

# Zero Waste as a New Concept for Sustainable Waste Management

UDC: 005.6:502.131.1 ; 628.4

Nataša Petrović<sup>1</sup>, Sonja Iščamović<sup>2</sup>, Veljko Jeremić<sup>3</sup>

<sup>1,2,3</sup>Fakultet organizacionih nauka u Beogradu

*The generation of waste has been one of the most prevalent and least thought about byproduct of human activity in history. The burying or bumping management approaches of the past, however, are no longer acceptable: environmentally, economically, or socially. In addition, predicted levels of population, production, and consumption growth in next century will increase the quantity and complexity of waste materials. If global problems such as climate change and waste remain unresolved, society must choose to continue attempting to incrementally reduce wastes and lessen impacts. Logically, there is a need for Zero Waste, which seeks to eliminate waste wherever possible by encouraging a systems approach that avoids the creation of waste in the first place.*

## 1. Introduction

*The world we have created today as a result of our thinking thus far has problems which cannot be solved by thinking the way we thought when we created them.*

Albert Einstein

Humanity seems to assume that the world has an infinite assimilative capacity for the mountains of waste that it generates. The problem did not start with the current generation or even with the industrial revolution; rather waste has been a problem since the appearance of humanity. Many solid waste management (SWM) experts refer to waste as a necessary by-product of activity. Furthermore, the economic growth and standard of living enjoyed by many nations today appears to justify the accumulation of waste. Unfortunately, expected growth and development trends indicate that the volume and composition of waste will make management more complex in the future. Solutions to the problems created by waste must first address the way in which waste is perceived.

The economic perspective is that waste is an externality to the industrial process. However, this approach is being challenged. Industrial ecologists note that waste represents an inefficient use of raw materials and rising raw material and disposal costs may ultimately impair a business' competitiveness. Municipalities and their taxpayers are also victims of increasing waste management costs, particularly in the siting, building, and operation of high technology landfills.

The concept of sustainable development, widely adopted after the Report of the World Commission on Environment and Development's 1987 report, Our Common Future, reflects the interdependence of environmental, economic, and societal issues. Management of waste, and indeed all pollutants, must be examined in the context of long term sustainability. So, the cur-

rent linear material flow from extraction to disposal is witness to resource depletion based economy and cannot be sustained. In response, many countries have adopted and promoted the concept of a waste management hierarchy based on the 4 R's: reduce, reuse, recycle, and recover. The objective of this hierarchy is to illustrate the relative preference given to the various waste management options and to encourage diversion and ultimately reduction based programs.

Solid waste management has been the focus of increasing attention by all levels of government, environmentalists as well as the public in general. As a result, a plethora of information and literature exists on the subject. In fact, each of the components of the 4 R's has spawned numerous research studies, academic publications, professional journals, as well as conferences. The management of solid waste has traditionally been the jurisdiction of municipal governments, which have concentrated on the establishment and operation of collection and disposal systems. Perhaps this localized management explains the presence of the varied terminology and definitions for waste. The literature lists many types of waste including agricultural waste, radioactive waste, liquid waste, hazardous waste, industrial waste, and residential waste. The primary sources of waste are industrial production and human consumption and the lines between these categories are often unclear.

While waste is woven tightly into our lifestyles, recent attempts to manage its disposal and/or treatment have brought attention to its very definition. In the absence of common physical characteristics, many definitions focus on waste as products or materials that have presumably been used and then discarded. The assumption is that materials and products have a single purpose and once fulfilled are useless. Waste could be defined as "unusable material leftover from a process of manufacture, the use of consumer goods, etc.; the useless by-

products of a process”, or “any substance (solid or hazardous) for which the owner generator has no further use and which he/she discards”, [4]. The very subjectivity of this traditional view of waste is problematic because it includes all materials that are discarded, including potential secondary materials.

## 2. Definition of zero waste

The Zero Waste International Alliance broadly defines Zero Waste as: “A philosophy and visionary goal that emulates natural cycles, where all outputs are simply an input for another process. It means designing and managing materials and products to conserve and recover all resources and not destroy or bury them, and eliminate discharges to land, water or air that do not contribute productively to natural systems or the economy”, [8].

