

Tidalwave

Overview:

One hundred years ago, Tidalwave was known as Galveston. It is located at 29.3013° N 94.7977° W on the southern coast of Texas. Due to climate change, the water rose and caused a significant loss of land.

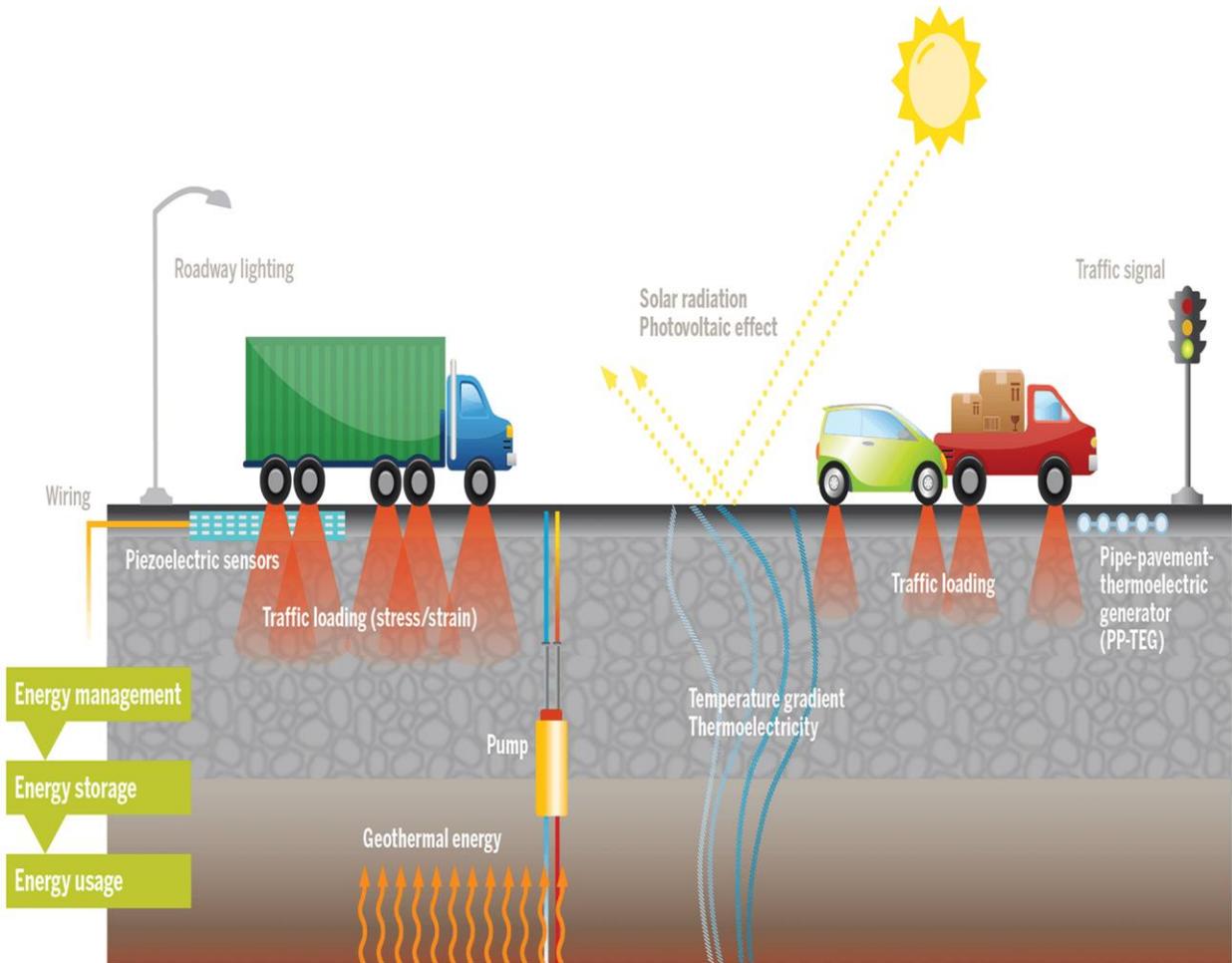
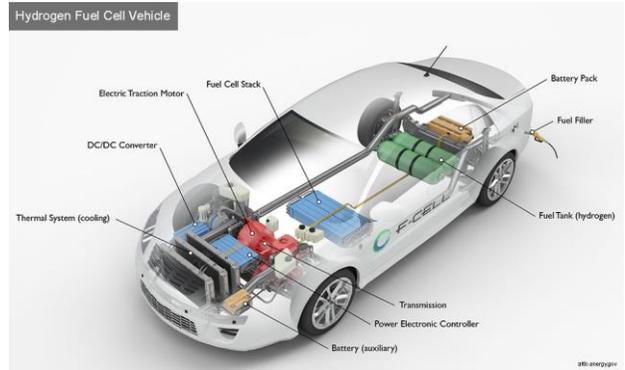
The climate of the Tidalwave is humid subtropical, with an annual rainfall of 50 inches per year. Temperatures are 29°F to 90°F. Tidalwave offers mild temperate, providing one of the coolest places in Texas during the summer and one of the warmest during the winter.

The population of Galveston in 2022 was 54,885; due to the loss of land, the population decreased to 25,569 in 2072. Due to the drastic environmental change, there was a shift in careers in Tidalwave toward a research-based economy focused on solving the climate crisis. With the island city losing land, wildlife habitats, and rising sea levels, it was time for innovative solutions in housing, agriculture, energy, and transportation to rebuild for the future.

A Closer Look:

Civil Engineers designed Tidalwave into compact communities of spacious buildings of mixed residential and commercial use. City planners utilized vertical farms that include greenhouses, aquaponic gardens, chicken coops, and livestock pens locally to reduce the need for transporting goods long distances. Most needed services are within walking distance. With abundant transportation, solar-powered buses, and hyperloop trains powered by hydroelectric fuel. Including hydro fuel cell buses and vehicles. Each neighborhood offers parks for exercise and family fun. Green communities help ensure the health and well-being of the Community by encouraging exercise, which decreases the stress and tension for the citizens. They are equipped with kinetic sidewalks like the entire city to generate electricity as citizens walk or ride

their bikes. Roadways also have the same technology to capture electricity as cars and buses drive.



