Understanding Refuse Derived Fuel

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Global Alliance for Incinerator Alternatives | Global Anti Incinerator Alliance

GAIA is a worldwide alliance of more than 800 grassroots groups, non-governmental organizations, and individuals in over 100 countries whose ultimate vision is a just and toxic-free world without incineration.

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Understanding Refuse Derived Fuel

Municipal governments throughout the world are facing choices about how to manage the unending stream of waste generated by their residents and businesses. In some places landfills and dumpsites are filling up, and all landfills and dumpsites leak into the environment. As populations continue to grow, the issue of waste becomes more urgent and more complicated. Many regions are already facing a waste crisis, and drastic measures are needed.

Enter private companies with an "innovative" technology they claim will not only eliminate waste but will also generate energy. Some municipal governments, seduced by the idea that they will be able to turn their urgent problem into something of immediate value, have made the mistake of investing significantly in refuse derived fuel (RDF) projects, resulting in the burning of waste in incinerators, cement kilns, and other combustion units.

However, producing RDF does not make household and industrial waste disappear, nor is the technology completely new or "high-tech," as the waste management companies selling it would have one believe. The basis of the technology is incineration, and the burning of garbage—whether in "waste to energy" (WTE) plants[i], incinerators, cement kilns, or other industrial burners—involves an unsustainable consumption of natural resources, pollutes the environment, compromises human health, and seriously disrupts the lives of huge numbers of informal sector recyclers.[1]

All waste-burning technologies have the same fundamental problems, making them particularly inappropriate options for countries in the global south:

- They produce poisonous and greenhouse gases, as well as toxic ash, which are inevitably released into the environment.
- They destroy valuable resources, precluding their re-use and wasting the energy and labor invested in their production.
- They undermine the livelihoods of millions of recyclers as the materials that these informal sector workers depend on are taken away and burned.
- They encourage the generation of waste, while discouraging recycling and segregation of waste at the source—practices that have significant comparative health, environmental, and social benefits.
- They require extra fuel to incinerate the large quantities of wet garbage that will not burn without extra treatment. Waste is an inefficient fuel due to its high moisture content, particularly in developing countries, which tend to have lower proportions of burnable plastic and paper.
- In many cases, these burning technologies violate local laws and policies, such as the Indian Municipal Solid Waste Management and Handling Rules, the Philippines Clean Air Act, and the EU Waste Hierarchy, which mandate source segregation and maximum recycling.

This report provides specific details relating to the impact of producing and burning RDF on the environment, public health, and informal recycler livelihoods. A description of the process used to produce RDF out of municipal solidwaste (MSW) follows.

Environmental Impacts of RDF Incineration

Incinerators are highly controversial because of the toxic emissions, hazardous byproducts, and destruction of resources that they inevitably cause. In order to dodge opposition and make the burning of waste more acceptable to the public, the industry has adopted the term "waste to energy" (WTE) to emphasize a seemingly advantageous trade-off of trash (undesirable) for electricity (desirable). This label is dangerously misleading, since all of the negative impacts of incineration on human health and the environment also result from incinerators with some energy recapture,whether they are burning RDF or another form of waste. Despite advances in technology designed to reduce the toxicity of incineration, in the last decade the damage caused by waste incinerators to public health and the environment has been proven the world over.[2,3] The truth is that the mechanical segregation technologies that are part of RDF production cannot eliminate common toxic substances like PVC (polyvinyl chloride) plastic or other domestic hazardous wastes like CFL tube lights that contain mercury. Incineration releases these harmful chemicals into the environment.

Further, although some of the heat from incinerators can be used to produce electricity, burning waste is an inefficient and costly way of generating power.[4] **Incineration produces significantly less energy than would be saved by recycling the materials being burned.**[5]

When burning RDF, or any kind of waste, the two main by-products are exhaust gases and ash, although some incinerators will also generate contaminated liquid effluent. If the incinerator's air pollution control equipment is sophisticated and operating properly, it will remove many of the pollutants from the exhaust gases and concentrate them in the ash. Consequently, the ash represents a cocktail of toxins; all the pollutants captured at various stages end up here. There are two types of ash: the heavy bottom ash, which comes from the furnace where the waste is burnt, and the lighter fly ash, which comes from the air pollution control equipment.

