Submission for Special Rapporteur's thematic report on detoxification/decarbonization

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The waste management sector has seen the promotion and implementation of highly problematic industrial waste disposal technologies on the grounds of reducing GHG emissions and toxic impacts from landfills. These technologies are promoted by waste management companies as climate-friendly, greenwashing its climate impacts in a variety of contexts, both in the public and private contexts to pursue its economic interests.

The key technologies with toxic impacts yet being promoted as climate solutions in our field of work are: waste-to-energy incineration (including carbon capture and storage - CCS), landfill gas capture, plastic-to-fuels, and EV batteries.

The alternative to polluting waste disposals are zero waste systems, which are versatile strategies that aim to continually reduce waste through source reduction, separate collection, composting, and recycling. Over 550 municipalities around the world are already implementing zero waste solutions, in a wide range of economic, social, climatic, and legal contexts. Furthemore, these systems are cost-effective to implement and produce fast results.

GAIA has recently produced a comprehensive report with the most updated data to date of how better waste management is critical to the climate fight, while building resilience, reducing toxic pollution, creating jobs, and promoting thriving local economies. Essentially, zero waste solutions provide a decarbonisation strategy for the waste sector that also contributes to a detoxification. GAIA's report modeled potential emissions reductions from eight cities around the world. They found that on average, these cities could cut waste sector emissions by almost 84% by introducing zero waste policies, with some, such as São Paulo and Detroit, able to reach net-negative emissions by 2030. The report is available here.

1. Waste-to-energy incineration

Solid waste incineration with energy recovery is often presented as a 'quick-fix' solution to reduce rapidly growing waste volumes while producing energy, especially for cities in the Global South. Africa is seeing the increasing emergence of Waste-To-Energy (WTE) incineration

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projects[1] with public support from the UN,[2] even though its own report outlined that waste incineration is especially unfeasible for low and middle income countries like those in Africa, due to its cost-prohibitive nature and unsuitable waste composition.[3] As stated in the report: "WtE technologies are…typically both a more expensive way of managing waste and a more expensive way of producing energy." A similar concerning trend has been observed in Asia Pacific.[4] Indeed, incineration is the most expensive waste management strategy and a major source of GHG and toxic emissions.[5] Even with emission savings from electricity generation taken into account, each tonne of plastic burned at that incinerator would result in the release of around 1.43 tonnes of CO_2.[6] Its high capital costs and required technical expertise create a risk of locking cities into undesirable practices for decades.[7] Incinerators have performed best in cities where the waste heat can be used in a district heating network (typically in Northern Europe); otherwise, the electricity produced is more carbon intensive than the electric grid, implying that it will displace lower-emitting forms of electricity.[8] In developing countries, incineration is not practical due to high moisture content and low calorific value (heating value) of the municipal waste stream.[9]

Nevertheless, many studies continue to tout incineration as a climate mitigation measure because it avoids landfill gas emissions and produces energy, often mislabelled as renewable energy (RE). These studies rely on worst-case comparisons in order to conclude that incineration is superior. In particular, they usually assume that unseparated municipal waste, with high organic content, will be sent to landfill without significant methane remediation

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[1] Gergel, Igor. 2021. "Waste to Energy in Africa: New Trends." Waste To Energy International. December 29, 2021. https://wteinternational.com/news/waste-to-energy-in-africa-new-trends

[2] "Ethiopia's Waste-to-Energy Plant Is a First in Africa." 2017. UNEP. November 24, 2017. http://www.unep.org/news-and-stories/story/ethiopias-waste-energy-plant-first-africa

[3] United Nations Environment Programme. 2010. "Waste and Climate Change - Global Trends and Strategy Framework." https://wedocs.unep.org/xmlui/handle/20.500.11822/8648.

[4] Wachpanich, Nicha, and Nithin Coca. 2022. "As Waste-to-Energy Incinerators Spread in Southeast Asia, so Do Concerns." Mongabay Environmental News. December 8, 2022. https://news.mongabay.com/2022/12/as-waste-to-energy-incinerators-spread-in-southeast-asia-so-do-concerns

[5] Moon, Doun. 2021. "The High Cost of Waste Incineration." Global Alliance for Incinerator Alternatives. https://zerowasteworld.org/beyondrecovery.

[6] United Kingdom Without Incineration Network. 2018. "Evaluation of the climate change impacts of waste incineration in the United Kingdom".

