The Zero Waste Approach to Resource Management

By Richard Anthony, Zero Waste International Alliance, www.zwia.org
An appendix of: Solid Waste Engineering, Worrell, Vessilind and Ludwig, Cengage Learning, 2017

The genesis of the Zero Waste movement comes from the realization that discarded materials are resources. These resources have been manufactured from a raw state with energy and labor. In the cases of metal and oil they are irreplaceable. The value of that energy and labor is still in the commodity, even after the user has discarded it.

A zero waste system is a resource management system. The process of wasting resources is against nature. In a zero waste system everything has a place before, during and after use. There is no away. In the best-designed system, the dismantling or demanufacturing would be designed into the product. The system of extraction, manufacturing, use, and disposal to incinerators or landfill will be replaced with systems that capture the material and recycle them into a closed loop system of reuse, repair, recycle/compost and redesign. Raw materials will be used as reserves.

This is called the “closed circle economy” and the analysis is called a “Cradle to Cradle” design. The recognition that, disposal by burning and landfill will leave a legacy of depletion and pollution for our children; will provide the basis for new analysis and new rules. These new rules will recognize the futures right to the planets’ resources and discourage wasteful and polluting practices.

Definition of Zero Waste

Toward the development of these new rules The Zero Waste International Alliance (www.zwia.org) have peer reviewed and approved of the following definition of Zero Waste.

“Zero Waste is a goal that is ethical, economical, efficient, and visionary, to guide people in changing their lifestyles and practices to emulate sustainable natural cycles, where all discarded materials are designed to become resources for others to use. “

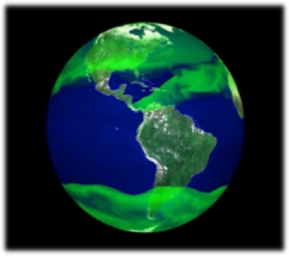
“Zero Waste means designing and managing products and processes to systematically avoid and eliminate the volume and toxicity of waste and materials, conserve and recover all resources, and not burn or bury them. “

“Implementing Zero Waste will eliminate all discharges to land, water or air that are a threat to planetary, human, animal or plant health.”

Zero Waste & Global Warming

Landfills are one of the largest sources of Greenhouse Gases (GHG) in any community.
Methane is 21-84 (see chapter 7) 84 times more potent than Carbon Dioxide (CO_2). In most California City’s Climate Plans, the Landfill is among the top three (traffic, farms) emitting GHG’s. The California Air Resource Board (CARB) officials in 2014 recommended managing compostable organic materials to farms or facilities with aerobic and anaerobic digestion technologies. This NASA Photo (Figure 1) shows the methane hovering over the North and South poles of planet earth.

Figure 1



Landfills and incinerators are in many ways an early end of life for first time used resources.

Figure 2 “waste berg” illustrates that there is 71 tons “Upstream” of wasted materials and energy for every 1 ton Municipal Solid Waste discarded.

Figure 2 waste berg

If every discard in California (CA) was recycled or composted, the savings would be the equivalent of eliminating all auto exhaust in CA (EPA Waste Assessment Model). California has passed legislation (AB 341) calling for a 75% reduction goal and recommending to Cities that source separation be required.

Zero Waste Communities and Businesses

A growing trend in the USA; New Zealand and Japan were the first nations to come up with Zero Waste Campaigns. Today Cities all over the world have adopted Zero Waste Goals. These include: San Francisco, Los Angeles, San Diego, Fresno, Oceanside and San Luis Obispo and dozens more in California. Around the USA: Fort Collin CO, Austin, TX, and Chicago IL. International examples include Over 66% of New Zealand Cities, Buenos Aires, Argentina, 400+ cities in Italy, Nagoya Japan, South Australia, and Vancouver Canada.