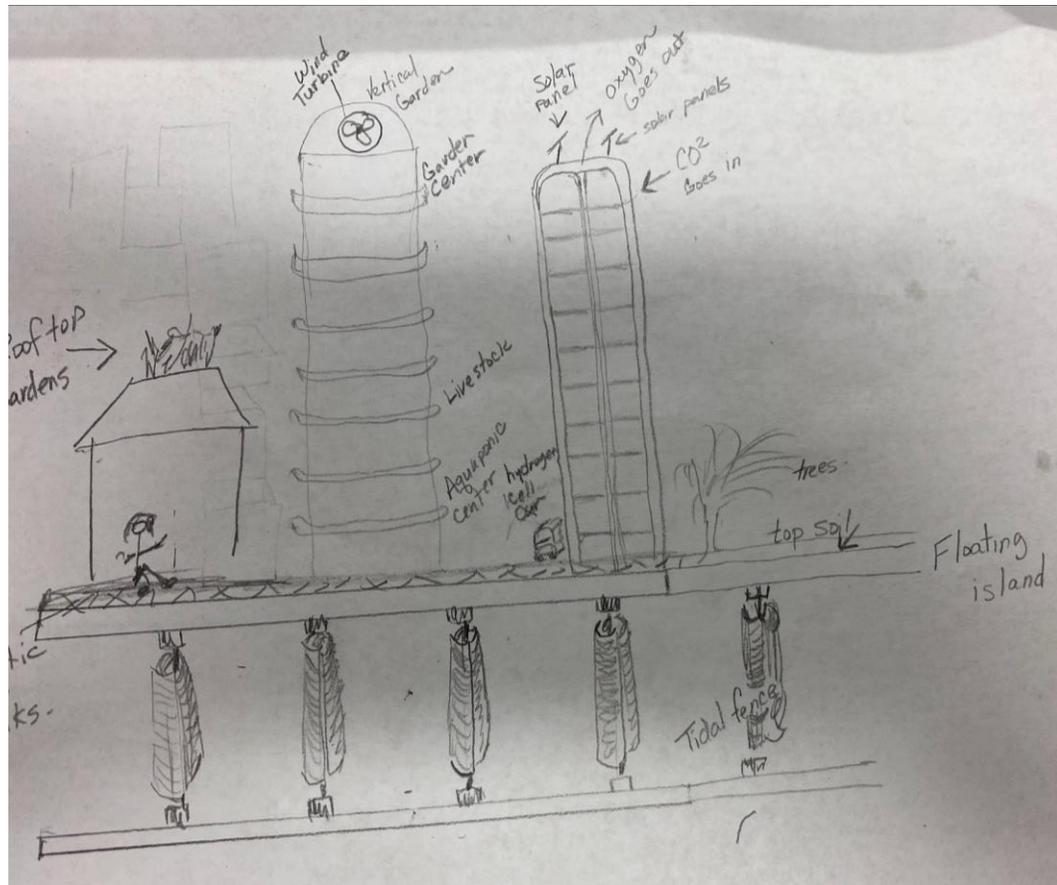
Environmental Engineers designed homes in Tidalwave with built-in carbon filters that remove carbon from the air. Bricks are made from recycled plastic bottles and

lids. Keeping with the theme of circular economy, orange piles are dried and used to create insulation for walls and attics. Tidalwave scientists have devised an alternative to wood-based sheet materials made from waste by-products from the food or agricultural sectors. Called Grant, the natural composite material is 100% biodegradable and vegetarian and can abide into a silhouette of a dossier. It has also developed a world-first insulation panel from mycelium, the white, thread-like root fungus. Natural mushroom fibers can exceed some insulation products.

Engineers utilize bamboo and recycled aluminum for the construction of homes and businesses. Most homes have a rooftop garden that provides food for the family, insulates the house, and reduces the atmosphere's carbon dioxide. Mechanical engineers use algae products in insulating materials, filters, and even bricks for homes. Algae products are used in insulating materials and scouring powder. They also use different types of species in this process in sewage-oxidation ponds. Our Robotic engineers, robotic repair personnel, and computer programmers make up twenty percent of the citizens who work with Climatologists. The city's mechanical engineers work with the city's climatologists to help decide the perfect place to put tidal wave energy transformers.



Floating Island provided not only the needed space to replace the loss of land from the rising sea level but also allowed engineers to attach tidal energy fences underneath, capturing 50% of the electricity needed to power the city. By 2122, 100% of Tidalwave's energy used in homes, businesses, and for entertainment comes from renewable sources. While tidal fences were just a dream 100 years ago, today, the vertical axis turbines capture the current from the tides without building a dam. Mechanical engineers worked with a marine biologist to create a vertical axis turbine mounted in a fence where the tides' movement caused the water to turn the turbines under the floating islands. Tidalwave's compact Community rounds out its renewable energy with hydrogen cell-powered transportation systems, solar power from rooftop panels, kinetic sidewalks, and wind turbines.



City Services:

The education system allows students to attend classes virtually for basic education needs through virtual reality. Through partnerships with local universities, select students participate in advanced engineering schools. These children learn complex math; therefore, by the time they are in high school, they will intern with scientists in the field.

Tidalwave residents are issued a device named The Tidalwave, An A.I. device that monitors everything from vital signs, monitors glucose levels and even energy consumption. It also serves as an entertainment and communication device. The device can be a bracelet, ring, or shoe insert. If there is an emergency, the device will notify the correct emergency response team.

Emergency response personnel monitor the A. I devise to provide needed aid. Robots and drones utilize infrared cameras to generate 3D maps of fires inside buildings to assist firefighters. Firefighters can deploy sonic wave fire extinguishers using low-frequency waves to suck the oxygen out of the building quickly.

Hospital doorways have built-in scanners that quickly determine individual needs as the patients enter the facility. Technicians quickly direct based on their needs. Biomedical engineers invented nanobots capable of repairing hearts, performing surgery, and even attacking cancer.

The Problem:

Climate change causes significant problems for coastal Tidawave including loss of land due to rising sea levels. City government officials knew they had to make changes. It was time for innovative housing, agriculture, energy, and transportation solutions to rebuild for the future. Engineers could switch from fossil fuels by utilizing renewable energy from tidal energy, solar energy, offshore wind energy, kinetic tiles for sidewalks and streets, and hydroelectric-powered cars.

By 2072 the population had decreased by almost 50%. Tourism was virtually nonexistent. The economy was at an all-time low. Something had to be done. The goal is to reduce carbon dioxide usage and find ways to remove carbon dioxide from the air. If not, the city was doomed.

The Solution:

City Planners adapted to the rising sea level residents by building floating islands to provide living space for residents due to land loss. The idea of a floating island dates back to 1969. Marine biologists conducted research and were able to design tidal fences that did not harm aquatic life and their habitats. Tidal wave scientists are studying different ways to construct tidal turbines to be an exact match of coral reefs. The turbines look and feel like coral reefs and coral. As a result, it gives the fish more habitat and room to hide. The main environmental risks of ocean energy technologies

include the collision of marine life with underwater turbines, the creation of underwater sound, and habitat changes.

In order to mitigate climate change, scientists developed methods that pull carbon dioxide out of the air and pipe it deep underground, where it transforms into rock. Huge fans pull air into a collection container with filters. When the filter reaches capacity, it closes. Carbon dioxide becomes a concentrated gas when the temperature reaches the desired level. This gas is injected into a tank of water, and mineralization takes place, turning it into stone over two years. When this process began in 2022 yearly, a plant could only remove carbon dioxide from 870 cars yearly. In 2122, the more advanced plant can remove the carbon dioxide produced by 2500 cars annually.

One trade-off is that citizens cannot use propane grills for cooking backyard steaks. Another trade-off involved retrofitting antique cars to run on hydro fuel cell technology. Many jobs in the coal and petroleum industry were lost due to new energy consumption. Employers had to retrain workers to perform in new careers.

Positive impacts result in a reduction in global warming resulting in the ability to reclaim some of the lost lands. The adverse effects on the underwater environment damaged the coral reef and caused a loss of habitat for many aquatic animals. The sequoia homes filtered carbon dioxide from the air but took up a tremendous amount of land resulting in fewer trees and plants to produce oxygen. However, the sequoia home removes more carbon dioxide from the air than the natural plant life.

There are many reasons people live in Tidalwave. One that you will notice quickly is mild temperatures throughout the year. Our city uses Innovative infrastructure, such as Sequoia buildings, and focuses on using local resources to reduce global warming.

Unique features such as artificial intelligence devices and rooftop gardens help ensure the health and safety of the city's residents. Tidalwave is a great place to live if

you want a modern, eco-friendly environment. Today, with the innovation of tidal fences combined with floating islands. Tidalwave's population growth has reached 98,367. Tourism once again plays a vital role in the economy.

Word Count 1438

Works Cited

“Advantages and Challenges of Wind Energy | Department of Energy.” *Energy.Gov*, <https://www.energy.gov/eere/wind/advantages-and-challenges-wind-energy>. Accessed 18 Nov. 2022.

“Alternative Fuels Data Center: Fuel Cell Electric Vehicles.” *EERE: Alternative Fuels Data Center Home Page*, https://afdc.energy.gov/vehicles/fuel_cell.html. Accessed 18 Nov. 2022.

