Re5 -ReVive - Rethink, Reduce, Reuse, Recycle & Reclaim: The Zero Waste Solution that Turned Around Garbage City

Garbage City Needed Relief

Near Cairo, where Egypt’s dessert plateau meets the Nile Valley, sits the thriving metropolis of Egabrag (2166 population: 151,515). Egabrag’s primarily flat terrain slopes up toward Mokattam Mountain, which means ‘broken mountain’ in Arabic. The mountain’s limestone was used to complete the Giza Pyramids in 2560 BC, when the wide Nile River reached Mokattam Mountain. With completion of the Aswan Dam in 1970, the river narrowed and is now 5.5 kilometers away. The region’s arid climate receives only 3 millimeters of rain each year. However, in 2133, Egabrag’s civil engineers constructed the East Nile Canal to bring back a waterfront.

In the early 2000’s, Egabrag was Mokattam Village, a downtrodden section of Manshiyat Naser at Mokattam Mountain’s base. The 40,000 residents were called the Zabbaleen, the garbage collectors of Cairo, and Mokattam Village was known as Garbage City. Organized infrastructure and basic utilities, such as water and sewage, were lacking. Narrow roadways were unpaved, and apartments and streets were used to sort garbage. The people were the outcasts of society and had little access to higher education and medical services.

Solid Waste Situation in Garbage City

Each day, 9,000 Zabbaleen would head out with mule-drawn carts and old trucks to collect Cairo’s trash, haul it back, and separate it by hand. Food waste was fed to pigs and goats. Items of value, such as paper, cardboard, glass, and electronics were recycled and sold for revenue. Plastics were reprocessed and molded into useful items. The economy of Garbage City was waste management and the Zabbaleen were the ultimate recyclers.
Issues with Garbage City’s Waste Situation

Since the economy was based entirely on waste management, there was little time for much else. Men, women, and children all helped with manual sorting of trash, and subsistence living kept the Zabbaleen poor. Due to the lack of sanitation, accidents and illnesses from garbage collection and separation were common. Raw trash throughout the city resulted in strong odors and numerous pests. Although the people had little, they had faith and valued education. This waste management knowledge eventually helped them build a better life for future generations.

Garbage City became Egabrag

Over time, residents refined their recycling and waste management techniques into cleaner, more efficient, and safer procedures. Then, brilliant engineers, with help from the University of Mokattam (the second great U of M), developed a marvelous waste management system. Garbage City was turned around and became Egabrag, which is garbage spelled backwards!

Today, the people of Egabrag are well-regarded, and tourists are eager to visit the beautiful desert oasis. The East Nile Canal flows through the exciting commercial district, and the North and South EgaPonds offer limitless recreational opportunities. Wide boulevards are lined with fragrant acacia and mimosa trees, and EgaTrams shuttle visitors to the University of Mokattam and the Attala Hotel and Wellness Retreat on top of Mokattam Mountain. The University of Mokattam is the world-leader in integrated waste management education, and global waste management conferences and international Future City competitions are hosted at Egabrag Expo near the famous cave church.

Egabrag’s world-class communication, education, and medical system is based on EpiTatt (epidermal tattoo) technology. The piezo-powered, holographic, voice-activated devices are 3D-printable, removable, and can be personalized. With EpiTatt, students can attend class virtually or in person. EpiTatt links with safety, police, and fire services and is also a real-time interface with physicians for remote health monitoring. Additionally, residents receive world-class medical treatment at the EgaMed Health Center and Medical School.

EgaLev, the efficient and universally-accessibly public transit system, moves residents between Egabrag’s zones and beyond. EgaPod personal vehicles generate power on solar-piezoelectric roadways and charge while parked at subhubs. Redundant energy processes include waste reclamation, space-based solar, and electrostatic wind systems. Efficient utilities, including biomimetic water harvesting systems that condense moisture from the air, are controlled by the triple-redundant EgaGrid. Self-sustaining architectures are made from 3D-printed biocement and include rejuvenating, hyperbaric interiors. Active membrane exteriors capture water, filter air, and convert light into energy.

Re5-ReVive: A Total Solution for Garbage Pollution

Egabrag’s engineers developed Re5-ReVive, which stands for Rethink, Reduce, Reuse, Recycle and Reclaim. Re5-ReVive considers all municipal solid waste streams, including organic materials, electronics, recyclables, non-recyclables, hazardous materials, and biohazards. With
Re5-ReVive, waste becomes a resource. Landfills for waste residue and sorting by hand are a thing of the past! Re5-ReVive’s parts are described below:

**Reduce:** Waste is reduced by not creating it in the first place. Packaging is greatly reduced through local shopping at Egabrag’s Farmer’s Market.

**Reuse:** Items from the Colossal Flea Market are repurposed. Valuable materials such as copper and rare earth metals are harvested for reuse through strategic landfill deconstruction.