In the business sector Zero Waste is a cost cutting and efficiency measure tied into international management policies. Hundreds of Businesses are achieving 90% diversion from disposal including Landfilling and/or Incinerators. New international measurements hare being developed by Quality Control Rating Services (Underwriter Laboratories UL). Today Companies like Wal-Mart, Toyota, Sierra Nevada Brewery, Frito–Lay, Vons /Safeway and hundreds of other have adopted sustainability plans that call for Zero Waste practices.

Basic Principles

Different from the Integrated Waste Management approach, the zero waste approach considers all discarded resources as commodities. Unwanted discards can be separated at the source, stored separately, separately collected, processed, and sent to markets for reuse and recycling/composting. Ninety percent of our daily discards could be managed this way in a community collection program.

The handling of the residual (less than 10%) can be discussed in the public forum on whether to require a product redesign or local ban.

There are five basic principles that are the pillars of the Zero Waste Approach.

- The first prinicple is that resources are finite.
    - The process of wasting resources is against nature. Therefore the ultimate option is to control population and recycle resources to survive. Because the human species is driven to survive, the reasons and the answers can be seen in nature. Where there are limits in materials and space, contradictions to the flow of nature are obvious.
- The second principle is that there is no away.
    - The notion of zero waste is as much as a principal of survival for the human species as it is a matter of fact in nature. A close examination of natural systems reveals that there is very little waste in nature. Everything is connected to each other. Every discard is an others feedstock. When the planet is seen as a finite sphere in space, there can be no away on planet earth. Everything that is sent away must go someplace.
- The third principle is that todays wasting and pollution rob the future of resources they will need.
    - The recognition that even though disposal by burning and the landfilling of ash or landfill without burning may be cost effective under today's rules, the legacy of depletion and pollution for our children will provide the basis for new rules. These new rules will recognize the futures right to the planets' resources and discourage waste.
- The fourth principle is Highest and Best Use
    - There is a hierarchy of use of materials that involves the highest and best use of materials in the areas of energy and resources. This includes: Reduce, Reuse, Recycleing, includes repair and composting The "Three R's" are used to teach pollution prevention. The first R in the "Three R's" (reduce, reuse and recycle) refers to source reduction, or the area of discard management that addresses over packaging and single use products. The 3 "R's" are taught as a means to demonstrate how product design can lead to decreasing waste. Consumers are encouraged to consider buying products that can be reused, repaired, recycled and composted.
- The fifth principle is required source separation.
    - Thus zero waste theory calls for disposal systems that place disposal costs responsibility on the manufacturers to redesign products for recycle ability. The discard management service provider whether government or private contractor, is mandated to collect source separated material from clearly labeled and conveniently located storage containers and deliver them to processing centers that will sort, process and reintroduce these materials back into the use system.

Resource Use

As the world population and living standard increases, world resources are used at increased rates as well. The impact of this increasing demand on the remaining of the planets finite resources like petroleum, metals, and its biodiversity of wild animals, birds,flowers, fish and trees is leading to their depletion and some cases, extinction.

Figure e from “The Limits to Growth” show poululation growth from 1900 to 2100.