“Alternative Fuels Data Center: How Do Fuel Cell Electric Vehicles Work Using Hydrogen?” *EERE: Alternative Fuels Data Center Home Page*,

<https://afdc.energy.gov/vehicles/how-do-fuel-cell-electric-cars-work>. Accessed 18 Nov. 2022.

Bennington-Castro, Joseph. "Walls Won't Save Our Cities From Rising Seas. Here's What Will." *NBC News*, NBC News, 27 July 2017, <https://www.nbcnews.com/mach/science/walls-won-t-save-our-cities-rising-seas-here-s-ncna786811>.

Brandon, Elissaveta M. "In the Face of Rising Seas, Are Floating Cities a Real Possibility? | Innovation | Smithsonian Magazine." *Smithsonian Magazine*, Smithsonian Magazine, 12 Aug. 2021, <https://www.smithsonianmag.com/innovation/in-face-rising-seas-are-floating-cities-real-possibility-180978409/>.

---. "In the Face of Rising Seas, Are Floating Cities a Real Possibility? | Innovation | Smithsonian Magazine." *Smithsonian Magazine*, Smithsonian Magazine, 12 Aug. 2021, <https://www.smithsonianmag.com/innovation/in-face-rising-seas-are-floating-cities-real-possibility-180978409/>.

"Galveston, TX - Official Website | Official Website." *Galveston, TX - Official Website | Official Website*, <https://www.galvestontx.gov/>. Accessed 18 Nov. 2022.

Galvis, Natalia. "19 Futuristic STEM Jobs: Finding a Career in the Future." *RobotLAB Group - Robotics Solution Integrator*, RobotLAB, 6 Feb. 2020, <https://www.robotlab.com/blog/19-futuristic-stem-jobs-finding-a-career-in-the-future>.

"How Does Solar Work? | Department of Energy." *Energy.Gov*, <https://www.energy.gov/eere/solar/how-does-solar-work>. Accessed 18 Nov. 2022.

Madden, Duncan. "Take A Trip To The World's First Floating City In The Maldives." *Forbes*, Forbes, 8 July 2022, <https://www.forbes.com/sites/duncanmadden/2022/07/08/take-a-trip-to-the-worlds-first-floating-city-in-the-maldives/?sh=2790af816484>.

Ozdemir, Derya. "Plans for World's First Floating Island City Revealed | IE." *Interesting Engineering | Technology, Science, Innovation News and Videos*, Interesting Engineering, 28 Apr. 2021, <https://interestingengineering.com/innovation/worlds-first-floating-city-to-save-maldives-from-rising-sea-levels>.

Perasso, Valeria. "Turning Carbon Dioxide into Rock - Forever - BBC News." *BBC News*, BBC News, 17 May 2018, <https://www.bbc.com/news/world-43789527>.

Stone, Maddie. "'Tidal Fence' Will Harness the Power of the Surf." *Gizmodo*, Gizmodo, 7 Aug. 2015, <https://gizmodo.com/tidal-fence-will-harness-the-power-of-the-surf-1722720975>.

“The School of the Future. What Will Schools Look like in 20 Years Time?” *TypeKids*, 10 Nov. 2017, <https://www.typekids.com/blog/the-school-of-the-future/>.

Thomas, Allison. “Generating Power Every Time You Hit the Road - Rutgers CAIT.” *Rutgers CAIT*, Rutgers CAIT, 5 Mar. 2019, <https://cait.rutgers.edu/generating-power-every-time-you-hit-the-road/>.

Tidal Energy | National Geographic Society.
<https://education.nationalgeographic.org/resource/tidal-energy>. Accessed 18 Nov. 2022.

“Tidal Power.” *Encyclopædia Britannica*, Encyclopædia Britannica,
<https://www.britannica.com/science/tidal-power>. Accessed 18 Nov. 2022.

“Urban Sequoia by SOM at COP26 - Google Docs.” *Google Docs*,
https://docs.google.com/document/d/1VGxn6uMv9zmEJg_Ey73q0B9jsgkHgsol-201YSITol/edit?usp=sharing. Accessed 18 Nov. 2022.

“What Is Tidal Energy [Scope, Advantages and Disadvantages].” *BharatGoGreen - Think Green Act Green*, <https://bharatgogreen.com/tidal-energy/>. Accessed 18 Nov. 2022.

“What Types of Jobs Will Be the Most Common in 100 Years? - Quora.” *Quora*,
<https://www.quora.com/What-types-of-jobs-will-be-the-most-common-in-100-years>. Accessed 18 Nov. 2022.

Terusan

Terusan is a port city located on the northern coast of the Indonesian island of Java. It is located 185 miles east of Jakarta, at 6°43'S 108°34'E. The city was founded during the 15th century and towards 1677 was colonized by the Dutch who built canals for the flourishing trade of cash crops. This is how the city acquired its name 'Terusan' which means canals in Sundanese. It lies on a flat alluvial plain and has a sunny, tropical monsoon climate with an average temperature range of 72°F to 90°F. Terusan has 252 rainy days and gets about 67" of rain every year. It has an elevation of 26ft above sea level.



Home to about 2,075,000 residents, Terusan has an astonishing number of mangrove trails, pool parks and beaches. Terusan lies within the 'Coral Triangle' and is home to 6.4 million acres of coral reefs which accounts for 9% of the world's coral reefs. The reefs support 35% of marine species and offer coastal protection, food and economic security. Tourism is an important industry due to these coral reefs and mangrove forests that line the coast. The Java Sea to the North is a major trade hub. The diverse population engages in farming, fishing, teaching and engineering. Terusan has coffee, spice, iron and automotive production as its main industry.

Infrastructure: Terusan's main impact due to climate change was rising sea levels. Flooding can go up to 25cm in many places. The residential zone features homes on stilts and amphibious bases that rise up with water logging. The high-density apartments provide spectacular coastal views. The city uses sensor-based floodgates to help contain floodwater outside of the buildings. Terusan has sea-walls to protect from storms. These sea-walls have sensors that make it rise higher with the tide. The lifesaving canals hold flood water excess.

Industrial zone infrastructure includes hydropower. Hydropower accounts for 60% of Terusan's renewable generation capacity. Tidal current powered turbines have a coil inside that turn the kinetic energy of water into electricity. Around 200 thousand barrels of oil per day would be required to produce the same amount of hydropower. The remaining 30% comes from solar and wind energy.



City Services: Transportation in Terusan is mainly city owned public transportation. In 2022, before Terusan shifted to being a zero-emission city, Terusan was ranked 29th in the world for unhealthy air quality. The public transportation system was underdeveloped. 70% of the city's greenhouse gases (GHG) came from vehicles. 75% residents used private transportation. In 2123, the public transportation is highly developed with electric trams and buses so nearly 80% use public transportation. Carefree becaks or pedicabs are seen plying the streets in tourist areas. Police use electric vehicles and drones. The city's hospitals, schools and universities are self-sufficient as they deploy their own renewable solar energy for power, vertical farms for food and rainwater harvesting for water.

City Innovation: Being a developing city, Terusan had layers of concrete blocking rainwater from naturally refilling underground reservoirs. This aggravated the flood situation in the city. One of the innovations to overcome this was constructing porous pavements and public pool parks. The water in porous pavements passes through rocks and into the ground, where it replenishes the groundwater supply. The replenished ground aquifers serve a dual-purpose benefit wherein they prevent over-ground flooding and land subsistence while allowing water harvesting. Pool parks are storm-resistant. These parks hold a filtration system that captures water and slowly releases it back into the canal. In a heavy flood, the park can hold half a million gallons of water. These innovations earned Terusan its sponge city name. To avoid rise in temperature due to GHG buildup, Terusan bans burning solid waste through landfill incineration. The city has moved to biodegradable packaging. The entire food industry's packing is made of wheat and barley and can now be deliciously eaten.