Biogas, the process of generating methane from source-separated, organic waste, is sometimes referred to as a form of "waste to energy", but since it is not a form of incineration, does not compete with recycling, and does not result in toxic byproducts, our discussion of so-called "waste to energy" in this paper does not include biogas.

Incineration produces significantly less energy than would be saved by recycling the materials being burned.

Numerous studies have confirmed that a typical waste incinerator releases dioxins, lead, cadmium, mercury, and fine particles into the atmosphere.[6,7] According to the United States Environmental Protection Agency, municipal waste incinerators are one of the top four sources of dioxin and furan emissions in the US.[8] These toxic substances are formed when plastics or materials containing chlorine are burnt. Since PVC, which is approximately two-thirds chlorine, is one of the most versatile and widely used plastics, keeping it out of the waste stream is virtually impossible. Hence, RDF inevitably contains PVC, and emissions from facilities that burn RDF are always laced with dioxins and furans.

Heavy metals are also a major source of environmental concern. Since these toxins are not destroyed during incineration, they end up in the incinerator ash, or they escape into the environment through the smoke stack and are transported through the air and deposited in water and soil, both near and far from the incinerator.[9]

RDF Co-Incineration

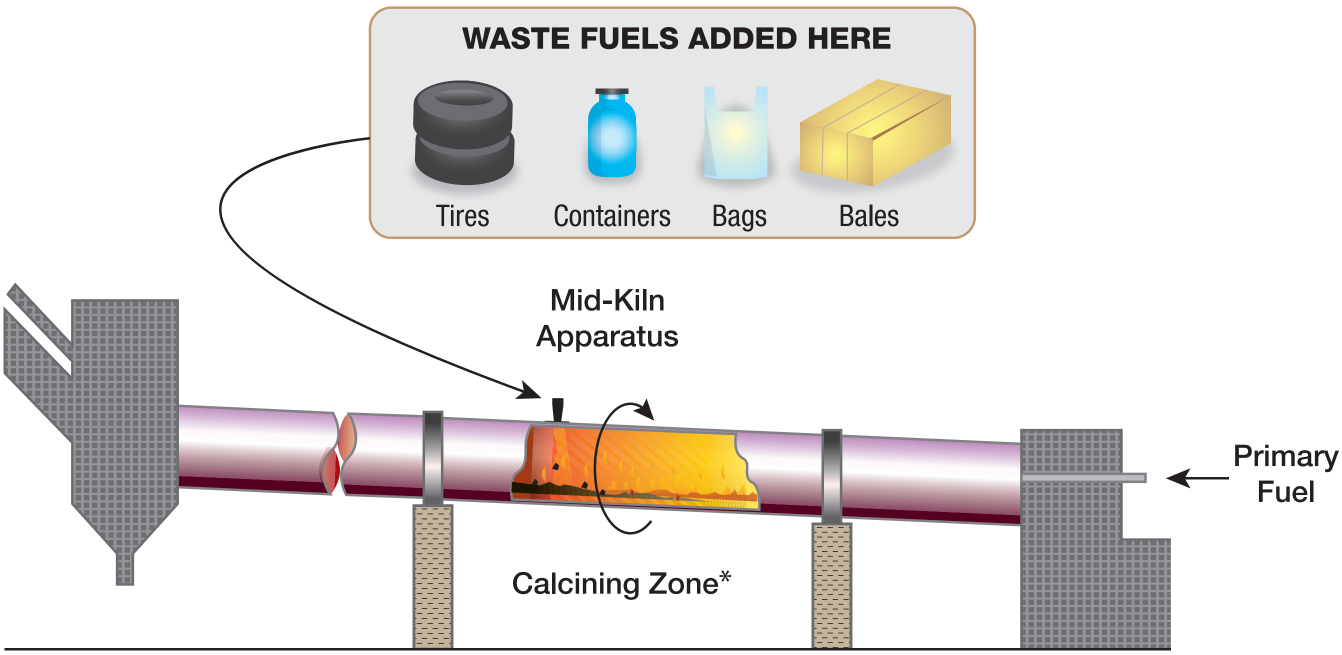
RDF is burned in dedicated RDF incinerators or is co-incinerated with coal or oil in multi-fuel boilers or cement kilns. Many countries like Spain, Mexico, and China have approved the co-incineration of industrial and municipal wastes in cement kilns. This has made cement kilns a major market for RDF. Cement kilns and industrial boilers are not designed to burn waste and generally have poor pollution control mechanisms that are not capable of capturing pollution caused by the use of conventional fuel like coal, let alone RDF, which is a more heterogeneous and toxin-laden fuel.[10,11,12,13,14]

In December 2011, **Mexico City** signed an agreement with CEMEX cement corporation to incinerate 7,000 tons of waste every day in cement kilns. The waste is made into refuse derived fuel and burned in the states of Hidalgo and Puebla. Mexico City pays CEMEX US $700,000 per month to take the waste.