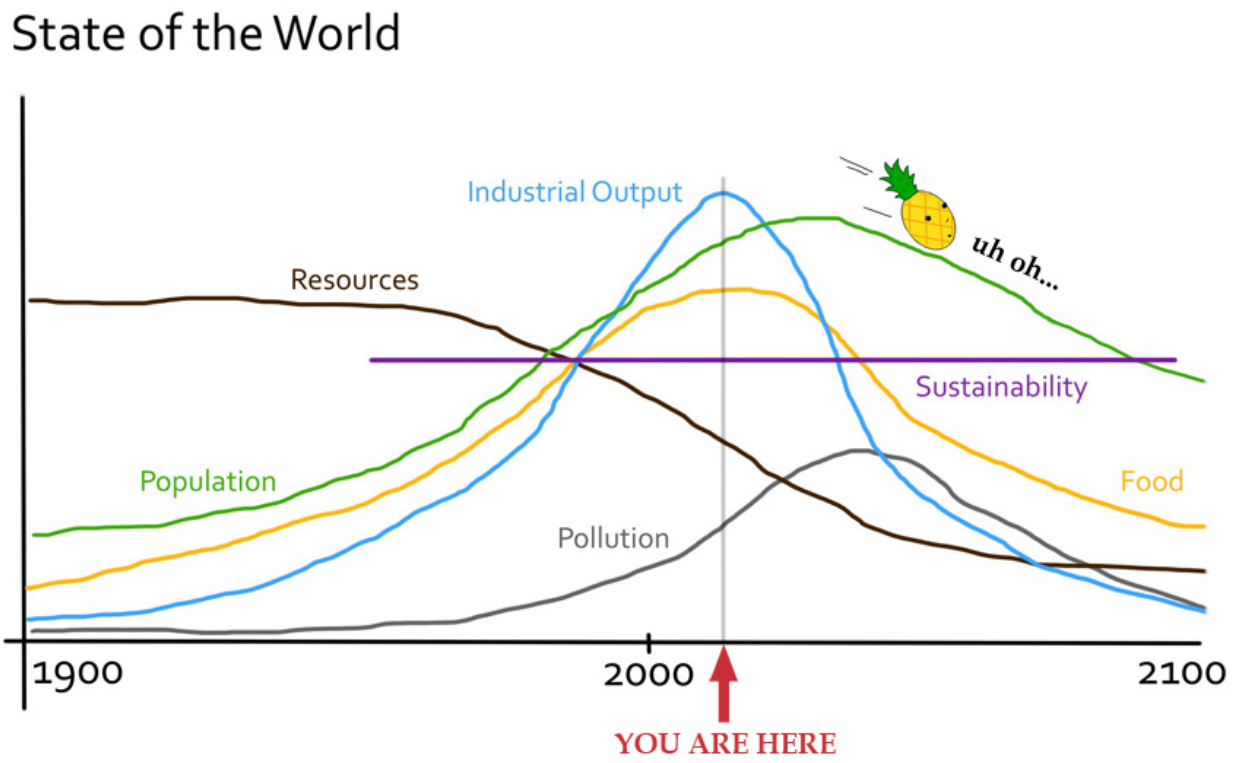


Figure 3

As time reaches 2000 the lines cross, showing the population of the planet increasing while resources are depleted. This projection is reality today with the new recycling mills and factories in India and China and using western discards as material feedstock.

As the resources become depleted and the demand increases the value of these discards increase as well. Todays recycled material market is 100 times higher than what it was in 1970. This table demonstrates that recycling and/or composting is not a waste of money, but results in valuable resources with increasing demand.

Green House Gas and other Pollution Reduction

Table 1, Table 1 shows the reductions in energy use, air pollution, water pollution, mining waste and water use when recycle resources are substituted for virgin materials. In the case of aluminum no new bauxite has to be mined and added to the aluminum melt to recycle it into another product. Steel today is the most recycled metal.

Table 1 Pollution, Energy and Waste Reductions with Recycling

	Aluminum	Steel	Paper	Glass
Energy Use	90-97%	47-74%	23-74%	4-32%
Air Pollution	95%	85%	74%	20%

Water Pollution	97%	76%	35%	
Mining Wastes	99%	97%		80%
Water Use		40%	58%	50%

This table created by the USEPA is the basis of the Waste Assessment Model. For each commodity the reduction by recycling in energy use, air pollution, water pollution, mining waste and water use is given. Aluminum can be melted and recycled with 99% less energy than it would take to mine bauxite and convert it to alumina and then aluminum.

The Zero Waste Approach to managing resources considers the planets need and demand for these materials and the energy and greenhouse gas savings that occur when discards are managed as commodities.

Zero Waste Management

Today whether it's your home, your business or your community there are basic approaches to handling discards. The Zero Waste approach looks at discards both, upstream and downstream what some would call the waste stream. Efforts to reduce this stream of discarded materials can happen before purchase and use (upstream or prevention) or after use (downstream, end of pipe or recovery). In other words the Zero Waste Approach is about the prevention of wasting and recovery of discards.