The transition: In 2022, due to global warming, rising sea levels were engulfing beaches, driving away tourists and fisherfolk, eroding land and the livelihood of people. Flooding led to decreased food production. The coral reefs were bleaching due to ocean acidification, warm sea temperatures and marine pollution. The rising sea levels would cause mangrove habitats to drown and with it wipe out entire fish populations. Monsoon flooding caused areas to be unsafe with unsanitary conditions. Transportation, manufacturing and landfill incineration were the three major sources of GHG in Terusan. Current mitigation efforts were not sufficient to achieve the temperature goals set by the 2015 Paris agreement. Further measures needed to be explored.

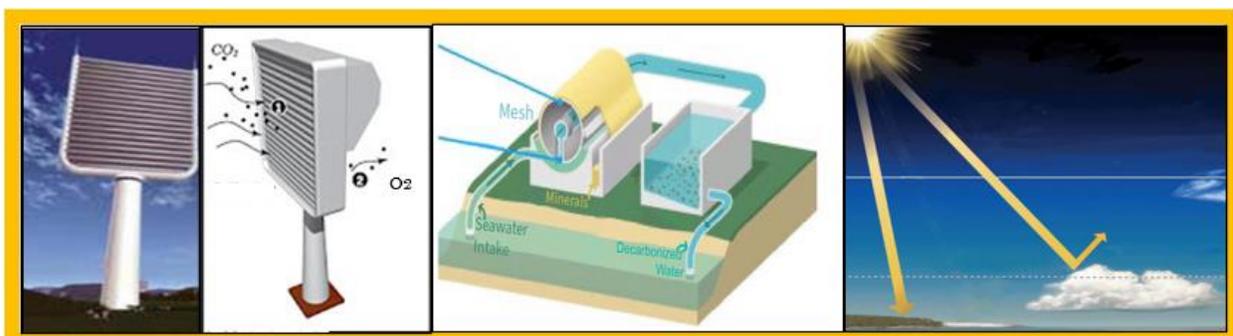
Terusan's main adaptation strategy is mangrove restoration. 'Mangroves for the Future' is a joint coastal ecosystem initiative of International Union for Conservation of Nature and United Nations. The planter sprays hundreds of seeds while hovering above the ground and plants mangrove trees near the coast. Restoring mangroves reduces sea level rise, and protects us against storm surges by acting like a natural barrier. In addition, they offer a lush habitat for 70% of the fish while filtering water. They also store tons of carbon in their roots. Mangrove forests hold more than 2 years' worth of global emissions, which would be released into the atmosphere and increase the effects of climate change if destroyed. The tangled roots of mangrove trees keep coastal sediment from slipping while the trunks absorb the force of waves. The city also uses agroforestry with integration of trees into farming. This sequesters more carbon than industrial agriculture and improves soil fertility. Terusan grows white pepper with other crops like mangoes, bananas and timber. This gives the food industry resilience against sea-level rise, extreme weather and reduced biodiversity. Engineered structures like pool parks, floodgates and sea-walls reinforce the natural adaptation strategies.



Terusan chose Carbon capture and storage (CCS) mitigation technology to sequester CO₂ directly from air and water. Artificial trees are structures that mimic a tree's way of taking CO₂ in and releasing oxygen. These trees are 1,000 times more efficient than natural trees. In an artificial tree, a unique resin absorbs CO₂ from the air. When the resin is dunked in water, it releases CO₂ which flows into the ground and reacts with ground minerals to form limestone and synthetic fuel. This was a big change from 2019 when 19,000 people died due to air quality. This has reduced infectious diseases and respiratory problems. Floods and extreme weather events have been more controlled due to stable temperatures.

Similarly, the city's ocean carbon capture technology sequesters CO₂ from the ocean. The ocean absorbs a quarter of the world's CO₂. The ocean and atmosphere are in a state of equilibrium. If CO₂ is taken out of the water, the ocean absorbs more from the air. The city uses an underwater technology with a mesh through which seawater passes giving water an electric charge. This triggers a chemical reaction that combines dissolved CO₂ with calcium and magnesium in the water, creating magnesite and limestone used for construction. The seawater flows back, to absorb more CO₂. Seawater naturally takes up CO₂ at a high concentration, 150 times the level in air. It also produces hydrogen as a by-product, used as fuel. This technology helps fish habitats thrive. Coral bleaching has decreased. Terusan can rely on the ocean for food and livelihood.

Marine Cloud Brightening (MCB) is another mitigation technology that works by altering the earth's solar radiation balance. MCB shades coral reefs below by reflecting light and heat from the sun. A sea salt sprayer uses seawater to generate millions of microscopic sea salt crystals. These crystals float into the sky to form a fog and bolster the existing clouds' reflectivity. The sprayer is attached to a barge and is used at specific sites of the reef, depending on atmospheric conditions. This technology helps strengthen food security through our ecosystem. Tourism is a booming business now.



Risks, tradeoffs and benefits: Our adaptation technology like floodgates, pool parks, sea-walls reduce flooding but they need constant maintenance. As a trade-off, our agroforestry and mangrove restoration strategies create a natural flood barrier and simultaneously allow for carbon sequestration. The use of hydro, wind turbines, solar panels and CCS technology helps negate GHG emissions, stabilize temperatures, increase life expectancy and reduce dependency on oil producing nations. The risk is that renewable energy generation is dependent on nature. CCS is very expensive and requires a lot of energy and as a trade-off Terusan has chosen a combination of mitigation technologies while it works on research to make CCS more cost-effective. MCB has an immediate effect in lowering temperature though it is temporary.

People that made it happen: Terusan's mechanical engineers and electrical engineers designed alternative energy sources for the city's power usage. Most buildings have flood resistant structure designed by its structural engineers. The electrical and environmental engineers developed mangrove planters and the CCS technology. Geothermal engineers helped with solar climate intervention like MCB. International organizations worked with local governments to make Terusan the climate friendly city it is today.

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References

Asian Development Bank. "The Coral Triangle, An Ecosystem Under Threat." Asian Development Bank, 2016, <https://www.adb.org/multimedia/coral-triangle/>

Bentrup, Gary, and Kate McFarland. "Agroforestry." *Agroforestry Climate Change Resource Center*, USDA National Agroforestry Center, www.fs.usda.gov/ccrc/topics/agroforestry

BBC News. (2022, November 2). What is climate change? A really simple guide. BBC News. Retrieved November 5, 2022, <https://www.bbc.com/news/science-environment-24021772>

BBC Science Focus. (n.d.). Climate change. BBC Science Focus Magazine. <https://www.sciencefocus.com/climate-change/>

Chatterjee, P. (2017, October 16). In Jakarta, solving problems with new Tech tools and People Power. *Eco*. Retrieved November 5, 2022, <https://www.eco-business.com/news/in-jakarta-solving-problems-with-new-tech-tools-and-people-power/#:~:text=Some%20of%20Jakarta%E2%80%99s%20tech%20tools%20may%20sound%20familiar,street%20lamp%2C%20and%20report%20it%20to%20local%20authoritie>

Clifford, Catherine. (2021, Feb 1). "Carbon Capture Technology Has Been around for Decades - Here's Why It Hasn't Taken Off." CNBC, <https://www.cnbc.com/2021/01/31/carbon-capture-technology.html>

"Climate Change." Energy.gov, Energy.gov, <https://www.energy.gov/science-innovation/climate-change>

Climate Works Foundation. (2022, April 1). Ocean carbon dioxide removal (CDR). Retrieved October 14, 2022, <https://www.climateworks.org/programs/carbon-dioxide-removal/oceans/>

"Cooling by Cloud Brightening." Reef Restoration and Adaptation Program, 14 June 2021, <https://gbrrestoration.org/program/cooling-by-cloud-brightening/>

Greta Friar, Abdul Latif Jameel World Water and Food Security Lab. (n.d.). A solution for urban storm flooding. MIT News | Massachusetts Institute of Technology. Retrieved October 14, 2022, <https://news.mit.edu/2018/storm-flooding-engineered-urban-green-space-0713>

Harrisburg, K. (2022, March 30). What are 'sponge cities' and how can they prevent floods? World Economic Forum. Retrieved November 5, 2022, <https://www.weforum.org/agenda/2022/03/sponge-cities-nature-tackle-climate-floods-urban/>

Holidify. (2020, June 9). The 4 major styles of architecture in Indonesia. Holidify. Retrieved November 5, 2022, <https://www.holidify.com/pages/architecture-of-indonesia-1277.html>

IPCC. (2013). Working Group I contribution to the fifth assessment report of the Intergovernmental Panel on Climate Change, [Climate change 2013: The physical science basis](#)

Itaipu Dam. (2018, Nov 21). "How Hydropower Can Help Climate Action." *Unfccc.int*, United Nations Climate Change, www.unfccc.int/news/how-hydropower-can-help-climate-action.