[7] Corvellec, Hervé, María José Zapata Campos, and Patrik Zapata. 2013. "Infrastructures, Lock-in, and Sustainable Urban Development: The Case of Waste Incineration in the Göteborg Metropolitan Area." Journal of Cleaner Production, Special Issue: Advancing sustainable urban transformation, 50 (July): 32–39. https://doi.org/10.1016/j.jclepro.2012.12.009; Hoornweg, Daniel, and Perinaz Bhada-Tata. 2012. What a Waste: A Global Review of Solid Waste Management. Urban Development Series. Washington, DC, USA: World Bank Group.

[8] Hogg, Dominic, and Ann Ballinger. 2015. "The Potential Contribution of Waste Management to a Low Carbon Economy." Eunomia. https://www.eunomia.co.uk/reports-tools/the-potential-contribution-of-waste-management-to-a-low-carbon-economy; Smith, Alison, Keith Brown, Steve Ogilvie, Kathryn Rushton, and Judith Bates. 2001. Waste Management Options and Climate Change. European Commission DG Environment; Vähk, Janek. 2019. "The Impact of Waste-to-Energy Incineration on Climate." Policy Briefing. Zero Waste Europe. https://zerowasteeurope.eu/library/the-impact-of-waste-to-energy-incineration-on-climate.

[9] Barton, J. R., I. Issaias, and E. I. Stentiford. 2008. "Carbon – Making the Right Choice for Waste Management in Developing Countries." Waste Management, OECD Workshop - Soils and Waste Management: A Challenge to Climate Change, 28 (4): 690–98. https://doi.org/10.1016/j.wasman.2007.09.033; Hoornweg, Daniel, and Perinaz Bhada-Tata. 2012. What a Waste: A Global Review of Solid Waste Management. Urban Development Series. Washington, DC, USA: World Bank Group.

measures. Moreover, the idea that WTE incineration produces renewable energy allows this industry to access the renewable energy and climate finance markets.[10], Given that incineration is the most expensive waste management approach,[11] its reliance on renewable energy subsidies and climate finance is key to its financial feasibility.[12] In the EU, RE subsidies have been supporting incineration for years, although the trend is changing. Having established ambitious targets such as achieving carbon neutrality by 2050, the European financial institutions are now choosing to support alternatives that are less carbon-intensive and are higher in the waste hierarchy, excluding Waste-To-Energy incineration from their sustainability agenda.[13]

The incineration industry also tries to secure climate finance via the carbon markets (Clean Development Mechanism, part of the Kyoto Protocol, UNFCCC)[14] and other climate finance channels. The latest report on climate finance for methane reduction stated that ⅔ of climate finance dedicated to this purpose had gone to the waste sector (USD 5.7 billlon) and within the waste sector, the money had mostly gone to WTE incineration (USD 4.6 billlon), not necessarily for the purpose of abating methane but rather for the creation of energy.[15] The same report stated: "While they offer a methane-free alternative to landfilling, incinerators also generate significant CO2 emissions and can lead to air pollution concerns if not properly operated (Mutz et al., 2017)."

In response to climate concerns of waste incinerators, Carbon Capture and Storage (CCS) has been considered to complement an incinerator facility. In Europe, the Innovation Fund considered several projects.[16] CCS is also included as a climate mitigation measure in the planning proposal of very controversial incinerators e.g. the Edmonton incinerator in London.

Waste incinerators produce a variety of pollutants throughout the entire waste management chain, from the combustion of municipal solid waste, to the transport of the waste via diesel sanitation trucks to the ash that is a byproduct of the combustion process.[17] The heterogeneous nature of MSW means that waste incinerators are burning a variety of consumer waste laden with heavy metals and other toxic compounds that results in the release of harmful