Up Stream prevention programs include;

- Clean Production
    - The goal of the final product is that the manufacturing of product will not hurt the product, the profit and the planet (triple bottom line). Factory managers are responsible for not incurring additional cost by creating and disposing of wasted and/or toxic materials.
- Product Redesign
    - If any of the triple bottom line parameters (actions hurt product, planet, profit) are exceeded, the product needs to be redesigned. In our new economy the product must be repairable and/or recyclable/compostable and there will be no toxics used or created by the process that cannot be reused and recycled by the manufacturer.
- Product Stewardship
    - A company takes pride in their products and create sustainable materials because is the right thing to do for the planet. In the past product stewardship was voluntary but today Companies are being required to take the lead in making their products and packages conform to international requirements.

Down Stream Recovery programs focus on capturing commodities at the point of discard.

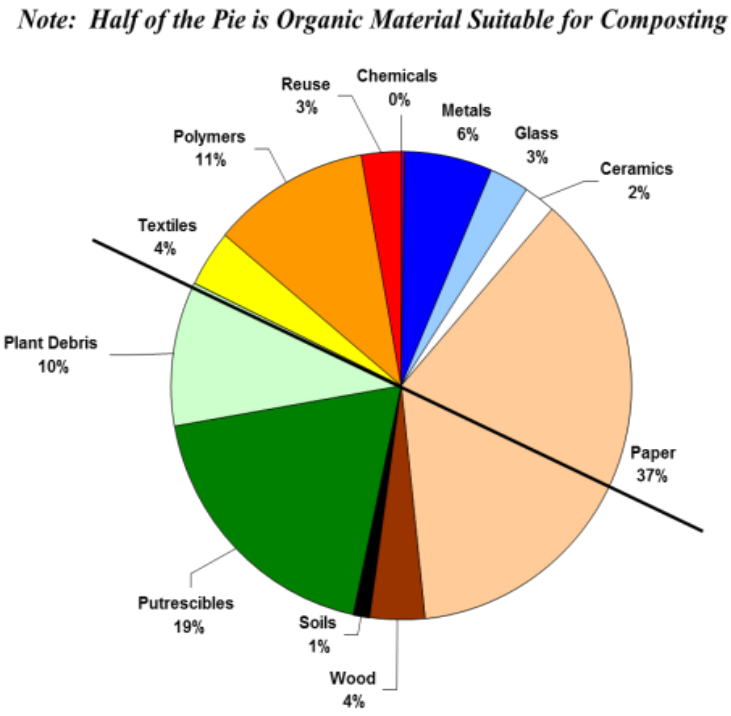
- Reuse materials should be handled through box truck collection and drop off centers where materials can be looked at for reuse and repair. If not reusable and repairable they are dismantled into the basic recycling categories. All reusable and durable goods should be collected separately and processed as commodities.

- Composting compostable organics is the basic way of handling organic discards. These materials can be collected as yard trimmings and food scraps and composted in the back yard and/or collected separately and sent to farms and facilities that have composting and anaerobic digestion capabilities. The result will be healthy farms with less water and petro chemical demands and no local human created sources of leachate and methane emissions from the Landfill.
- Recycling all containers and paper products. These containers include metal, glass, paper and plastic.
- Resource Recovery Parks are the new transfer stations where commodity clusters can be collected separately and then transferred to the processing facilities. Special discards like rocks and wood have recovery areas at these parks.

Market Categories

All discards can be sorted in to twelve categories. The Figure 3 Market Categories Pie chart shows the basic percentages that these commodities have in the total discard system.

Figure 3 Market Categories



Note that half of this material is compostable.