IUCN, (2022, June 27). "How Mangroves Got Their Roots Back in East Java ", <https://www.iucn.org/news/asia/201707/how-mangroves-got-their-roots-back-east-java>

Jong, H. N. (2022, January 8). As blackouts loom, Indonesia's energy crisis highlights its addiction to coal. Mongabay Environmental News. Retrieved November 5, 2022, <https://news.mongabay.com/2022/01/as-blackouts-loom-indonesias-energy-crisis-highlights-its-addiction-to-coal/>

Lovelock, Catherine. (2015, Oct 15). "Rising Seas Will Drown Mangrove Forests." UQ News, The University of Queensland, <https://www.uq.edu.au/news/article/2015/10/rising-seas-will-drown-mangrove-forests>

Mairs, J. ,2016, December 6. Chains of pools proposed to ease flooding in Copenhagen. Dezeen. Retrieved November 5, 2022, <https://www.dezeen.com/2016/07/12/hans-tavsens-park-korsgade-sla-copenhagen-denmark-flooding-urban-planning/>

McFarland, Katie. (2018). "How Can Agroforestry Support Climate Change Mitigation in the Northeast?" *Climate Hubs*- US Department of Agriculture, www.climatehubs.usda.gov/hubs/northeast/topic/how-can-agroforestry-support-climate-change-mitigation-northeast

Mead, N. V. (2016, November 23). The world's worst traffic: Can Jakarta find an alternative to the car? The Guardian. Retrieved November 5, 2022, <https://www.theguardian.com/cities/2016/nov/23/world-worst-traffic-jakarta-alternative>

Montague, M. (n.d.). Our Oceans and the fight against climate change. BBC Earth. Retrieved November 5, 2022, <https://www.bbcearth.com/news/our-oceans-and-the-fight-against-climate-change>

NASA. (n.d.). The Climate Time Machine. NASA. Retrieved October 14, 2022, from <https://climatekids.nasa.gov/time-machine/>

NOVA online. (2020, December 1). Can we cool the planet? | full documentary | nova | PBS. YouTube. Retrieved November 5, 2022, <https://www.youtube.com/watch/PeYJTluQ5tM>

NYC Parks, (2017). "Design and Planning for Flood Resiliency Guidelines for NYC Parks.", <https://www.nycgovparks.org/planning-and-building/planning/resiliency-plans/flood-resiliency>

Peters, Adele. (2021, June 3). "This Carbon-Capture Tech Removes CO2 from the Ocean by Making Seashells." Fast Company, <https://www.fastcompany.com/90642340/this-carbon-capture-tech-removes-co2-from-the-ocean-by-making-seashells>

Piaskowy, Joe. (2015, Sept 2). "Carbon Capture Needs a Forest of Artificial Trees." *Climate Change*, Northwestern University, <https://www.climatechange.medill.northwestern.edu/2015/02/09/carbon-capture-needs-a-forest-of-artificial-trees/>.

“Responding to Climate Change.” Global Climate Change, Vital Signs of the Planet, NASA, 18 July 2022, <https://climate.nasa.gov/solutions/adaptation-mitigation/>

Royal Netherlands Institute for Sea Research. (2020, Dec 7). “Java's Protective Mangroves Smothered by Plastic Waste.” Phys.org, Phys.org, <https://phys.org/news/2020-12-java-mangroves-smothered-plastic.html>

Suarez, I. (2020, February 10). 5 strategies that achieve climate mitigation and adaptation simultaneously. World Resources Institute. Retrieved October 14, 2022, <https://www.wri.org/insights/5-strategies-achieve-climate-mitigation-and-adaptation-simultaneously>

United Nations. (n.d.). Climate adaptation. United Nations. Retrieved October 14, 2022, <https://www.un.org/en/climatechange/climate-adaptation>

Water and Climate Change.” *UN Water*, United Nations, 2021, www.unwater.org/water-facts/water-and-climate-change.

World Health Organization. (2020, March 17). “Water and Climate Change.”, www.who.int/news/item/17-03-2020-water-and-climate-change.

Libratum

Location:

Libratum is built in the area of former Los Angeles (34°3'8.0460"N and 118°14'37.2588"W) which lies in a basin in Southern California, adjacent to the Pacific Ocean, with mountains as high as 10,000 feet, deserts, freshwater lakes and reservoirs. Libratum has an average rainfall of 15 inches, with temperatures between 85-105°F and forests that cover over 650,000 acres and is the playground of the huge metropolitan area of the city. The forests manage the watersheds within their boundaries to provide valuable water to Southern California and to protect surrounding communities from catastrophic floods. Our city's population is around 650,000 people supporting a variety of diverse, vibrant cultures.

Climate Change Impact Without Adaptation or Mitigation:

100 years ago, our city was on a path to the inevitable destruction of our ecosystem and economy. Rising temperatures and frequent heat waves exacerbated drought conditions and worsened many types of disasters including storms, floods, and forest fires. The resulting loss of life, and damage to infrastructure, agriculture, and productivity would have been immense. The root cause was the rampant use of nonrenewable sources of energy and their resulting greenhouse gasses that caused the global climate to warm.

City Life:

Libratum's people have access to many jobs, work opportunities, and recreation. They are innovative, motivated, and creative thinkers. Libratum welcomes and celebrates different cultures. There are various specialized jobs specifically to reduce climate change. Jobs for limiting carbon footprint and the emission of greenhouse gasses include renewable energy scientists, environmental scientists/lawyers, climatologists, conservation scientists, etc. Our recreation centers include amenities like - parks, shopping/community centers, sporting venues, gyms, movie theaters and restaurants/bars. Our dependence on vertical farming has freed up surrounding land areas from agriculture to be purposed into nature parks for our citizens to enjoy.

Infrastructure:

Libratum residents live in dense urban high-rise living areas. More space is devoted to eco-friendly nature parks. It also allows the city to efficiently provide services like fire/police/ER, healthcare, and transportation without having to waste energy. This allows for efficiency of scale and enhances our climate change mitigation solution. These living areas have specialized ultra-white pigment-based outdoor panels mounted on movable louvers that can reflect 99.99% of infrared light making air conditioning unnecessary (one of the largest contributors to greenhouse gas emissions). We use renewable geothermal-based heating/cooling complements at night. Libratum uses compacted vertical farming that focuses on hydroponics agriculture that utilizes technologically advanced AI-based systems that can control light, air, water, and nutrients to maximize food production with minimal land. This efficient form of agriculture allows us to save on transportation and reduce our ecological footprint and dedicate more land area that was used decades ago for farming into ecologically rich nature preserves. Nuclear fusion technology, perfected over the past 75 years using the engineering design process, to produce no greenhouse gasses, powers all of Libratum's main infrastructure systems: the electric grid, water, sanitation, recycling, waste treatment, lighting, heating/cooling, etc. Fusion reactors power desalination plants that store and provide fresh water to our city and feed a very large drip irrigation system. This ensures that the neighboring forest cover has enough humidity to allow for abundant growth and reduces the risk of forest fires and mitigates heat waves. State-of-the-art fire suppression/fire retardant materials protect our citizens and infrastructure.