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[10] Tangri, Neil. 2021. Waste Incinerators Undermine Clean Energy Goals. no-burn.org/wp-content/uploads/2021/11/Waste-Incinerators-Undermine-Clean-Energy-Goals-1.pdf
[11] Moon, Doun. 2021. "The High Cost of Waste Incineration." Global Alliance for Incinerator Alternatives. https://zerowasteworld.org/beyondrecovery.
[12] GAIA, Burning Public Money for Dirty Energy, 2011. no-burn.org/wp-content/uploads/2021/11/Burning-Public-Money-GAIA-2011_2.pdf
[13] Zero Waste Europe, The EU is clear: Waste-To-Energy incineration has no place in the sustainability agenda, 26 May 2021
[14] GAIA, The EU Double Standards on Waste and Climate,
[15] Climate Policy Initiative, The Landscape of Methane Abatement Finance, 2022. Available here: https://www.climatepolicyinitiative.org/publication/the-landscape-of-methane-abatement-finance/
[16] Zero Waste Europe, CCS for incinerators? An expensive distraction to a circular economy, 2021. Available here: https://zerowasteeurope.eu/library/ccs-for-incinerators-an-expensive-distraction-to-a-circular-economy/
[17] Baptista, Ana Isabel, and Adrienne Perovich. 2019. "U.S. Municipal Solid Waste Incinerators: An Industry in Decline." The New School Tishman Environment and Design Center. https://www.no-burn.org/u-s-municipal-solid-waste-incinerators-an-industry-in-decline/.

air pollutants when combusted.[18] Populations in close proximity or downwind to the facility may be exposed directly through inhalation of air pollutants or indirectly through consumption of contaminated food or water.[19]

Emissions from waste incineration include metals (mercury, lead, and cadmium, among others), organic compounds (dioxins like polychlorinated dibenzo-p-dioxins, PCDD) and furans, PAHs, VOCs, and other POPs, including polychlorinated dibenzofurans (PCDF), PCBs, and hexachlorobenzene (HCB),[20] acid gasses (including sulfur dioxide and hydrogen chloride), particulates (dust and grit), nitrogen oxides, carbon monoxide, and carbon dioxide (CO_2).[21] Smoke and particulates emitted from burning plastic and other waste can trigger respiratory health problems, particularly among children, the elderly, people with asthma, and those with chronic heart or lung disease,[22] while PCDF and PCBs are known carcinogens and emitted metals are known neurotoxins.

Some examples of places where toxic pollution from WTE incineration has been documented:

- In Belgium, the emission of dioxins from combustion of household waste was found to be 36 times higher than the emission limit value (0.1 ng TEQ/m3) for modern municipal waste incinerators.[23]
- In the Netherlands, a waste incinerator in operation revealed emissions of dioxins, furans and persistent organic pollutants far beyond the limits set by EU laws.[24]
- In Oporto, Portugal, environmental samples collected throughout several years showed that closing the incinerator greatly reduced air pollution levels in the area.[25]
- In Seoul, Korea, a study observed an increased risk of asthma-related hospitalization in relation to a person's distance from an incinerator, and concluded that asthma should be considered an adverse health outcome during health impact assessments of incineration plants.[26]

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[18] Baptista, Ana Isabel, and Adrienne Perovich. 2019. "U.S. Municipal Solid Waste Incinerators: An Industry in Decline." The New School Tishman Environment and Design Center. https://www.no-burn.org/u-s-municipal-solid-waste-incinerators-an-industry-in-decline/.

[19] Baptista, Ana Isabel, and Adrienne Perovich. 2019. "U.S. Municipal Solid Waste Incinerators: An Industry in Decline." The New School Tishman Environment and Design Center. https://www.no-burn.org/u-s-municipal-solid-waste-incinerators-an-industry-in-decline/.

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[21] UNEP, Solid Waste Management: Sound practices – Incineration, http://www.unep.or.jp/ietc/ESTdir/Pub/MSW/sp/SP5/SP5_4.asp

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[23] D. Fernández-González, I. Ruiz-Bustinza, J. Mochón, C. González-Gasca, L. F. Verdeja. 2017. Iron Ore Sintering: Environment, Automatic, and Control Techniques. *Mineral Processing and Extractive Metallurgy Review* 38:4, pages 238-249. https://www.tandfonline.com/doi/citedby/10.1080/10962247.2015.1058869

[24] Toxico Watch and Zero Waste Europe, Hidden emissions: A story from the Netherlands, 2018. Available here: https://zerowasteeurope.eu/wp-content/uploads/2018/11/NetherlandsCS-FNL.pdf

[25] Coutinho, Miguel, Margaret Pereira, and Carlos Borrego. 2004. "Air Quality Impact of the Shut-down of a Hospital Waste Incinerator in the Oporto Region."

[26] Bae, Hyun-Joo, Jung Eun Kang, and Yu-Ra Lim. 2020. "Assessment of Relative Asthma Risk in Populations Living Near Incineration Facilities in Seoul, Korea." International Journal of Environmental Research and Public Health 17 (20): E7448. https://doi.org/10.3390/ijerph17207448.