Market Categories

1. **Reusable** are materials that can be reused, repaired and /or dismantled for recycling
2. **Paper** includes cardboard , newspaper, writing paper, tissues and towels
3. **Plant Debris** include all yard trimmings
4. **Putrescible** are food scraps and organics that putrefy
5. **Wood** includes painted and unpainted although some painted wood is problematic

6. **Ceramics** are rocks, concrete, asphalt
7. **Glass** includes containers but not leaded glass
8. **Polymers** are plastic and can be sorted into resin codes for high resale value
9. **Soil** includes dirt
10. **Metal** includes ferrous magnetic metals like steel and iron and nonferrous metals like copper, aluminum, brass, gold etc.
11. **Textile** as reusable but in a class of their own and include cloth and woolen natural fiber as well as synthetic fibers
12. **Chemicals** are hazardous for disposal but they can be given out for further use.

Each of these materials in their categories has a positive monetary value. Credit for this system must be given to Dr. Dan Knapp of Urban Ore in Berkeley California.

Master Category Clusters

When people in rural areas have discards they try to use it all. Both the cost and distance involved in removal and the saving and practical use of resources are key drivers. Typically reusable products are taken to the Church or a local charity or given to the family and neighbors for reuse and repair. (Reuse) Excess food goes to family, workers, neighbors, animals and ultimately the land (Compost). Bottle and Cans can are a problem but are used for storing material, and ultimately recycled at rural transfer stations (Recycling). Paper and wrappers are burned as fuel. Special discards like pesticide containers must be hauled away.

Based on practical experience in marketing commodities, In a Zero Waste System four sorts are needed (Reusable and repairable products, recyclable materials, compostable organics, and landfill for legacy and badly designed materials). Containers can be varied and different colors. State of the Art (2015) programs use Wheel Carts for storage and collection. These vary in size.

The Blue Cart (recycle) is for paper and containers (paper, metals, glass, and polymers). The comingled four commodities can be sorted with magnets and hand sorters at a Materials Recovery Facility (MFR), baled and sold.

The Organic cart should be Green and can collect food, vegetative debris, food dirty paper, paper, plant debris, putrescible, wood and soil. The comingled organic commodities are taken to a composting facility to be processed into soil.

Discarded items sometimes called Bulky Waste or items set out for Charity Pickup need to be collected in a box truck and taken to a warehouse for further sorting. These materials include furniture, appliances, clothing, toys, tools, reusable goods, and textiles. This collection can be made on call.

Transfer stations and landfills need to be converted to Resource Recovery Parks to handle self-hauled loads and special discards. These materials include Chemicals, construction and demolition materials, wood, ceramics, soils and in case of self-hauled reuse, recycle and compost categories.

Clusters and Facilities

Table 2 shows the facilities needed for each cluster.

Table 2

Clusters	Facilities	Construction and Demolition (C and D):
Recyclables: **Paper and containers made of Paper, Metals, Glass, Polymers** **Organics:** **Food, vegetative debris, food dirty paper, paper, plant debris, putrescible, wood** **Reused Products:** **Furniture, appliances, clothing, toys, tools, reusable goods, textiles** **Special Discards:** **Chemicals, construction and demolition materials, wood, ceramics, soils**	**Recyclables:** **Papers, plastic, glass and metal containers (Material Recovery Facility mrf)** **Organics:** **Food, vegetable debris, and food paper, putrescible, untreated wood and sheetrock (Composting or AD)** **Reuse & Repair:** **Reuse, repair, dismantling, reconditioning, remanufacturing, manufacturing and resale of furniture, large and small appliances, electronics, textiles, toys, tools, metal and ceramic plumbing, fixtures, lighting, lumber and other used building materials (Repair and Dismantling)**	**Rock, soils, concrete, asphalt, brick, land clearing debris, and mixed construction and demolition materials (Sorting and Grinding)** **Regulated Materials:** **Used motor oil, paint, pesticides, cleaners, and other chemicals (Reuse, Take Back and HHW disposal)**

Reusable materials need a warehouse for sorting and dismantling. An unloading area, baler and loading dock are necessary.

Recycling materials need a Materials Recovery Facility (MFR). This facility takes in comingled containers and papers and with magnets, lasers, blowers and hand sorting creates bales for global markets. Many MRF'S are all hand sorted. The value a bale of cardboard is relatively the same in India as it is in Colorado.