City services:

Libratum's public transportation system is made up of hyperloops at speeds of more than 300 mph. These tunnels are maintained at near vacuum levels and electromagnetic fields propel the hyperloop cars. Surface transportation consists of super-capacitor-based eco-friendly electric cars and bikes along with powered walkways that allow people with limited mobility to get around. Libratum has the most advanced universal healthcare for its citizens. Every living center has advanced AI-based diagnostic pods that citizens can use to get detailed analyses of their health. Advanced mRNA-based therapeutics have helped us fight even the most incurable of cancers. Moving to more plant-based food and helping people get plenty of open spaces with nature everywhere has helped greatly improve the health of our population. Our city has excellent education programs taught by teachers and AI robots with many educational services installed. Our schools have a standard K-12th grade program along with college education, offered virtually or in-person.

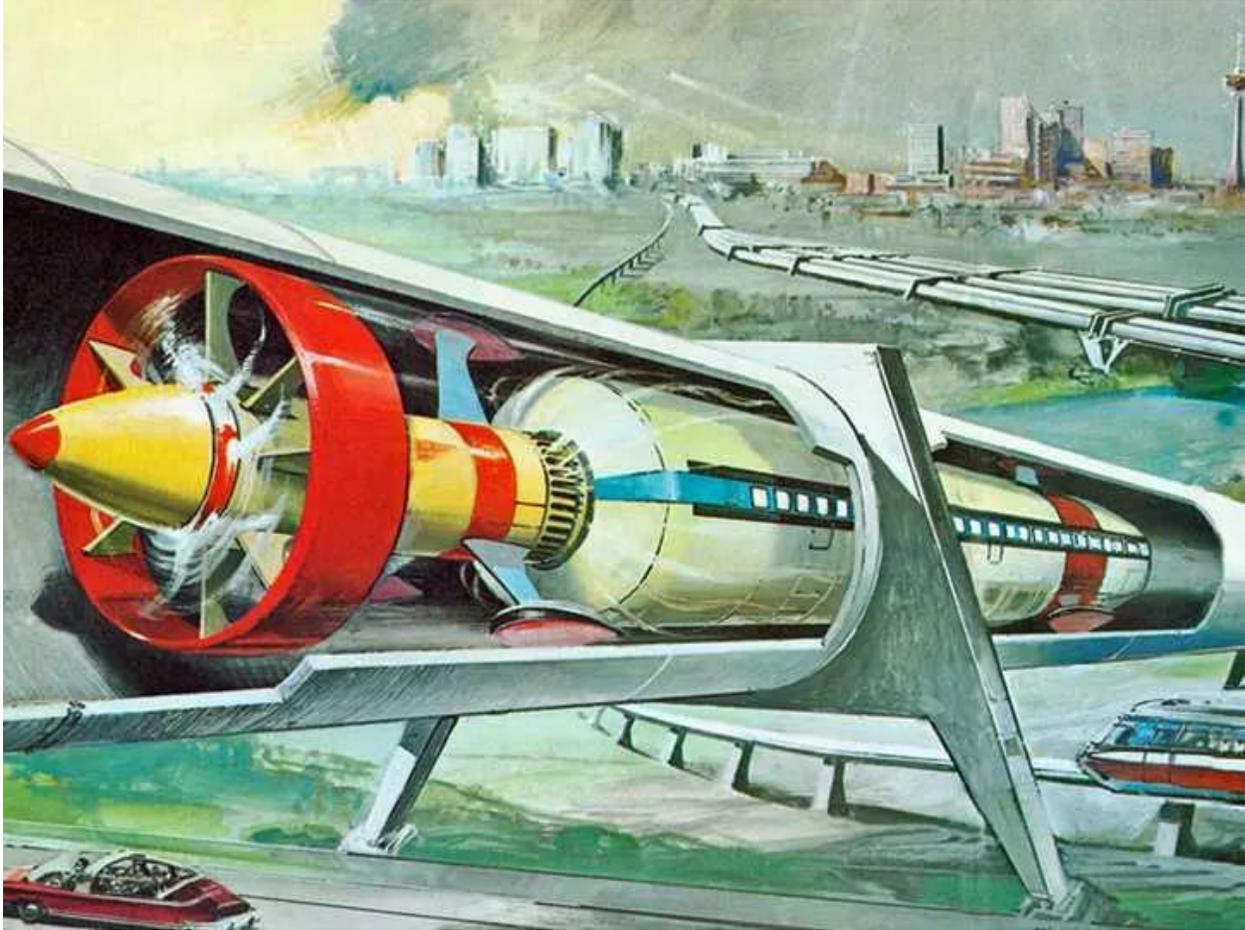


Figure1: Libratum's hyperloop transportation system

City Innovation and Futuristic Elements:

Libratum seeks to control temperature and access to clean water for agriculture and life support. This is accomplished through the use of our fusion reactor which can power a giant centrifugal slingshot that can lob a projectile high into the stratosphere without the need for rocket propulsion. This system, the Libratum Spectral Irradiator - disperses billions of irradiators microbots into the stratosphere which can selectively make their surface more reflective and can be triggered to swarm together. Tiny micro-electro-mechanical actuators (MEMS) on their surface can act like flight control surfaces and allow them to navigate in the stratosphere like *intelligent aerosols*. Nano communication links between the micro-bots allow them to form a Hive-like structure. Hence, they can quickly self-assemble into a very large solar reflective disc like structure that can dramatically cool down surface temperatures. They essentially mimic a volcanic explosion that can radiate heat away from the city and bring down temperatures like a wide-area thermostatic controller. Additionally, our desalination plant pumps water throughout the city and into the surrounding nature areas. The water lines in dense urban areas are close to the surface and loop back to giant cooling towers powered by fusion and can act like a gigantic radiant cooler and drop temperatures inside our city. Libratum has multiple plants for

capturing carbon-di-oxide directly from the air, each capturing up to 1500 tons of carbon-di-oxide every year. The captured carbon-di-oxide is then sent through an underground pipeline where it's mixed with water and injected into basalt rock. It turns to stone in about two years.