In 2012, the United States Environmental Protection Agency loosened regulations to allow burning of processed municipal and industrial waste in cement kilns. Although the term "RDF" is not used, this is in fact refuse derived fuel. Burning wastes in cement kilns and boilers allows facilities to pollute at higher levels than incinerator pollution limits.

In **Europe**, waste and RDF contribute 20% of the energy needed by cement plants (15% from fossil origin and 5% from biomass). In 2006, 70% of the cement production installations in Europe sourced energy from alternative fuels. Some installations sourced up to 65% of energy from fossil waste, and 45% of installations sourced energy from biomass, although this was in smaller quantities.[15]

In May of 2012, air samples taken close to the exterior of Indian cement plants (in Himachal Pradesh and Tamil Nadu) running on conventional fuels, such as coal and oil, revealed high levels of heavy metal contamination.[16] Using RDF in cement kilns poses an even greater environmental danger. A study on emissions by the European Commission showed that combustion in a cement kiln of one ton of RDF, compared to hard coal, caused a significant increase in the emission of mercury, lead, and cadmium.[17]



Cement kilns are enormous cylindrical ovens. The inside of the kiln is lined with fire resistant brick and reaches extremely high temperatures. The kiln is fueled by primary fuel (e.g., powdered coal, oil, or gas) that is fed through the burner end and solid fuels, like RDF, that are added via the mid-kiln apparatus. This illustration is representative of a typical RDF feeding process. Methods may vary depending on processes and fuel type used.

**While industry states that the calcining zone reaches an air temperature of 1800°C, the material being treated gets to a maximum of only 1200-1450°C. A key issue is that the kiln inlet reaches 800-950°C, meaning that the waste is not combusted at high temperature and more pollutants can potentially be formed.*

Impacts on Human Health

Studies have shown that people living near incinerators that burn waste, including RDF, are exposed to high levels of dioxins and furans.[18] These highly poisonous substances can cause reproductive and developmental problems, damage the immune system, interfere with hormones, and also cause cancer.[19] In 1996, a study of residents living in an urban area near a waste incinerator in Italy found a 6.7-fold increase in deaths from lung cancer.[20]

Dioxins and furans are two of the “dirty dozen” persistent organic pollutants (POPs) targeted for global elimination under the Stockholm Convention on POPs. POPs degrade very slowly in the environment. They accumulate in body fat and through the food web, affecting organisms at every level. Human beings are most affected when they consume dairy products, meat, and fish. The effects of POPs are not only local; dioxins and furans are carried by wind and ocean currents great distances around the globe, impacting environments—and human health—far from their source.

Persistent organic pollutants (POPs) are toxic chemicals that adversely affect human health and the environment. Because they can be transported by wind and water, POPs generated in one country can and do affect people and wildlife far from where they are used and released. They last for long periods of time in the environment and, when ingested, accumulate in the body, becoming more concentrated as they are passed from one species to the next through the food chain.

Heavy metals, another dangerous pollutant from incinerators and cement plants, have also been shown to accumulate in the body.[21] These toxins target almost all systems in the body including the central nervous system, the cardio-vascular system, the respiratory system, and the liver and kidneys. Pregnant women and children are the most vulnerable to heavy metal pollution. Some heavy metals, such as mercury, are known to cross the placental barrier and harm the foetus.

Nanoparticles or ultrafines, so minute in size that they are not visible even under normal microscopes, are yet another major source of concern resulting from incineration.[22] The particles are so small that they bypass all body barriers and enter the blood stream where they are carried to various organs. In pregnant mothers, these particles also cross the placental barrier and affect the foetus.[23]

The many toxic substances used in manufacturing (e.g., heavy metals and chlorinated compounds like PVC) inevitably become part of our waste. When unsegregated municipal solid waste (MSW) is collected and burned, regardless of the treatment it may undergo, the toxins in the waste end up in the incinerator emissions.

