

## **Waste Not Want Not**

**City: Marhielo**

**Team: New Lebanon JrSr High**

Welcome to Marhielo, an island city in chilly Antarctica. Specifically, we live on King George Island (440 square miles in area) in the South Shetland Islands off the coast of northwest Antarctica. Settled in 1821, Marhielo grew to a population of 500 by 2015. Now in 2150, we boast a population of over 45,000 (median age 35yrs) growing daily because of the number of people who are drawn to a colder climate. With the advent of global warming we are one of the last places in the world with snow, so people flock to our city for recreational activities (skiing, snowboarding, ice fishing and skating) and to watch the beautiful Aurora Australis from our glass-ceilinged hotel rooms. We also draw many tourists looking for a summer home to escape the increasing temperatures of the world.

Though our city's name is from *mar hielo*, Spanish for "icy sea," it's not frigid here. In fact, due to climate change over the past 135 years, our average summer/winter high temperatures have risen from about 63° /11° to over 70° /16° respectively. The nearby ocean helps to moderate climate as well.

Fuel cells, a clean and efficient energy source, provide most of the heat energy for our city. Fuel cells use hydrogen from biomass provided by our compost systems. The hydrogen chemically reacts with oxygen from the air, producing energy, heat, and water. We use the energy to power our city, supplemented by geothermal energy and wind energy from turbines on the mountain. The byproducts of the fuel cells (heat/water) are used by our vertical farms.

Vertical farms with an aquaponics system provide the food for our city. This system uses fish and crops to create a sustainable loop which feeds both the plants and fish until they're ready to be sold at the farmer's market in our city. With the market so close to Marhielo's residential area, transportation costs are low and packaging is minimal, producing less waste.

Marhielo is a safe city. Heat-detection systems use infrared technology to determine when there is a fire or intruder in a building. The system then notifies the authorities, who respond quickly due to our maglev pods. Maglev pods are fast, environmentally friendly, and energy-efficient. Residents of Marhielo use these cars to get around - when they're not walking on our porous pavement (made from recycled tires) or taking the vacuum train. All transportation avenues have imbedded nanowarming devices that clear the ice and snow without salt, sand or

plowing. We are also an educated city, having access to online education provided at central school locations. Our holographic civic center keeps us entertained.

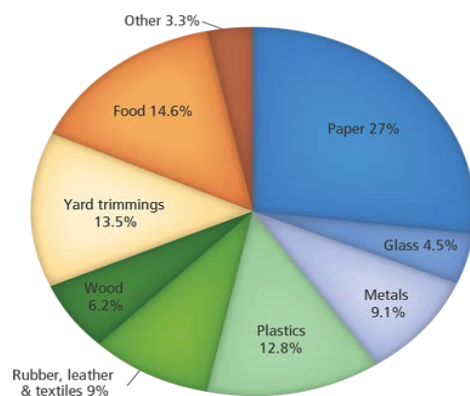
Living in the Antarctic Circle means that residents of Marhielo experience polar night (a period of 24 hours when the sun doesn't rise) and its opposite, polar day (24 hours of sunlight) Our engineers have created windows containing fiber optic technology that can effectively make it look like the sun is shining, even when it's pitch dark outside. This technology uses LED lights calibrated to the wavelength of the sun assisted by a thin sheet of plastic with nanoparticles inside that imitate the natural atmospheric variations of sunlight.

Our city is laid out in a simple, easy-to-navigate manner. Our downtown commercial area is by the ocean, which allows easy access to South America...only 5 to 10 minutes away by vacuum train. Behind the main body of the city is Brimstone Peak, a mountain with man-made terracing. These terraces help prevent runoff from snow melt and provide residential areas with a beautiful view of the city and the ocean beyond. On the rear side of the mountain you can find a luxurious ski resort.

Marhielo was developed as a result of many individual research stations on the island. We still maintain many scientific facilities, including a nanotechnology center and research facilities where we study climate change and rehabilitate wildlife affected by oceanic pollution and the rising temperatures of Earth.

### Total MSW Generation (by Material), 2013

254 Million Tons (before recycling)



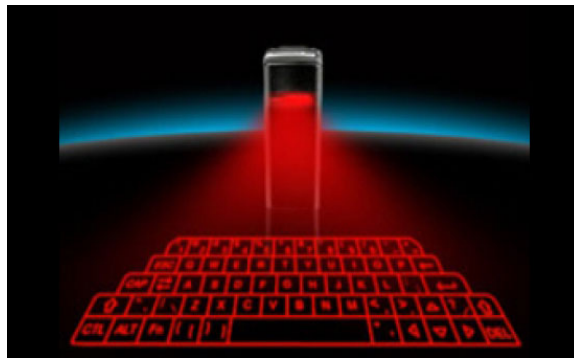
<http://www3.epa.gov/epawaste/nonhaz/municipal/>

What has caused our climate to change so drastically? One simple reason is trash. In 2015 waste was handled in an environmentally irresponsible manner. Most garbage was dumped into

landfills, where it sat for years. However, most trash did not decompose, being made of plastic or other non-compostable materials. People tried to reduce waste by recycling and sometimes composting, but this was not enough. The garbage kept accumulating, creating pollution and causing climate change from the released methane. In 2013, people produced 254 million tons of municipal solid waste, roughly equivalent to 4.40 pounds per person per day.