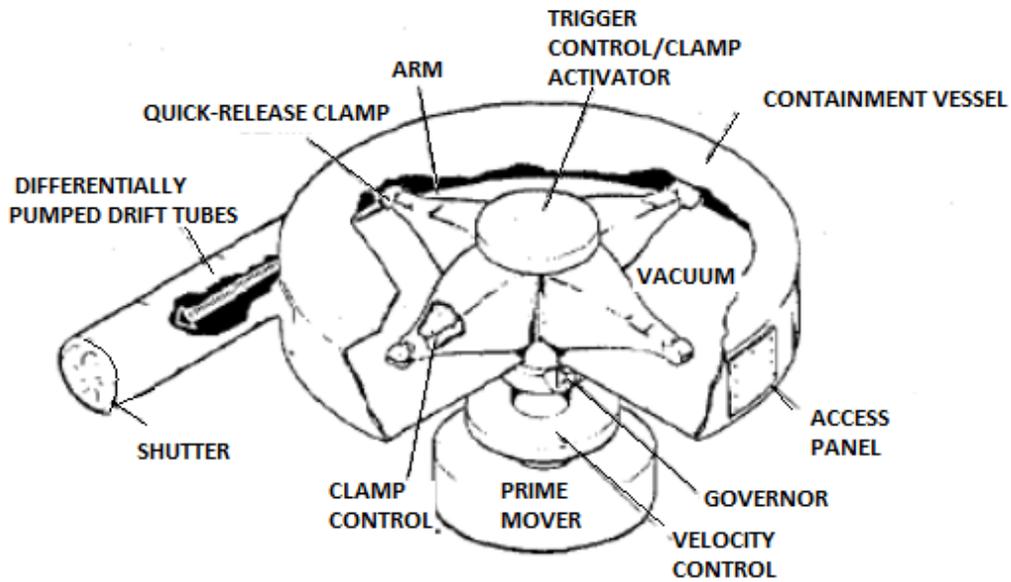


Figure2: Edge-release centrifugal projectile accelerator

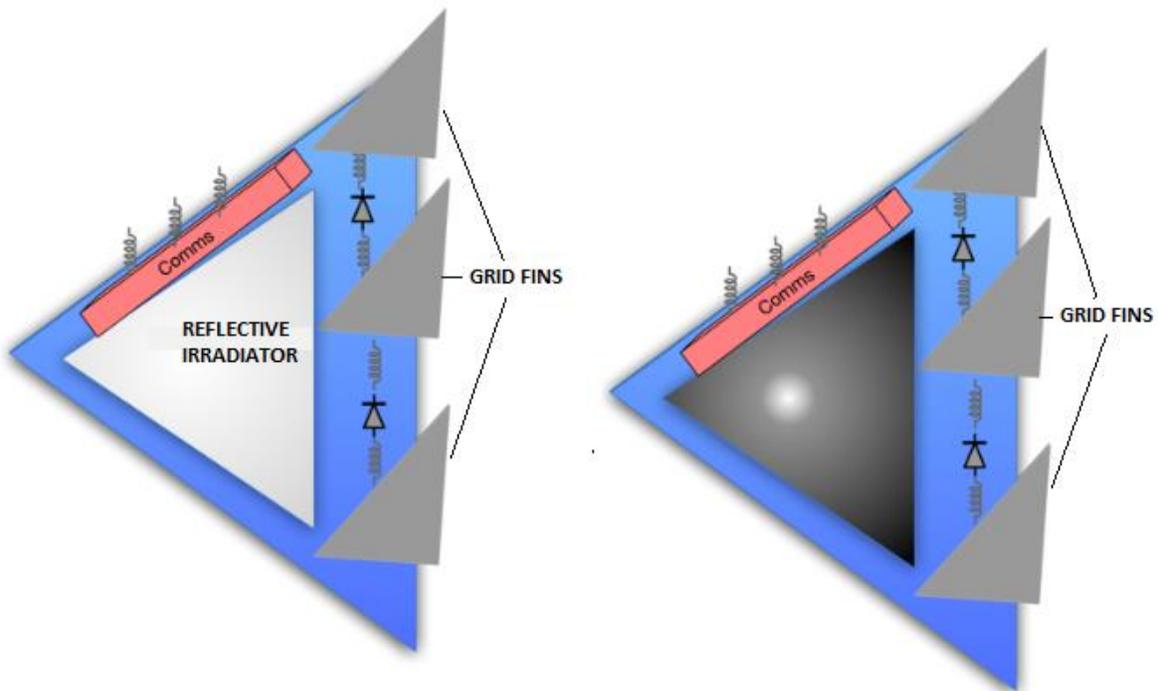


Figure3: Micro-bot with reflectivity control

Climate Change Adaptation:

Our Libratum Spectral Irradiator and Urban Radiant heat collection system help us manage the risks of heat waves. A DPER program (Disaster Preparedness and Emergency Response) system which has advanced AI capabilities forecasts and reacts to heat waves by triggering micro-bot irradiator hives and increasing the radiant cooling of our urban areas to provide rapid relief from the effects of high temperatures. Innovative building materials and our special pigment white paint keep indoor areas cool and habitable irrespective of outside temperature and weather conditions. Our energy, transportation, and agriculture systems have built-in redundancies, and harnessing fusion energy provides us with the security that changes to the climate will not affect our way of life.

Climate Change Mitigation:

Our climate mitigation plan to combat heat waves has three main parts: Firstly, eliminating greenhouse gas emissions through our eco-friendly fusion technology. Secondly, sequestering carbon-di-oxide by vastly increasing the biomass by agroforestry and capturing carbon-di-oxide in our urban areas through large scale carbon capture technology to fuel agriculture. Lastly, managing the worst effects of heatwaves through our Spectral Irradiator technology, city scale radiant cooling and solar reflective hyphenate pigment-based cooling of living spaces.

How Our Solution Protects Our Citizens:

Libratum's multi-purpose Spectral Irradiator can deploy both projectiles with ultra-thin foil-like mirrors that can unfold/unfurl and reflect energy from the sun as well as sulfate aerosol dispersant that can mimic a volcanic explosion and provide wide area cooling. AI-based systems constantly monitor solar spectral activity, and stratospheric conditions and react automatically to heat threats. AI-based health monitoring tools use biosensors on our watches and wristbands to automatically send first aid throughout the city.

Risks, Trade-Offs, and Compromises of Adaptation and Mitigation:

The Spectral Irradiator is a giant hammer and therefore comes with risk and tradeoffs. It has taken decades of research, design, re-design and testing to fine-tune the system. The aerosol-like microbots can rapidly cool the temperature if they remain in a hive format for very long and

can live in the upper stratosphere for about three years. Very intensive computing is required to constantly calculate how many micro-bots are active in the atmosphere and where they are in relation to each other for proper hive behavior that can effectively radiate the sun's heat. Occasionally, collisions, atmospheric debris, electrical discharge in the stratosphere can knock out bots and rapid launches from our slingshot launcher will have to quickly replace the damaged bots.

Engineering Disciplines:

Libratum's engineers are world-class. They work in diverse fields like energy, AI, computer programming, electrical, mechanical, agricultural, industrial, bio-medical, environmental, and geo-engineering fields. They work hard every day ensuring all our complex systems like infrastructure, food, utilities, energy, waste management, recycling, industrial production, etc. are running smoothly and harmoniously. We have engineers, architects, and scientists working around the clock to mitigate climate change and invent new and more efficient methods of reducing our carbon footprint.

Libratum is the best climate change-free city of the future!

Word Count: 1495

References:

1. Alter, Lloyd. "Elon Musk Gets 'Verbal Approval' for East Coast Underground Hyperloop." Treehugger, Treehugger, 11 Oct. 2018, www.treehugger.com/elon-musk-gets-verbal-approval-east-coast-underground-hyperloop-48500 (Figure 1)
2. Dickinson, Tim. "New Tech to Tackle the Climate Crisis." Rolling Stone, Rolling Stone, 24 Mar. 2021, www.rollingstone.com/culture/culture-lists/climate-crisis-new-tech-1144643/hydrogen-ships-1144690/.
3. Environmental and Energy Study Institute (EESI). "Adding Trees to Farms Can Mitigate Climate Change and Increase Resilience." EESI, www.eesi.org/articles/view/adding-trees-to-farms-can-mitigate-climate-change-and-increase-resilience.
4. EverWalk. "The Climate Science of Urban Cooling Corridors." EverWalk, 9 Aug. 2021, <https://everwalk.com/the-climate-science-of-urban-cooling-corridors/>.
5. "Facts and Figures." United Nations, United Nations, www.un.org/en/actnow/facts-and-figures.
6. Fawzy, Samer, et al. "Strategies for Mitigation of Climate Change: A Review - Environmental Chemistry Letters." SpringerLink, Springer International Publishing, 30 July 2020, <https://link.springer.com/article/10.1007/s10311-020-01059-w>.