Compostable materials need land to grind the materials, trommel sort, windrow the material, wet and turn for aerobic composting. CO2 and soil are the products. In an anaerobic system the material is reduced without air and creates methane which is extracted for reuse. The final digestate needs to be composted and stabilized and can be used as a soil amendment.

Construction and Demolition (C and D) material can be as much as 1/3 of all discards disposed of at a landfill. Comingled C and D materials can be sorted on a belt to recover metal, wood and rock.

Toxic materials need to be taken back to manufacturers or collected and safely packed for proper disposal.

Revenue and Jobs from Discards

To estimate the value of discards take the annual tons disposed of at the landfill and/or incinerator and apply the percentages in the pie chart. You can look at local studies to see if there is a waste

characterization analysis. These studies typically sort samples of discards in 75 or more categories. These can be combined into the twelve market categories.

Once the annual amounts of materials discarded by category are calculated, their value can be estimated. The value of baled material is based on official published market prices. These prices are posted in markets journals, newsletters and internet sites. The price for finished compost is used for the organic materials.

There is a collection and processing cost but when compared to the cost of polluting (landfill and incineration) these materials have net positive end value. In Table 4 market values for each commodity class are posted. One third of the value is from reusable materials. This is a good illustration showing why we should manage these materials away from landfill. Other commodities like paper, metal and polymers have a global value as well.

The jobs calculation comes from the Institute for Local Self Reliance. They use a one job average could be created for every 10,000 tons disposed of at Landfill or incineration. For the one million tons in the table there was nearly $50,000,000 annual dollar lost to the Landfill and more than 2000 potential jobs.

Table 3 shows the value of commodities in terms of revenue and job creations.
The value of a ton of baled paper, metal, and polymers (plastic) is a global price and is basically the same worldwide. Reusable and Organic materials are locally used products. The value and amount of labor used for reuse and repair would vary as labor rates are different around the world.

Table 3 Commodity Value and Jobs Estimate for the State of Delaware

Clean Dozen℠ Master Categories	Jobs	Tons per Year	Market Price $/T (est.)	Total Value of Discards in Delaware ($)
1. Reuse	350	28,000	550	15,400,000
2. Paper	65	370,000	20	7,400,000
3. Plant Trimmings	30	100,000	7	700,000
4. Putrescible	85	190,000	7	1,330,000
5. Wood	24	40,000	4	320,000
6. Ceramics	7	20,000	4	80,000
7. Soils	20	10,000	7	70,000
8. Metals	35	60,000	40	2,400,000
9. Glass	75	30,000	10	300,000
10. Polymers	1,020	110,000	100	11,000,000
11. Textiles	340	40,000	200	8,000,000
12. Chemicals	4	2,000	15	30,000
Total	2,055	1,000,000		47,030,000

Residuals
The residuals are less than ten percent. Of this sometimes as much as 6 percent are diapers. This is a product that needs to be redesigned. Counties, Cities and Joint Powers Agencies have the power to make rules in the name of health and safely. Products like these should be compostable.

The rest of the residuals are composite packaging material, wrappers and legacy waste like lead painted wood. Some of this can be redesigned and the remainder for now can be buried in a double lined landfill with no unprocessed organics mixed in.

Summary
The elements of a Zero Waste system include:

1. Producers taking responsibility for the impact of their product on the environment,
2. Producers designing products for the environment,
3. Clean production systems at factories that create neither wasted materials nor toxic discharges,
4. Retail stores take back products that are not recyclable or compostable,
5. Consumer purchase products that are environmentally friendly,
6. Resource recovery parks replace transfer stations and landfills,
7. Rules are changed to require separation, ban organics from landfill, no c and d without a plan and take back where no recycling system or composting system is in place,
8. Tax rules are changed to tax resources not labor,
9. Many new jobs in reuse, repair, recycling and composting care created.