Job Displacement and Economics

Traditionally, recycling has provided productive work for an estimated 1% of the population in developing countries by engaging them in processes such as collection, recovery, sorting, grading, cleaning, baling, processing, and manufacturing into new products.[24] According to the World Bank's latest study, formal and informal solid waste management represents between 1% and 5% of all urban employment.[25] In India, recycling currently supports more than 1.5 million people.[26] As practiced in many places, the production and incineration of RDF is incompatible with any kind of recycling. All facets of the technology are designed for very large quantities of unsegregated MSW, and it is typical for a private waste management company contracting with a municipality to get exclusive rights to the city's entire waste stream. As a result, RDF and other mechanized facilities frequently deprive informal recyclers and their families of their livelihoods, thereby pushing them deeper into poverty. Moreover, recycling by informal recyclers generates even more jobs "upstream"—in processing and remanufacturing the recycled materials. According to statistics provided by the Alliance of Indian Waste Pickers, for every informal recycler employed in India, on average, 25 jobs are created upstream.[27] Hence, RDF projects literally steal the means of survival for a large number of people and transfer the economic value of their livelihoods to big corporations.

RDF and incineration projects usually represent the privatisation of at least part of the waste management system in the cities where they are established. Many waste management companies have been able to strike deals with city governments that make them huge profits through tipping fees and other miscellaneous charges over and above waste management fees. When a community builds an RDF plant, it is essentially making a long-term commitment to an unsustainable waste management practice that not only destroys materials that could otherwise be recycled, but threatens the livelihoods of many people working in the waste sector.

Although informal recyclers work in extremely hazardous conditions, often without any recognition from the government, they are at least able to make a living, and some are improving their living and working conditions through organizing. The costs of RDF and incineration projects run into millions of dollars while sustainable practices like recycling, which cost a fraction of that and financially support many more workers, are typically sidelined altogether.

In places like western Europe and the United States where recycling systems are more formal, the growth of recycling is hampered by incineration. Both regions could create hundreds of thousands of new jobs by increasing recycling and composting.

Notably, it is not uncommon for RDF incinerators to face closure within the first few years due to operational challenges and technological breakdowns, leaving the city responsible for the outstanding debts associated with the failure.
[See below: Track Record of Waste Incinerators in India]

Most progressive scientists, policymakers, and citizens agree that incineration is outdated and toxic. Still, industry continues to push it as a "modernisation" of the waste management system, basing its arguments and justifications on several myths, each of which is addressed below.

Track Record of Waste Incinerators in India

Delhi

The first WTE incineration facility in India was set up in 1987 at Timarpur, Delhi, to produce 3.5 megawatts (MW) of power at a cost of US $8 million. It soon became inoperative due to a mismatch between the quality of waste received and the plant design.
("Waste to Energy: An Imperative for Sustainable Waste Management"; published in IDFC's Policy Group Quarterly, No 3/ March 2009.)

Hyderabad

The RDF-based power plants at Vijayawada and Hyderabad, each of which was expected to generate 6 MW, started commercial operations in 2003. However, to overcome the poor heating value of the waste received—about 1,000 Kcal/kg and way below the optimum 2,500 Kcal/kg—the plants supplement MSW with agricultural wastes as auxiliary fuel. To this day, these RDF plants remain grossly underutilized as the desired amount of waste is not being received.
("Waste to Energy: An Imperative for Sustainable Waste Management"; published in IDFC's Policy Group Quarterly, No 3/ March 2009.)

Pune

The 1,000 tonnes per day RDF-based waste processing facility in Pune, operated by Hanjer Biotech, has been facing a severe operational crisis since its inception. Multiple breakdowns and fires at the facility have caused several health problems for residents of surrounding villages. Villagers launched a protest by blocking all trucks entering the facility, leading to a waste crisis in the city.
(Sources: http://www.punemirror.in/printarticle.aspx?page=comments&action=translate&sectid=2&contentid=20100525201005250026156 35b7f50b48&subsite, http://articles.timesofindia.indiatimes.com/2011–12–24/pune/30554501_1_swach–waste–management garbage–depot.)

Rajkot

The Gujarat Pollution Control Board noted multiple instances over several years in which the waste processing facility (also operated by Hanjer Biotech) in Rajkot, Gujarat caused serious pollution in the area due to the mishandling and burning of solid waste.
(Source: http://www.consumercomplaints.in/complaints/hanjer–bio–tech–energipvtltd–nakrawadi–rajkot–rajkot–gujarat–c541343.html.)