Marhielo's solution to this problem is straightforward. We have eliminated traditional oil-based plastics entirely, opting instead for compostable bioplastics made from corn, starch, and keratin from chicken feathers. These bioplastics are fully biodegradable, and are disposed of in our composting facility, along with food scraps and yard wastes. In 2013, these three components made up 41% of the waste stream. We also recycle metals, glass and paper (16% of waste stream), and have implemented tax breaks for everyone who uses reusable cloth diapers. Household waste is easily disposed of using vacuum tubes lined with a silicon nanolayer (making tubes easy to clean), which lead from homes to the waste management facilities.

Electronic waste, which accounted for most toxic chemicals in landfills of the past, has been replaced with holographic technology. A small box produces the holographic keyboard for the user and projects the monitor image on a flat surface.

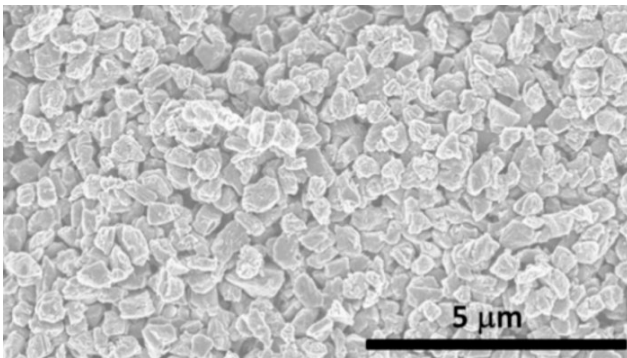


<http://explorecuriosity.org/Explore/ArticleId/492/itech-bluetooth-virtual-keyboard-492.aspx>

We have also rethought landfills. 100% of our solid waste is now processed in either recycling or composting facilities on the outskirts of the city. In the recycling facility, we separate metals and other recyclable materials using magnets and nanotechnology, then sell it back to producers to use again to make new materials. About 60% of our waste is recycled, almost double the 34.4% (or 87.2 million tons) that was recycled in 2013. In the composting facility, food scraps, yard waste, and other biodegradable materials quickly decompose, thanks to sensors that make sure temperature and humidity conditions are ideal for the nanobots and

bacteria to work. We also use the methane produced by the compost. Methane is a compound of the two elements carbon and hydrogen, which we separate using graphene filters. Hydrogen is used in the fuel cells powering the vertical farms, creating a sustainable loop of biomass->compost->methane->hydrogen->fuel cell. In the past, methane was considered the most dangerous greenhouse gas. The second product from methane is the carbon used to create nanotubes, graphene filters, and synthetic diamonds. The nanotubes are used in composting facilities, as well as in our desalination plants to purify water for our city. Carbon is also used to create products including Q-carbon, a carbon product similar to diamonds.

**A micrograph of a q-carbon film, studded with nano diamonds**



<http://www.extremetech.com/extreme/219186-q-carbon-is-harder-than-diamond-incredibly-simple-to-make>

Marhielo's nanobots, made inexpensively with recycled bioplastics and metals, are what make our waste system unique. These serve many purposes; they separate and sort materials on their way to the waste processing facilities, they help biodegrade the waste in our composting facilities, and they sort and collect different types of recyclables to be reused. Working together with natural decomposition microorganisms, nanobots help to quickly disassemble the molecules of waste, fueling chemical reactions that turn our garbage into healthy soil which supplement the thawing permafrost.

There are some tradeoffs to this system of waste management. The facilities can produce unpleasant smells, but nanofilters are used to eliminate this concern. Again, nanotechnology comes to the rescue in managing any ground pollution underneath the building. Layers of carbon nanotubes beneath the building funnel any seepage away from the ground and into processing plants. Another disadvantage is the cost and electricity demands of a large-scale system like this. However, our fuel cells produce more energy than we need, especially when the products of the

compost system go directly to creating more energy. The cost is also covered by the income we make from selling our recycled materials to other countries. In essence, the problems are solved by the results.

Several disciplines of engineering were important in developing Marhielo; three of special interest are plastics, microsystems, and environmental engineering. Plastics engineers focus on all parts of the plastic-making process, including design and manufacture. This is important in Marhielo because bioplastics compose a large portion of the waste processed in our waste management stream. If we still used oil-based plastics, our compost facilities would be largely ineffective. Our microsystems engineers work on the molecular level, creating technology that is effective on a small scale. Microsystems engineers in Marhielo play an essential role in engineering products to break down and sort waste, line the vacuum tubes, and decompose the methane gases. Finally, environmental engineers investigate environmental concerns and advise on ways of correcting the problems. They monitor the environmental impact of the waste management stream, always looking for ways to lessen our carbon footprint.

Every morning in Marhielo we wake up to a sparkling city - not just because of the snow and ice, but because of our unique and clean waste management system.

**Word Count: 1,493 (without titles, citations, and references)**

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