Unlike our current system of managing waste, Zero Waste seeks to eliminate waste wherever possible by encouraging a systems approach that avoids the creation of waste in the first place. A Zero Waste systems approach turns material outputs from one process into resources for other processes.

Although there have been great strides in expanding recycling over the last decade, recycling more materials is not enough to achieve a truly sustainable economy. If materials are buried in a landfill or burned in an incinerator, industry must extract and process new virgin materials to make new products. It’s as if there is a long shadow of depleted resources and wastes left over for every product and package used that is much larger than the product or package itself.

The U.S. Environmental Protection Agency (EPA) also determined that “Source reduction and recycling can reduce greenhouse gas emissions at the manufacturing stage, increase forest carbon sequestration, and avoid landfill methane emissions”, [6]. EPA determined that energy use and greenhouse gas emissions were reduced the most by eliminating waste and the reuse of materials. That is why Zero Waste emphasizes the reduction and reuse of materials first, then recycling and composting, so that resources are not unnecessarily wasted in the first place. So, we can conclude that Zero Waste: redesigns the current, one-way industrial system into a circular system modeled on Nature’s successful strategies; challenges badly designed business systems that “use too many resources to make too few people more productive”; addresses, through job creation and civil participation, increasing wastage of human resources and erosion of democracy; helps communities achieve a local economy that operates efficiently, sustains good jobs, and provides a

measure of self-sufficiency; aims to eliminate rather than manage waste.

Zero Waste strives for:

- 100% Resource Efficiency;
- Zero Solid & Hazardous Waste;
- Zero Emissions - to air, water or soil;
- Zero Waste in Production & Admin Activities;
- Zero Waste in Product Life;
- Zero Toxics:
  - to reduce risks to nature,
  - the presence of toxics creates hazardous waste.

## 3. The hierarchy of zero waste

Zero Waste focuses first on *reducing* the volume and toxicity of waste by eliminating them in the first place. Zero Waste then focuses on *reusing* materials and products for their original intended uses, and then for alternative uses, before recycling. Once materials have been reduced and reused as much as possible, then Zero Waste focuses on *recycling* and *composting* all remaining materials for their highest and best use.

Waste management strategies should aim at maximizing energy and material recovery while minimizing the final amount of waste delivered to landfill and the pollution related to all treatment and collection steps. Environmental problems must be solved step by step, using appropriate technological, economic and social constraints, achieving Reuse and approaching the ideal target of zero emissions may require that we have to pass through the lower levels of the pyramid of Figure 1, in order to acquire experience, knowledge, understanding and organization.

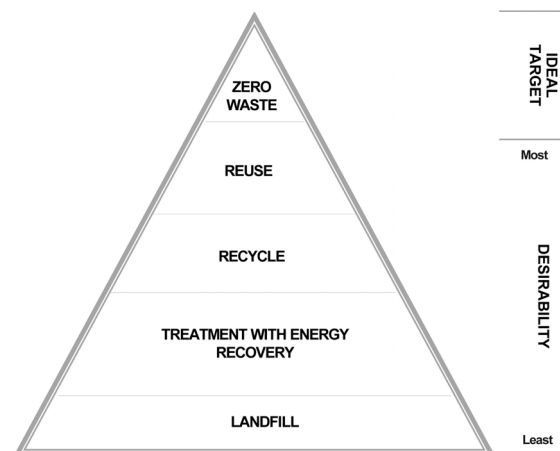


Figure 1. - The waste management hierarchy, [1]

Ecosystems recycle every kind of waste, and the concept itself of “waste” is no longer appropriate. The products from one component or compartment are always a useful resource for another component or compartment.