Producing RDF

RDF is typically made in the form of pellets, bricks, or fluff. Its manufacture starts with the collection of un-segregated municipal waste, including organic waste (primarily food waste) and materials like paper, cloth, plastic, and wood that provide the calorific value required to burn. Before these can be formed into RDF, however, the combustible wastes must be separated from non-combustibles such as glass and metal, and the larger items must be broken into smaller pieces. Ideally, during the separation stages, hazardous materials would be removed completely, but unfortunately, this is nearly impossible.

Another serious challenge in making RDF, particularly in less developed or tropical countries, is moisture. Since organic materials are not separated out at source, MSW has very high moisture content. By region the countries in the East Asia-Pacific region have the highest proportion of organic waste at 62%, followed by Middle East and North Africa at 61% and Latin America and South Asia regions at 54% and 50% respectively.[28] Many RDF plants separate out some of the organic matter and sell it as compost. The steps taken and their sequence—as well as the specific machinery used—may differ depending on the waste characteristics, climatic conditions, technologies available, and final treatment(s) planned in a given location. Nonetheless, because the final compost is derived from unsegregated MSW, inevitably, it is highly contaminated.[29]

The production of RDF includes a series of steps. The steps taken and their sequence—as well as the specific machinery used—may differ depending on the waste characteristics, climatic conditions, technologies available, and final treatment(s) planned in a given location. The steps below have been observed in India. Other countries may take additional steps to separate out more of the recyclable and compostable content before preparing the fuel for its final form. A detailed description of the steps is provided below.[30]

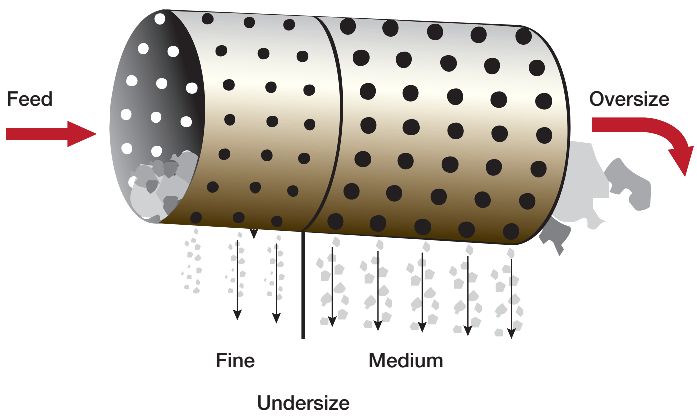
Preparation for mixed composting. RDF plants store freshly-collected waste for up to a week, often spraying it with strongly scented chemicals and enzymes to cover odors and hasten the de-composition process. This not only produces toxic leachates (juices of decomposing organic matter) but also contaminates compost produced later in the process. Compost is recovered through "fine refinement" in which the waste is passed through trommel screens of varying mesh sizes. All the fines that fall through are separated as compost to be sold. However, in very poorly source separated wastes the quality of the compost is highly contaminated as other fines like pieces of plastic, broken glass, particles from tube lights (containing mercury), etc., also end up in the final product. Independent studies conducted by GAIA[31] and the Indian Institute of Soil Sciences (IISS)[32] have found levels in excess of regulations prescribed by India and the EU in compost produced by such mixed waste processing facilities. Nonetheless, some of the compost from such facilities is sold in the open market.

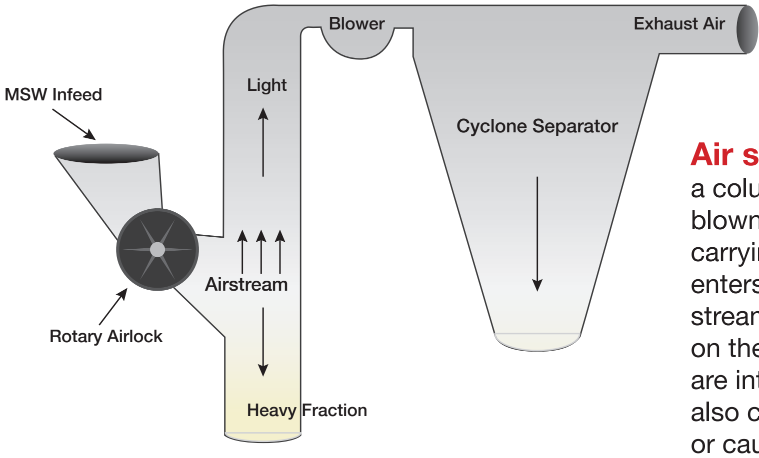
Drying. The partially decayed waste is dried, either under the sun, by hot air, or by a combination of both. This important step in the process differs in each facility depending on the investment or land availability. Solar drying is not possible during rainy seasons, and most facilities run at a fraction of their capacity during the rains, sending most of the waste to landfills. Mechanical drying, on the other hand, requires significant amounts of energy that could easily render RDF plants unprofitable without huge government subsidies.