- In China, waste incineration contributes to 17% total dioxin emissions in this country, which is one of the greatest producers of dioxins in the Asian continent.[27]
- In various locations in Europe, biomonitoring studies of toxicity in the vicinity of the waste incinerators showed high elevation of dioxin levels in chicken eggs raised around incinerators in Europe, with the majority of eggs exceeding the EU action limits for food safety. The results of the analysis of the vegetation near incinerators such as pine needles and mosses also showed high elevation of dioxin levels.[28]

Moreover, approximately 26 - 40% of waste becomes bottom ash, and the toxic residues from incineration, such as ash and wastewater, require special treatment and separate disposal.[29] However, they are mostly sent to landfills, where the ash can spread via wind and air; in some places, they are mixed into concrete, buried in salt mines, mixed into asphalt for roads, or even spread on agricultural lands, mislabeled as soil fertilizer.[30]

Workers and nearby communities can be directly and indirectly exposed to these toxic emissions through inhaling contaminated air, touching contaminated soil or water, and ingesting foods that were grown in an environment polluted with these substances.[31] These toxic substances pose a threat to vegetation, human and animal health, and the environment, and they persist and bio-accumulate through the food chain.[32]

In some countries, newer incinerators apply air pollution control technologies, including fabric filters, electrostatic precipitators, and scrubbers. However, the filters do not prevent hazardous emissions, such as ultra-fine particles that are unregulated and particularly harmful to health,[33] from escaping into the air.

2. Plastic-to-fuel used to generate "sustainable" fuels

Plastic production and waste generation are doubling every twenty years. In light of the global plastic crisis, technologies such as turning plastic waste into fuel and burning it are being falsely marketed as circular, climate-friendly, and sustainable.

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[27] D. Fernández-González, I. Ruiz-Bustinza, J. Mochón, C. González-Gasca, L. F. Verdeja. 2017. Iron Ore Sintering: Environment, Automatic, and Control Techniques. *Mineral Processing and Extractive Metallurgy Review* 38:4, pages 238-249. https://www.tandfonline.com/doi/citedby/10.1080/10962247.2015.1058869
[28] Zero Waste Europe. 2022. The True Toxic Toll: Biomonitoring of Incineration Emissions. https://zerowasteeurope.eu/library/the-true-toxic-toll-biomonitoring-of-incineration-emissions/
[29] Petrlik, Jindrich, and Ralph Anthony Ryder. 2015. "After Incineration: The Toxic Ash Problem." International Pollution Elimination Network. https://ipen-china.org/sites/default/files/documents/After_incineration_the_toxic_ash_problem_2015.pdf.
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[31] UNEP, Solid Waste Management: Sound practices – Incineration, http://www.unep.or.jp/ietc/ESTdir/Pub/MSW/sp/SP5/SP5_4.asp
[32] Rinku Verma et al., Toxic Pollutants from Plastic Waste—A Review, 35 Procedia Envtl. Sci. 701, 701-08 (2016), https://doi.org/10.1016/j. proenv.2016.07.069.
[33] Bart Ostro et al., Associations of Mortality with Long-term Exposures to Fine and Ultrafine Particles, Species and Sources: Results from the California Teachers Study Cohort, 123(6) Envtl. Health Persp. 549, 549–56 (2015), https://www. ncbi.nlm.nih.gov/pubmed/25633926

These plastic-to-fuel technologies such as gasification and pyrolysis incineration, are often promoted as "chemical recycling" or "advanced recycling" by the plastic and waste industry, with these terms being used interchangeably, potentially misleading the public. These technologies are popping up across the globe, both as large-scale industrial investments and small-scale, backyard projects.[34]

Pyrolysis and gasification of plastic waste and the final combustion of produced fuel release toxic substances.[35] In addition to toxic additives and contaminants in plastic including bisphenol-A (BPA), cadmium, benzene, brominated compounds, phthalates, lead, tin, antimony, and volatile organic compounds (VOCs), toxic chemicals are newly formed during high-heat processes, including dioxins and furans, benzene, toluene, formaldehyde, vinyl chloride, hydrogen cyanide, PBDEs, PAHs, and high-temperature tars, among many others.[36] Uncontrolled pollution from such processes could pose significant health and safety risks for local populations and place a heavy toxic burden on workers, especially in countries with less stringent emission standards and communities.