**Recycle:** Recycling saves the value of waste. The recycling complex processes recyclables, including glass, paper, aluminum and other metals, while Smart Design assists with material separation.

**Reclaim:** Organic waste ‘rots’ in the absence of oxygen in anaerobic digesters to produce biogas and compost byproduct. Plasma gasification systems process non-recyclables, hazardous materials and biohazards to produce synthetic gas and slag aggregate byproduct.

**Rethink:** The key to zero waste is rethinking it. Reduce what can be reduced. Reuse what already exists. Recycle what can be recycled. Reclaim energy and useful byproducts from everything else!

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**Outcomes of Re5-ReVive**

Re5-ReVive brought awesome quality of life improvements to Egabrag. The zero waste solution was implemented using modular scalability, where revenue from reclaimed energy was reinvested to expand waste management capacity. Compost byproduct from anaerobic digestion of organics enhances the agricultural zone’s soil. Slag aggregate from the plasma gasification process is used as filler for 3D-printable biocement construction materials. Biocement is created through microbial-induced calcite precipitation, where sand is combined with agricultural zone urea and friendly bacillus pasteurii bacteria from the algae towers.
Technology and Infrastructure

Recyclables and waste arrive at processing facilities straddling the industrial and agricultural zones through waste-specific underground vacuum tubes located at all major buildings. Convenient in-home anaerobic digesters also convert food waste into biogas for cooking. With Re5-ReVive, non-recyclable waste streams result in energy production, energy storage, and useful byproducts:

Re5-ReVive is Energy Efficient

Re5-ReVive reclaims energy from all non-recyclable waste. Egabrag’s energy needs include 1,750 MW-hr/year in residential areas and 3,500 MW-hr/year for city services, including transportation and waste management collection, separation, and processing. Since Re5-ReVive produces 7,000 MW-hr/year, and renewable energy sources produce another 3,500 MW-hr/year, abundant excess energy yields a revenue stream for reinvestment:

- Biogas from anaerobic digestion of organics (food, agricultural, yard, and forestry waste) is combusted to produce electricity. B3-sponge (Biodegradable-Biopolymer-Biosponge) adsorbs carbon dioxide emissions.
- Plasma Gasification at 10,000°F is cleaner than incineration. Synthetic gas (carbon monoxide and hydrogen) is produced from non-recyclables, hazardous waste, biohazards, and landfill deconstruction residue.
- Even sewage produces energy at bioengineered algae towers, which consume black water and B3-sponge to create hydrogen, another green energy source.
Energy is stored in graphene-supercapacitor batteries throughout Egabrag, and recycling waste versus harvesting new materials saves natural resources, energy, carbon dioxide, and space:

<table>
<thead>
<tr>
<th>Material: Recycled vs. Virgin</th>
<th>Energy Reduction (%)</th>
<th>Energy Savings (kW-hr/ton)</th>
<th>CO₂ Reduction (%)</th>
<th>Space Savings (m³)</th>
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<td>42</td>
<td>38</td>
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**Key Issues of Re5-ReVive**

Re5-ReVive is a carbon-neutral solution for waste management that minimizes negative environmental impacts. Strong odors and pests from raw trash are no longer problems. B3-sponges capture carbon dioxide emissions from energy reclamation processes, as well as ammonia from biocement production. Algae towers consume saturated B3-sponges, along with black water from throughout Egabrag. Underground vacuum tubes efficiently carry waste materials to processing facilities, reducing roadway traffic from waste transport.

**Tradeoffs & Compromises**

Change was hard, but once residents learned about Re5-ReVive’s health and safety benefits, they were eager to implement it. Grants from the University of Mokattam provided original funding, and modular scalability allowed Re5-ReVive to grow steadily in the industrial and agricultural zones. Excess energy production generates a revenue stream. Health concerns are a thing of the past because trash is no longer sorted by hand, and since Re5-ReVive produces no emissions, Egabrag has excellent air quality.
Exceptional Engineers Revived Garbage City

Many engineers contributed to Garbage City’s turnaround:

- Polymer engineers developed B3-sponge systems.
- Controls engineers developed EgaGrid utility management and EpiTatt communicators.
- Electrical engineers developed renewable energy sources.
- Transportation engineers created EgaPod personal vehicles and EgaLev public transit.

Civil and bioenergy engineers were most critical in implementing Re5-Revive. Civil engineers developed Re5-Revive’s infrastructure systems, and bioenergy engineers converted waste into renewable energy to power Egabrag’s future.

Re5-Revive: a zero waste, garbage pollution solution developed by Egabrag’s extraordinary engineers!
References


<http://www.graphenea.com/pages/graphene-supercapacitors#.Vk-U8NKrKg>.