Manual separation. Bulky items such as large pieces of wood, rocks, long pieces of cloth, etc. are removed by hand before mechanical processing begins. Equipment involved in manual separation usually includes a sorting belt or table. Handpicking of refuse is perhaps the most prevalent MSW handling technique; it is also the only technique for removal of PVC plastics. Indian laws strictly prohibit thermal destruction of PVC due to its harmful emissions, but with so many different forms of PVC in the waste stream it is virtually impossible to eliminate it.

A worker manually separates large objects from the conveyor at Hanjer Biotech Energies Ltd. in Nagpur, India. This is done to prevent damage to the machinery. (Photo: GAIA)

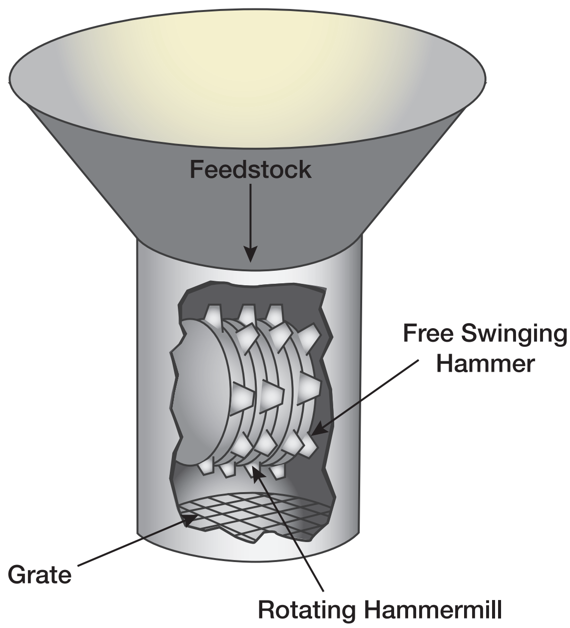
Screening. Size separation usually happens at two or more stages in the process. It is done by passing the waste through trommel screens, most commonly rolling drums with different mesh sizes. Trommels are attached to the conveyors at various stages of processing and are inclined to allow oversize materials to pass along them. Some facilities also include spikes inside the trommels that act as bag bursters to free items that may be inside plastic bags.





Air separation. In this step, fans are used to create a column of air moving upwards. Light materials are blown upwards, and dense materials fall. The air carrying light materials, like paper and plastic bags, enters a separator where these items fall out of the air stream. The quality of separation in this step depends on the strength of the air currents and how materials are introduced into the column. Moisture content is also critical as water may weigh down some materials or cause them to stick together. This is particularly true with waste from the Global South, which typically contains more than 50 percent moisture.

Size reduction. Two types of devices are commonly used for this process: flail or hammer mills and shear shredders. Hammer mills consist of rotating sets of swinging steel hammers through which the waste is passed, and shear shredders are used for materials that are difficult to break apart such as tires, mattresses, plastics, etc. The hammers need frequent resurfacing or replacement. Both are energy and maintenance-intensive. Hammer mills shatter items such as fluorescent light bulbs, compact fluorescent lamps, and batteries. Toxic substances released from these commonplace domestic items end up in the RDF and compost.



Magnetic separation. Electro-magnets are used in this step so they can be switched on or off to allow removal of collected metals. However, not all metals can be removed by magnets. Stainless steel and copper, for example, are only weakly magnetic or are not magnetic at all. A further limitation of this technique is that small magnetic items will not be picked up if they are buried in non-magnetic materials, and larger magnetic items can drag unwanted items like paper, plastic, and food waste along with them.

