-waste and environment, and the co-construction of power banks. See Pixelache BioSignals event "The Battery is the Message": https://www.pixelache.ac/events/biosignals-samir-bhowmik-the-battery-is-the-message.

<sup>&</sup>lt;sup>64</sup> See Wolfgang Ernst, *Digital Memory and the Archive*, edited by Jussi Parikka (Minneapolis, London: University of Minnesota Press, 2013).

<sup>&</sup>lt;sup>65</sup> Hertz and Parikka, "Zombie Media," 427.

economy or ecology."<sup>66</sup> They call for a stronger articulation of media archaeology as an art methodology, that addresses not only the past, but also discarded electronic waste. Parikka has also urged "to catalyze the media archaeological interest of knowledge into a critique of the present" and, "to push communication and media studies out from its sole focus on media to the world of chemicals, materials and energy consumption."<sup>67</sup>

Hertz and Parikka consider Circuit Bending as a media archaeological art method that challenges contemporary socio-technological issues such as Planned Obsolescence, the blackboxing of technology and the interior inaccessibility of everyday consumer products:

Circuit bending is an electronic DIY movement undertaken by individuals without formal training or approval and focused on manipulating circuits and changing the taken-for-granted function of the technology. The manipulator of consumer electronics often traverses through the hidden content inside of a technological system for the joy of entering its concealed underlayer, often breaking apart and reverse-engineering the device without formal expertise, manuals or defined endpoint.<sup>68</sup>

While the process of salvaging Lithium-ion cells and reconstructing power banks involves reverse-engineering, it does not occur within the confines of the original device. So, unlike Hertz and Parikka's Circuit Bending, that involves "manipulating circuits and changing the taken-for-granted function of the technology," opening up an obsolete laptop battery pack emptying its contents to build a new power bank, albeit smaller in power, is a separate methodology in its own right. I consider this as artistic tinkering, as a hands-on approach, to understanding the political economy of Lithium batteries. Similar to the manipulator of consumer electronics, the battery artist, recycler and re-purposer

<sup>&</sup>lt;sup>66</sup> Media archaeology has been known to be focused on the documentation of obsolete and dead media technologies. But more so for "excavating repressed, forgotten or past media technologies in order to understand the contemporary technological audio-visual culture in alternative ways." See Hertz and Parikka, "Zombie Media," 427.

<sup>&</sup>lt;sup>67</sup> Jussi Parikka, "So-Called Nature: Friedrich Kittler and Ecological Media Materialism," in Sustainable Media: Critical Approaches to Media and Environment, ed. by Nicole Starosielski and Janet Walker (London: Routledge, 2016), 199.

<sup>&</sup>lt;sup>68</sup> Hertz and Parikka, "Zombie Media," 426. "Circuit bending" is the creative short-circuiting of consumer electronics primarily for the purpose of generating novel sound or visual output. See Reed Ghazala, "The Folk Music of Chance Electronics, Circuit-Bending the Modern Coconut," (*Leonardo Music Journal* 14, 2004): 96–104.

also "traverses through the hidden content inside of a technological system." Unlike Circuit Bending, the repurposing involves acts of salvaging parts and components for reuse in a different medium. But it is similar to Circuit bending as a way to— "reappropriate, customize and manipulate consumer products in unexpected ways, even when the inner workings of devices are intentionally engineered as an expert territory."<sup>69</sup> As an artistic methodology, Hertz and Parikka elaborate:

...bending media archaeology into an artistic methodology can be seen as a way to tap into the ecosophic potential of such practices as circuit bending, hardware hacking and other ways of reusing and reintroducing dead media into a new cycle of life for such objects. <sup>70</sup>

Building on Hertz and Parikka's ideas, I propose media archaeology also as an energy art practice, as an artistic methodology to study energy ecologies of media, to resist technological obsolescence, and study its effects on the environment. I also draw inspiration from several other artists whose works could not be claimed as media archaeological but are significant in exploring the energetic materialities of media. These examples of art negotiating energy use and consumption, and reverseengineering media can be found in the works of Jim Campbell's *Portrait Of Rebecca With Power Line Fluctuations* (1992) where fluctuations of the power line become visible through an interaction between a portrait and a light bulb on a TV screen.<sup>71</sup> Or, in the work of Sam Lewitt's *More Heat than Light* (2016) at the *Kunsthalle* Basel that draws energy and data from a cultural institution's infrastructure, and reroutes electrical current used for lighting to create heat thus disrupting one of the exhibition space's primary operations.<sup>72</sup>

Other related examples include Jamie Allen and David Guthrie's *Critical Infrastructure* (2013) that investigates the material basis of media technics;<sup>73</sup> and Timo Arnall's *Internet Machine* (2014) a multi-screen film that documents the invisible infrastructures of the Internet that in a sense exposes the energetic underpinnings of the World Wide Web.<sup>74</sup> Of particular interest is Anthony Dunne's *Hertzian Tales*, a conceptual and artistic work that investigates the cultural role and aesthetics of the

<sup>&</sup>lt;sup>69</sup> Hertz and Parikka, "Zombie Media," 426.