Ecosystems self-organize in such a way that all available resources are utilized to the maximum possible extent and no unused resources are left. Zero Waste encourages local and regional public-private partnerships to develop Resource Recovery Parks to provide the infrastructure and services needed to accomplish all of these functions. In a Zero Waste system, any materials that cannot be easily and conveniently reduced, reused, recycled or composted are either returned to the manufacturer direct or through retail channels, or no longer used.

Nature, for itself, has life cycles function without producing waste. Goods and materials, at present industrial system, are extracted from the earth's crust, transported to manufacturing sites, used to produce products (all materials not part of end product are discarded as waste), then products are transported to users and finally, at the end-of-life, discarded as waste. To eliminate or reduce waste, we can use the cyclical pattern modeled by nature as the most efficient, less costly, and most profitable, which avoids systematic deterioration of the environment. The cyclical system apply the equation "waste = resource" and eliminates wastes from the environment as indicated in Fig.2.

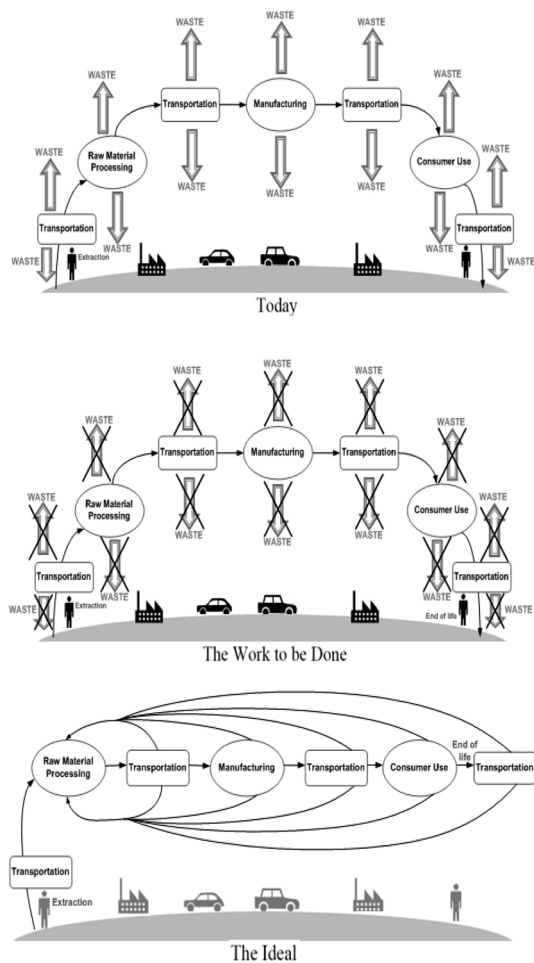


Figure 2. – Nature life cycle and cyclical system

#### 4. Zero waste objectives and strategies

The following objectives and strategies have to been identified in order to provide a framework to guide in the planning and decision making process towards achieving Zero Waste. The Zero Waste goal will only be possible to accomplish if sufficient funding, staffing and authority are provided and recommended policies are adopted.

##### Objective 1 – Reduce - Work with Residents and Businesses to Eliminate Waste

###### Strategy 1: Expand educational and technical assistance programs

1. Encourage residents and businesses to eliminate wastes as a priority, on a voluntary basis.
2. Provide technical assistance to local businesses to adopt sustainable best business practices to minimize waste and avoid landfill and incineration (e.g., more waste audits, how-to guides, and periodic advice on how to implement recommendations of waste audits).
3. Promote and incentivize businesses to create and market products and services that utilize processes and means that reduce the volume and toxicity of waste and materials.

###### Strategy 2 Promote Voluntary Take backs

1. Encourage retailers and their suppliers to take-back products and packaging that are currently difficult to reuse, recycle or compost.
2. Promote take-back programs.

##### Objective 2 – Reuse – Develop Infrastructure beyond Recycling

###### Strategy 1 Expand opportunities for reuse of used materials and products

1. Develop and present to citizens and businesses a list of the highest priority materials to be reused, such as used building materials, used plastic toys, textiles and leather, and arrange for each of these materials to be accepted in at least one drop-off location each.
2. Work with local reuse nonprofits and businesses to expand convenient drop off locations.