Producing the final product. Once all of the separating and size reduction steps are complete, the final RDF product can be formed into bricks or pellets or can be left as fluff. Each form is derived from material separated at a particular stage in the process. Large pieces that escape the trommel screening stage and lighter materials like plastic bags that get blown off during air separation are baled together as RDF bricks. The shredded material from the hammer/flail mill and medium size rejects from the trommels are used for the RDF fluff. Finally, the residual waste is mixed with binders like agricultural husk and passed through a pelletizing machine that converts the waste into pellets.

RDF Pellets

RDF Brick

RDF Fluff

Density-Based Separation

Some of the newer RDF facilities incorporate density-based separators. The most common of these is the ballistic separation technique. Ballistic separation is based on a fast moving conveyor belt which flings items into the air. Those that carry furthest tend to be denser. Some facilities employ this separation technology as a pre-composting step with the rationale that compostables tend to be softer and less elastic, so—even if relatively dense—will not bounce as far. However, some compostables (for example, potatoes) are relatively dense and therefore could behave in the same way as a reject (such as a battery).

The Mechanical Segration Myth

Mechanical processing plants employing technologies like the ones described above can never achieve anything close to 100 percent separation due to the complex nature of modern municipal waste, which contains household chemicals, various types of petrochemical-based synthetic materials like polyester cloth scraps, chlorinated plastics and paper, batteries, metals, etc.

PVC is the second most prevalent plastic in use today. The global installed capacity of PVC production is 47.5 million tons per year.[33] Incineration of PVC is strictly prohibited under many national environmental protection laws because of its toxic emissions.

"...burning RDF is an inefficient way to generate energy; less energy is produced than would be saved by recycling. In short, the costs versus benefits of RDF are way out of balance"

The Bottom Line

Studies have shown that there are numerous undesirable consequences inherent in the production and burning of RDF, many patently dangerous. Collecting mixed waste for RDF undermines incentives to reduce waste, competes with recycling for materials, and takes away the livelihoods of informal recyclers. The incineration of RDF in cement kilns, incinerators, and other combustion units releases harmful chemicals into the air and concentrates toxins in ash which must be disposed of later. In some countries, facilities where RDF is produced often sell compost laced with heavy metals and other pollutants without restriction.

Furthermore, burning RDF is an inefficient way to generate energy; less energy is produced than would be saved by recycling. In short, the costs versus benefits of RDF are way out of balance. The waste hierarchy rightly prioritizes the segregation of waste at source, along with recycling, reuse, and biological treatment of organics. For a zero waste future that is socially and environmentally just, cities need systems that encourage citizen participation, reduce the quantity of waste that is generated, and handle waste as close to its source as possible.

Private companies promising to alleviate a community of their waste problem by centralizing collection and production of RDF are, in actuality, offering to exchange one set of problems for another; they are not offering a solution.

Endnotes

[i]"Waste to energy" is a term that has been coined by industry to imply a clean and simple waste–in–energy–out transaction. In fact, burning waste is an inefficient and costly way to produce energy (see endnote 5 below). We refer to such waste burners as "incinerators with some energy recapture" to more accurately describe the technology.

[1]Terms used in other regions of the world include waste picker, reciclador, catador, grass roots recycler, etc.e, in actuality, offering to exchange one set of problems for another; they are not offering a solution.

[2] Incineration and Human Health, Greenpeace March 2001: http://archive.greenpeace.org/toxics/reports/euincin.pdf.

[3]The American People's Dioxin Report – Center for Health, Environment and Justice http://www.mindfully.org/Pesticide/Dioxin–Report–CEHJ.htm#Municipal_Solid_Waste

[4]*U.S. Energy Information Administration (Department of Energy), Updated Capital Cost Estimates for Electricity Generation Plants*, November 2010. http://www.eia.gov/oiaf/beck_plantcosts/pdf/updatedplantcosts.pdf.

[5]USEPA: Solid Waste Management and Greenhouse Gases: A Life–Cycle Assessment of Emissions and Sinks, 3rd edition September 2006.

[6]Incineration and health issues' – Friends of the Earth briefing aimed at helping campaigners ensure that health issues are fully considered in any assessment of incineration. http://www.foe.co.uk/resource/briefings/incineration_health_issues.pdf.

[7]Allsopp et al, "Incineration and Human Health," Greenpeace Research Laboratories, March 2001.