<sup>&</sup>lt;sup>70</sup> Hertz and Parikka, "Zombie Media," 429.

<sup>&</sup>lt;sup>71</sup> See Jim Campbell, Portrait Of Rebecca With Power Line Fluctuations, 1992. Jim Campbell: Portfolio: Public Art & Commissions, 1992.

http://www.jimcampbell.tv/portfolio/objects/portrait\_of\_rebecca/.

<sup>&</sup>lt;sup>72</sup> See Sam Lewitt More Heat than Light, Kunsthalle Basel, Exhibitions 2016. https://www.kunsthallebasel.ch/en/exhibition/more-heat-than-light/

<sup>&</sup>lt;sup>73</sup> See Transmediale 2013 Residency projects: https://transmediale.de/resource/residency-project.

<sup>&</sup>lt;sup>74</sup> See Timo Arnall Internet Machine, http://www.elasticspace.com/2014/05/internet-machine.

use of machines and energy, exploring an abstract space between art and design as provocation and ambiguity, questioning media technologies and their aesthetic potential.<sup>75</sup> Dunne's electrosphere, a dreamy Hertzian space made of invisible and hidden electromagnetic fields is where the message of the object awaits to be discovered. My previous artistic work *Light is History* (2012) is also a model example of energy art that gathers community participants, their energy consumption and domestic energy artifacts in a public installation.<sup>76</sup> It recycles and repurposes old electric meters into vitrines and bright therapy lamps powered by the community's energy savings. Following similar methodologies of recycling and repurposing, the Community Power Bank project aimed to provoke discussions of energy and environment. Here, with the experimentation with Lithium batteries, I contend that the political economy of energy in media can be tackled by artistic methodologies of reuse.

To reiterate, energy in its multiple scales of generation, supply and consumption, its deep connections to media that have not been studied deserve a prolonged and sustained research. Through the media archaeological lens these are contemporary issues in dire need to be excavated and analyzed. The common perception that energy as unrelated field to media and communications studies needs a re-evaluation. While information may not be matter nor energy, as Wiener famously proclaimed, digital manipulation of information does have thermodynamic costs.<sup>77</sup> This cost is reflected in the economies of the battery, energy generation and supply. Chemicals, metals and minerals that form the energetic backbone of communications, that are increasingly and dangerously depleting the earth are a media archaeological problem.

Thus, as I have demonstrated, media archaeology as an energy art method could excavate media and its infrastructures to uncover their energetic ecologies, further opening them up for artistic examination through the lens of energy and environment. As an approach it will allow conversation about the political economy of contemporary black boxed media technologies as linked to Planned Obsolescence,

<sup>&</sup>lt;sup>75</sup> See Anthony Dunne, "Hertzian Tales: Electronic products, aesthetic experience, and critical design," (The MIT Press, 2008).

<sup>&</sup>lt;sup>76</sup> Samir Bhowmik, Karthikeya Acharya and Lily Diaz, "Light is History: A Community Participated Museum Installation in Helsinki." *The International Journal of the Inclusive Museum* 6, no. 1 (2013) 145 -157.

 <sup>&</sup>lt;sup>77</sup> Wiener says: "Information is information, not matter nor energy." See Norbert Wiener, *Cybernetics* or Control and Communication in the Animal and the Machine (Cambridge, MA: MIT Press, 1985 [1948]), 132; Parrondo, Juan MR, Jordan M. Horowitz, and Takahiro Sagawa. "Thermodynamics of information," *Nature physics* 11, no. 2 (2015): 131-139.

it's supporting infrastructure and the related issues of energy, resource depletion and environmental impact.

As Parikka says, "the effects of media's materiality as chemistry and as toxicity are evident in considering what [is] necessary to sustain [...] immaterial communication."78 From Leyden jars to the Lithium battery, rare minerals and 'wet' chemicals that constitute the battery are what drive and support new media technologies even today. Battery innovation at the turn of the twentieth century transformed modern media technologies and even held the promise of a batterydriven power grid. But market-driven energy trade, cheap coal-driven power generation and scales of electrification did not allow such a trajectory. This made batteries become secondary, as backups and as disposables. Innovation was relegated to the background. Poisonous chemistries dominated energy storage. The emergence of portable computing finally put volatile batteries into the mix of new media technologies. Even then, they have commanded little attention since being bundled into the hardware, except when recharging or expensive replacement. Today, a critical component that powers contemporary digital culture, batteries are still ruled by Planned Obsolescence. And, when media devices become obsolete, sometimes as a direct consequence of expired chemicals, they end up on the shores of a poor nation, or they end up in vast poisonous landfills. This undesirable flow of energy and matter into waste has a direct impact on our ecosystems and climate. And, the messiness of battery chemicals, their unethical mining, extraction and their unpredictability remain hidden glued inside our portable media devices.

<sup>&</sup>lt;sup>78</sup> Parikka, A Geology of Media, loc: 1883; see also Jussi Parikka, ""Dust and Exhaustion," The Labour of Media Materialism," CTheory, September 3, 2013.

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