###### Strategy 2 Work to preserve residential buildings that are still functional

1. Encourage adaptive reuse as a priority in building standards for residential construction.

### **Objective 3 – Offer Recycling and Composting Services to All**

#### **Strategy 1 Expand Recycling Services**

1. Develop and communicate to the public a list of the highest priority materials for recovery of those currently disposed to be added to local recycling programs (e.g., film plastics). Include materials on this list in at least one drop-off location each.
2. Maintain one or more recycling drop-off centers.
3. Support other regional recycling centers and businesses to help them expand and provide additional services needed.
4. Work with independent recyclers to help the community recycle their waste.

#### **Strategy 2 Expand Composting Services**

1. Develop composting collection program for discarded food and food-contaminated paper as the second highest priority for new services for both the residential and commercial sectors. Include composting programs on the list of highest priority materials for recovery and provide at least one drop-off location for these materials.
2. Help interested businesses to start food waste composting pilot program.

### **Objective 4 - Incentives and Support for Zero Waste Initiatives**

#### **Strategy 1 Establish Rate-Based Incentives and Disincentives to Reduce Land filling**

1. Seek ways to incentivize businesses to adopt Zero Waste goals and to develop Zero Waste plans.
2. An example of a possible progression from rate incentives to mandates is presented as follows:
  - a. Stage 1 - In the first stage of this plan, create a progressive multi-stage rate structure tied to measurable material reduction goals to ensure that both residents and businesses that waste less pay less.
  - b. Stage 2 - Beginning in stage two, implement first stage rate structure incentives, targeted at high priority waste materials to be reduced. Provide progress report both at mid-year and at year end. Evaluate mid-year progress and move to stage two rate structures if insufficient progress has been achieved.
  - c. Stage 3 - Beginning in stage three, if progress meets operational reduction targets, then maintain rate structures. If not, then advance to higher stage rate structures for another six-month trial, reporting back, twice each year until stage 4.

d. Stage 4 - If, by the end of stage 3, designated materials have not been decreased, following implementation of progressive rate structure and periodic reporting, then consider adopting bans or mandates with fines to require proper handling of those materials which have not been successfully reduced.

3. Develop and communicate to residents and businesses a list of the highest priority materials for recovery of those currently disposed, to eliminate from the waste stream in addition to materials already being reduced or recovered. Suggest viable alternatives to those materials and products and where to get them. Provide information and assistance as needed for implementation.

#### **Strategy 2 Adopt Business Investment Policies to Expand Services**

1. Encourage the cost effective development and expansion of services to reduce, reuse, then recycle and compost for all materials. Establish minimum qualifications for service vendors to provide such services as appropriate to ensure public health and safety. Establish mandatory service vendor reporting requirements to accurately capture quantities and weights of diverted materials.
2. Implement policies that penalize the discharge of toxic materials into the environment.
3. Increase public and private collection and processing services on an open, competitive basis, and help develop new businesses that add value to materials recovered and minimize residues that require disposal.
4. Stimulate innovative services to be added by the private sector and nonprofit groups. Encourage different types of services to be provided for different types of businesses.
5. Develop new requirements for owners and managers of multi-family dwellings and multi-tenant commercial buildings that ensure that all tenants have reasonable access to services and premises-based facilities comparable to single-family dwellings and small businesses.
6. Utilize economic resources staff to promote expansion of services related to reduce, reuse, recycle, and compost.
7. Establish target for the full avoided disposal costs to be basis for evaluating economics of Zero Waste programs and policies

**Strategy 3 Educate and engage the community to support Zero Waste initiatives**

1. Continue to develop and implement a public education and communications program concurrent with the design of new waste diversion programs. Develop new Zero Waste promotional materials. Promote positive Zero Waste buying power and behavior with promotional materials and website.
2. Continue to implement new education and outreach in advance of the implementation of any new programs to obtain the maximum support for new initiatives that will help in achieving Zero Waste goal.
3. Coordinate outreach programs for sustainability and pollution prevention with Zero Waste, waste prevention and recycling programs.
4. Implement community-based social marketing programs to more actively engage residents and businesses.
5. Work with industry groups to promote Sustainable Business and Green Business programs.
6. Recognize business and residential Zero Waste leaders.