- This is particularly the case with the small-scale pyrolysis initiatives that are appearing across Africa, Asia and Latin America.
- In the U.S., a pyrolysis facility in Oregon sent over 49,000 tons of waste styrene to burn in cement kilns located in marginalized communities in 2018.[37]

Even if those pollutants are successfully captured or neutralized, they remain in the product itself or in byproducts such as fly ash, char, slag, and wastewater. Cleaning the toxicants from plastic-to-fuel products is extremely difficult, expensive, and creates additional toxic waste streams.[38]

The American Chemistry Council recognized residual waste from plastic-to-fuel as a major problem— approximately 15 to 20 percent of the overall feedstock used in the process[39] Because aromatic molecules do not oxidize easily,[40] plastic-to-fuel processes release particulate emissions which form soots that increase emissions and reduce combustion efficiency.[41]

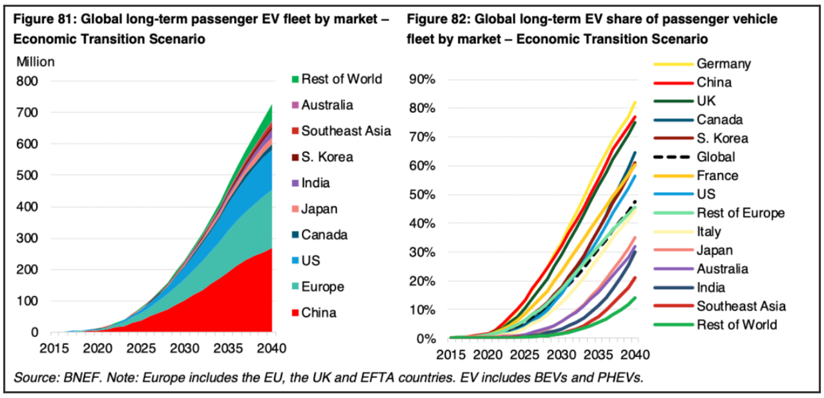
[34] GAIA, Plastic to Fuels: a Losing Proposition, 2022. Available here: https://www.no-burn.org/wp-content/uploads/2022/03/PTF_a-losing-proposition_March-2-2022.pdf
[35] Paladino, O., and A. Moranda. 2020. "Human Health Risk Assessment of a Pilot-Plant for Catalytic Pyrolysis of Mixed Waste Plastics for Fuel Production." Journal of Hazardous Materials. https://doi.org/10.1016/ j.jhazmat.2020.124222
[36] Rollinson, Andrew N., and Jumoke Oladejo. 2020. "Chemical Recycling: Status, Sustainability, And Environmental Impacts". https://doi.org/ 10.46556/onls4535
[37] Patel, Denise, Doun Moon, Neil Tangri, and Monica Wilson. 2020. "All Talk and No Recycling: An Investigation of the U.S. 'Chemical Recycling' Industry." Global Alliance for Incinerator Alternatives. https://doi.org/10.46556/WMSM7198
[38] Rollinson, Andrew N., and Jumoke Oladejo. 2020. "Chemical Recycling: Status, Sustainability, And Environmental Impacts". https://doi.org/ 10.46556/onls4535
[39] RTI International. 2012. "Environmental And Economic Analysis Of Emerging Plastics Conversion Technologies". RTI International. http://energy.cleartheair.org.hk/?p=1281
[40] Rollinson, Andrew N., and Jumoke Oladejo. 2020. "Chemical Recycling: Status, Sustainability, And Environmental Impacts". https://doi.org/ 10.46556/onls4535
[41] Kathrotia, Trupti, and Uwe Riedel. 2020. "Predicting the Soot Emission Tendency of Real Fuels – A Relative Assessment Based on an Empirical Formula." Fuel 261 (February): 116482. https://doi.org/10.1016/ j.fuel.2019.116482

Some processes use catalysts, and both toxins from the plastic and newly created toxins can remain in the spent solvent.[42] For example, a 100,000 tonne-per-year plant would produce 2.5 million cubic meters of post-processing n-hexane, a substance known to cause neurotoxicity and respiratory diseases.[43]

Condensation, cooling, and liquefaction of gasses require water, which needs to be treated before being discharged into local sewage systems. According to one source, 34 gallons of water is used per ton of feedstock processed.[44]

3. Electric vehicle battery recycling can be toxic, safe and effective recycling is needed

In the transition from fossil fuels, global demand for Electric Vehicles (EVs) is rising dramatically. From 16.5 million electric cars in 2021 to 77 million in 2025, 229 million in 2030, and 727 million by 2040.[45]



It is critical to reduce the consequences of EV batteries minerals mining, as described in comments from Earthworks on reducing mineral demand, respecting Indigenous rights and the right to clean water, and implementing mandatory mineral recovery rates and safe tailings management.