[8]An Inventory of Sources and Environmental Releases of Dioxin–Like Compounds in the United States for the Years 1987, 1995, and 2000. http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=159286.

[9]Incineration and Human Health is available from the Greenpeace Press Office: http://www.greenpeace.org/international/en/publications/reports/incineration–and–human–health/.

[10]Friends of the Earth, "Briefing: Burning Waste in Cement and Lime Kilns," July 2005.

[11]European Commission – Directorate General Environment, "Refuse Derived Fuel, Current Practice And Perspectives (B4–3040/2000/306517/MAR/E3) Final Report," July 2003.

[12]"The EPA's Sham (Bifurcated) Hazardous Waste Combustor MACT Rule and Enforcement Failures by EPA and State of Texas are Related to Health Hazards from Toxic Waste Incineration in Cement Kilns at Midlothian, Texas," Written Testimony of Neil J. Carman, Ph.D. to Congressional Subcommittee Hearing on Investigations and Oversight, U.S. House Committee on Science and Technology, March 12, 2009.

[13]European Commission Reference Document on Best Available Techniques in the Cement, Lime and Magnesium Oxide Manufacturing Industries, May 2010.

[14]Jung–Myung Cho and Suzanne Giannini–Spohn, Environmental and Health Threats from Cement Production in China," August 31, 2007.

[15]Cement Industry Energy and CO2 Performance: 'Getting the Numbers Right', The Cement Sustainability Agenda, World Business Council for Sustainable Development, 2009, at: http://wbcsdcement.org/pdf/csi–gnr–report–with%20label.pdf

[16]Air samples taken by community groups in Himachal Pradesh: http://www.tribuneindia.com/2011/20110307/himachal.htm#2.

[17]European Commission, Directorate General Environment, 2003. Refuse Derived Fuels, current practice and perspectives. Final report.

[18]Incinerators and Human Health. State of Knowledge of the Impacts of Waste Incinerators on Human Health. Greenpeace Research Labs, 2001http://archive.greenpeace.org/toxics/reports/euincin.pdf

[19]World Health Organisation – Dioxins and their effects on human health. http://www.who.int/mediacentre/factsheets/fs225/en/index.html.

[20]Incineration and Human Health is available from the Greenpeace Press Office or at http://www.greenpeace.org.uk.

[21]Up In Smoke – Why Friends of the Earth Opposes Incineration, June 2003.

[22]The Deadliest Air Pollution Isn't Being Regulated or Even Measured by Peter Montague – Rachel's Democracy & Health News #915, Jul. 12, 2007.

[23]Medina, Sylvia, Project Coordinator. Summary report of the Aphekom project 2008–2011. Aphekom (www.aphekom.org) 2011.

[24]Carl Bartone, "The Value in Wastes," Decade Watch, September 1988.

[25]Daniel Hoornweg and Perinaz Bhada–Tata, "WHAT A WASTE: A Global Review of Solid Waste Management," World Bank, March 2012.

[26]Data based on estimations provided by the Alliance of Indian Wastepickers.

[27]Livelihoods with Dignity – Alliance of Indian Wastepickers, March 2010.

[28]"WHAT A WASTE: A Global Review of Solid Waste Management," World Bank, March 2012.

[29]Heavy Metals in Mixed Waste Compost in India – GAIA, 2012.

[30]Based on field visits to Integrated Solid Waste facilities in India and *Composting of Mechanically Segregated Fractions of Municipal Solid Waste – A Review.* Paul Bardos, r3 Environmental Technology Limited.

[31]Independent lab analysis on compost samples from mixed waste composting facilities in Nagpur and Pune commissioned by GAIA in 2010.

[32]An assessment of municipal solid waste compost quality produced in different cities of India in the perspective of developing quality control indices – J.K Saha, N. Panwar, M.V. Singh, 2009. Study updated in 2013: http://www.hindustantimes.com/India–news/Mumbai/Mumbai–Compost–from–city–waste–is–high–in–heavy–metals/Article1–1052468.aspx.

[33]Research and Markets: Polyvinyl Chloride (PVC) Global Supply Dynamics to 2020 – China Emerges as the Leader in Global Production.

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GAIA is a worldwide alliance of more than 800 grassroots groups, non-governmental organizations, and individuals in over 100 countries whose ultimate vision is a just and toxic-free world without incineration.