**Strategy 4 Develop Resource Recovery Park**

1. Develop or help developing a Resource Recovery Park to provide location(s) for expansion of reuse, recycling and composting businesses.

**Objective 5 -Lead by Example and Advocate Zero Waste**

**Strategy 1 Maintain a Public Advisory Review Body for Zero Waste Policy**

1. Continue a Zero Waste Task Force or other advisory body at discretion of Council, made up of community representatives to serve for limited duration to review the staff prepared Zero Waste Operations Plan and advice the Council on its implementation of and changes to associated City Zero Waste policies.

**Strategy 2 Maintain Active State and Regional Profile on Zero Waste Public Policy**

1. Work with State and Federal legislators and support other communities in the region to adopt similar Zero Waste goals and plans. Work with them where appropriate to remove and resolve mutual obstacles.
2. Undertake a coordinated effort with regional cooperation, to support state and national efforts to adopt:
  - Extended producer responsibility;
  - Deposit programs;

- funding of zero waste initiatives through statewide or regional landfill surcharges and product charges;
- Full cost accounting for waste disposal;
- Packaging levies (e.g., on plastic bags);
- Minimum recycled content standards for additional products;
- Design for the environment programs;
- Green procurement and green building guidelines for the public sector;
- National measuring, monitoring and reporting in achieving zero waste goals; and
- New mechanisms for financial assurance for post-post-closure liabilities for landfills.

**Strategy 3 Minimize long-term landfill liabilities**

1. Ensure that the full capital and operating, closure, post-closure and post-post-closure costs are factored into current rates and financial assurances, particularly for private landfills.
2. Establish a target to reflect the benefits of avoiding these future liabilities as an avoided disposal cost.
3. Work actively with landfill contractor and regulators to increase mechanisms for financial assurance for landfill liabilities.

**Strategy 4 Provide Funding to Implement Zero Waste Plan**

1. Create a Zero Waste fund to encourage local innovation and participation. Fund community Zero Waste initiatives with fees levied on the transport, transfer and disposal of wastes where feasible.
2. Leverage the investments of the private sector by adopting supportive policies and providing technical assistance and support letters for independent financing and/or grants. The more that nonprofits and private companies invest in expansion of reuse, recycling and composting programs, the less is needs to invest.
3. Identify and support proposals for state, federal and foundation grants and loans for businesses and service providers.

**Objective 6 - Update Waste Data and Develop Zero Waste Operations Plan**

**Strategy 1 Update Waste Data**

1. Proceed promptly with a Waste Composition Study to report updated data in categories and subcategories designed for programs targeted to reduce or recover those materials. Include analyses of different

segments of the commercial and industrial sectors, and institutions (including restaurants, medical services, retail, offices, multi-family dwellings and government/schools).

2. The Waste Composition Study should clearly identify reusable materials and materials in the waste stream that are likely to be significant targets for programs to reduce or reuse such materials.
3. After the Waste Composition Study is completed, monitor measure and keep the community informed of progress and results. Provide annual reports on progress of all waste reduction initiatives. Highlight results of recent policy and program changes.

### **Strategy 2 Develop Zero Waste Operations Plan (ZWOP)**

1. Identify what type of facilities need to be developed by and for to meet the service needs identified in this Strategic Plan.
2. Evaluate whether facilities exist or will be built to meet needs by the private sector, or recommend what facilities the public sector will be required to build. Compare costs of capital-intensive approaches that could be built on more expensive land vs. more land-intensive lower cost approaches that exist or could be built on the outskirts (e.g., for composting facilities).
3. Evaluate the market value of reusable materials, recyclables and compostable material still being land filled.
4. Identify public or private programs necessary to reduce, reuse, recycle or compost the materials identified from the Waste Generation Study.
5. Design different programs for different sectors, including multi-tenant buildings (residential and commercial), downtown businesses, strip malls, restaurants and hospitality industry, and major industrial areas. Provide universal access to opportunities to reduce, reuse, then recycle and compost.
6. Evaluate long-range reliance on single-stream recycling services versus expanded source separated collection.
7. Identify candidate locations for other new public and private facilities that might be required, with a conceptual basis for how to pursue the development of those facilities.