Recycling best practices will be essential to limit the human risks from EV battery recycling, and harmful practice should be prevented:

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[42] Sherwood, James. 2019. "Closed-Loop Recycling of Polymers Using Solvents." Johnson Matthey Technology Review 64 (January). https:// doi.org/10.1595/205651319X15574756736831; Rollinson, Andrew N. 2021. "Technical Briefing – The Reality of Waste-derived Fuels: Up In the Air." GAIA. https://www.no-burn.org/jetfuels

[43] Rollinson, Andrew N. 2021. "Technical Briefing – The Reality of Waste Derived Fuels: Up In the Air." GAIA. https://www.no-burn.org/jetfuels/

[44] Ocean Recovery Alliance. 2015 "Plastics-to-Fuel Project Developer's Guide - Ocean Recovery Alliance." Accessed March 6, 2022. https:// www.oceanrecov.org/about/plastic-to-fuel-report.html.

[45] EVO Report 2022. Bloomberg Finance. Accessed March 6, 2023. https://about.bnef.com/electric-vehicle-outlook/.

- **Pyrometallurgy is battery incineration:** Alarmingly, pyrometallurgy is considered the established method for lithium-ion battery recycling[46] and has the worst consequences for environmental and human health:
    - Burning plastics and other components in EV batteries releases a range of toxic gasses, heavy metals, and particles, which can be extremely harmful to human health. Example:
        - *When Korean LIB recycler SungEel HiTech proposed building a pyrometallurgy EV battery recycling plant in Endicott, NY using incineration techniques, the grassroots organization called NoBurnBroome's science team found that the project would release PFAS. As a result, community backlash against the proposal led to Endicott's Board of Trustees rescinding a law that would have allowed incineration in the recycling of lithium-ion batteries.*[47]
    - Most current pyrometallurgical processes do not recover lithium (failing to curb lithium mining)[48]
    - Pyrometallurgy requires the highest amount of energy input and emits the highest amount of GHG emissions.[49]
    - The furnace slag is hazardous and can impose environmental and health risks,[50] all of which will likely harm lower-income and marginalized communities the most.
- **Hydrometallurgy recycling has harmful consequences:** crushed batteries are dropped into a chemical solution to extract minerals.[51] Inorganic acids in leaching agents can lead to secondary pollution and release toxic gasses like Cl_2, SO_2, and NOx.[52]
- **Direct recycling should be considered best practice for EV battery recycling:** uses manual and automated dismantling of batteries, avoiding use of incineration or chemicals,[53] recovering the most minerals, and is the most environmentally beneficial (e.g. highest reductions in GHG and SOx emissions).

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[46] Latini, Dario, Marco Vaccari, Marco Lagnoni, Martina Orefice, Fabrice Mathieux, Jaco Huisman, Leonardo Tognotti, and Antonio Bertei. 2022. "A Comprehensive Review and Classification of Unit Operations with Assessment of Outputs Quality in Lithium-Ion Battery RecycliLarouche, François, Farouk Tedjar, Kamyab Amouzegar, Georges Houlachi, Patrick Bouchard, George P. Demopoulos, and Karim Zaghib. 2020. "Progress and Status of Hydrometallurgical and Direct Recycling of Li-Ion Batteries and Beyond." *Materials* 13 (3): 801. https://doi.org/10.3390/ma13030801.
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[53] Element Energy. 2021. Batteries on wheels: the role of battery electric cars in the EU power system and beyond. https://www.transportenvironment.org/wp-content/uploads/2021/07/2019_06_Element_Energy_Batteries_on_wheels_Public_report.pdf

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WTE incineration

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Case studies on toxicity of WTE incineration

1. Case of Indonesia: Plastic Waste Poisons Indonesia's Food Chain
2. Case of China: High levels of dioxins found in chicken eggs sampled near waste incinerators and metallurgical plant in China
3. Case of the Netherlands: The hidden impacts of incineration residues

Plastic-to-fuel

Rollinson, Andrew Neil, and Jumoke Oladeho. 2020. "Chemical Recycling: Status, Sustainability, and Environmental Impacts." *Global Alliance for Incinerator Alternatives*, June. https://doi.org/www.doi.org/10.46556/ONLS4535.

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