8. Reduce potential releases from degrading landfill sites that has a growing stake in.

9. Recommend policies and incentives consistent with this Strategic Plan.
10. Estimate jobs expected to be created and financial benefits from implementing the Zero Waste Operations Plan.
11. Identify which financing tools might be most helpful to local businesses to expand services needed to achieve Zero Waste.
14. Determine what funding, staffing and authority will be needed for staff to implement a Zero Waste goal.
15. Establish targets and goals for the Operational Plan.
16. Establish criteria for implementing bans and mandates where voluntary efforts have not been effective in meeting Zero Waste.

### **5. Conclusion**

Sustainable development represents a commitment to advancing human well-being, with the added constraint that this development needs to take place within the ecological limits of the biosphere. Human economy depends on the planet's natural capital that provides all ecological services and natural resources. As a result of population increase and economic development, humans have exerted a considerable impact on the earth and are facing a series of incompatibilities among the natural resources, environment, and economy, such as the dichotomy of population growth and depression of resources and environment deterioration.

By understanding why human race need to reduce the amount of waste that all of us produce and dispose of, we can make a big difference to the scale of residual waste that needs to be treated. We (people) all need to make a concerted effort to think about the types of products we are buying, and consider whether they can be reused or recycled. Human interaction with the regenerative capacity must thus be managed carefully. Just as it is in our self-interest to track our financial assets carefully, it is equally important to track our ecological assets, which provide the ecological services that sustain human life and economic activity.

On the other hand, Zero Waste has to be a design principle for the 21st Century that seeks to redesign the way resources and materials flow through society. Zero Waste requires eliminating subsidies for raw material extraction and waste disposal, and holding producers

responsible for their products and packaging 'from cradle to cradle'. The goal is to promote clean production, prevent pollution, and create communities in which all products are designed to be cycled safely back into the economy or environment.

## REFERENCES

- [1] Cherubini, F., Bargigli, S., Ulgiati, S.: *"Life cycle assessment of urban waste management: Energy performances and environmental impacts"*, Waste Management 28, pp.2552-2564, 2008.
- [2] Petrović, N., Petrović, B.: *"Utjecaji proizvoda na životnu sredinu"*, Zbornik radova XXXI Simpozijuma o operacionim istraživanjima SYM-OP-IS 2004, Rudarsko-geološki fakultet Univerziteta u Beogradu, Iriški Venac, Fruška gora, 2004.
- [3] Petrović, N.: *"Merenje ekološke podobnosti proizvoda"*. Zbornik radova (editor dr Dragan Radojević, ISBN: 86-82183-07-2) XXXIII Simpozijuma o operacionim istraživanjima SYM-OP-IS 2006, Institut Mihailo Pupin, Banja Koviljača, 2006.
- [4] Petrović, N.: *"Environmental Managment for Business"*, Book of Abstracts of the International Conference "Business and Globalization" - KEEFP 2007, University "St. Kliment Ohridski", Faculty of Economics - Prilep, Ohrid, Republic of Macedonia, 2007.
- [5] UN Conference on the Human Environment. Draft Declaration on the Human Environment. United Nations Environment Programme; 1972. Annex I. <http://www.unep.org>.
- [6] U.S. Environmental Protection Agency, Office of Solid Waste, Solid Waste Management and Greenhouse Gases: a Life-Cycle Assessment of Emissions and Sinks, May 2002, 2<sup>nd</sup> edition, EPA530-R-02-006, page ES-9.
- [7] <http://www.zwia.org/standards.html>
- [8] <http://www.zerowaste.com>