7. Foerster, Jim. "The Economic Realities of Heat Waves." Forbes, Forbes Magazine, 1 Aug. 2022, www.forbes.com/sites/jimfoerster/2022/07/29/the-economic-realities-of-heat-waves/?sh=13ed8b493e63k.
8. Groch, Sherryn. "Space Mirrors, Fake Volcanoes: The Radical Plans to Fix the Climate." The Sydney Morning Herald, The Sydney Morning Herald, 13 Feb. 2020, www.smh.com.au/national/space-mirrors-fake-volcanoes-the-radical-plans-to-fix-the-climate-20200122-p53tq3.html.
9. "Here's How Heat Waves Can Impact Economies, as Well as People and Wildlife." World Economic Forum, <https://www.weforum.org/agenda/2022/07/heat-waves-economy-climate-crisis/#:~:text=And%20beyond%20the%20immediate%20threat,%E2%80%9D%20points%20out%20Phys.org>.
10. Iberdrola. "Adapting to Climate Change: What Will the Earth Look like in 2030?" Iberdrola, Iberdrola, 22 Apr. 2021, www.iberdrola.com/sustainability/climate-change-mitigation-and-adaptation.
11. Paul Abela, MSc. "Can Space Mirrors Save Humanity from Climate Catastrophe?" Medium, Climate Conscious, 12 Oct. 2020, <https://medium.com/climate-conscious/can-space-mirrors-save-humanity-from-climate-catastrophe-6a3cb548b950>
12. *Spinlaunch*, <https://forum.nasaspaceflight.com/index.php?topic=45852.40>.(Figure 2).
13. "Using Cool Pavements to Reduce Heat Islands." EPA, Environmental Protection Agency, www.epa.gov/heatislands/using-cool-pavements-reduce-heat-islands.

Calibra-by-the-Sea

In 2122, Calibra-by-the-Sea (“Calibra”) is a climate-conscious city with towering skyscrapers, sloping xeriscaped mountains, bright skies, and a blue ocean . . . but it wasn’t always that way. Increasingly-frequent mudslides devastated the northern Chilean city at 23.6509° S and 70.3975° W. With a cool, arid climate, temperature ranges from 56° -76°F, and annual rainfall averages under 0.1mm, how did 57 mudslides happen within a hundred years? Extensive copper and lithium mining contributed to a climate change impact domino effect devastating Calibra. Greenhouse gasses trapped heat, increasing air temperatures and causing rain rather than snow to fall on the barren, parched soil of mining-stripped mountains, producing massive mudslides. Simultaneously, rising sea temperatures pushed vital food sources out to sea creating food insecurity. **Without comprehensive adaptations and mitigation, Calibra would not survive.**

After Chile’s 2022 constitutional revision addressing climate change, Calibra sought balance and resiliency in confronting **its most pressing climate change impact - changing precipitation patterns**. Mining-dependent for centuries, Calibra’s long journey to carbon neutrality via **green mining mitigation** weighed heavily on our citizens, so **SeguroNet, our innovative comprehensive safety net adaptation**, builds resilience in our citizens and our spaces, as we adapt to and mitigate numerous interrelated climate change impacts. Using the engineering design process, Calibra transformed its environment, healthcare, power, infrastructure, education, and economy with policy and technological innovations.

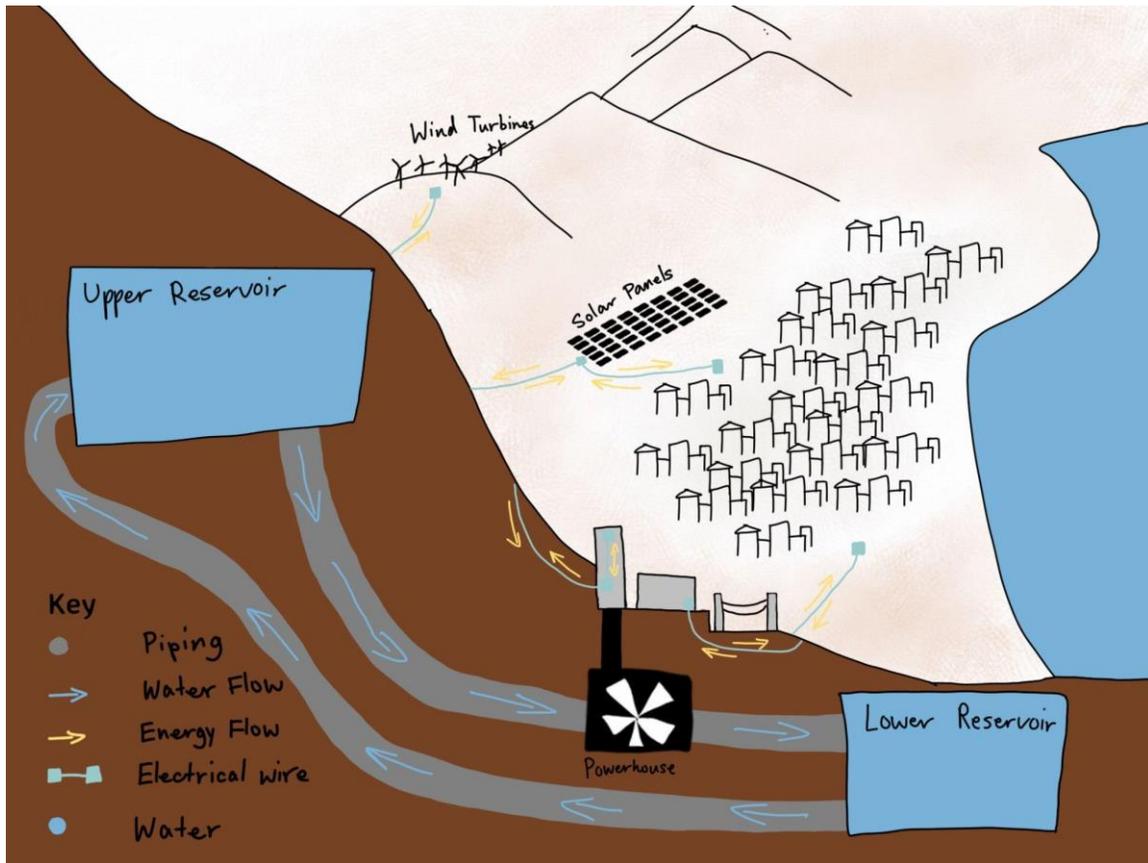
Our diverse 750,000 residents include indigenous Atacameños, Chileans, and Bolivians, who are innovative and deeply connected to nature and community. Jobs include technology, agriculture, healthcare, ecotourism, and green mining. Unique contradictions include snowy mountaintops near a dry desert, mixed-use modern skyscrapers near Atacameñan mud roundhouses, and “desierto florido”, an explosion of colorful blooms after minuscule annual rainfall. The Atacama desert hosts biking, hiking, star-gazing, and NASA’s Mars simulations.

Innovative **infrastructure** balances resilience-building adaptations with greenhouse-gas-reducing mitigation. Ocean-view buildings use bamboo reinforcements, with a 200-year lifespan, instead of steel, and eco-friendly flood-resistant Dura-namel exteriors made from adapted synthetic dental enamel replaced concrete, eliminating 8% of CO₂ emissions. When a mudslide is detected, roadways automatically elevate to keep roads open. Recycled plastic piezoelectric roads generate light energy. Public transit winds through our mixed-use commercial and residential high-rises, intergenerational, and low-income housing, reaching the Atacama desert, renewable energy, and green mining industrial zones.

Replacing fossil fuels, renewable energy sources include fusion (45%), solar (45%), and wind (8%), supplemented with stored energy through innovative molten salt Concentrated Solar Power and water batteries, which combined can generate up to 50% of energy need for 20 hours. Repurposed Atacama salt-flats, abandoned after lithium mining, focus sunlight onto mirrors,

heating salt, creating steam that turns a turbine, producing energy. Renewable energy pumps water to the water battery's upper reservoir, which stores water until the city needs energy; sending water to the lower reservoir creates kinetic energy to power the city.

1. Renewable Energy Water Battery

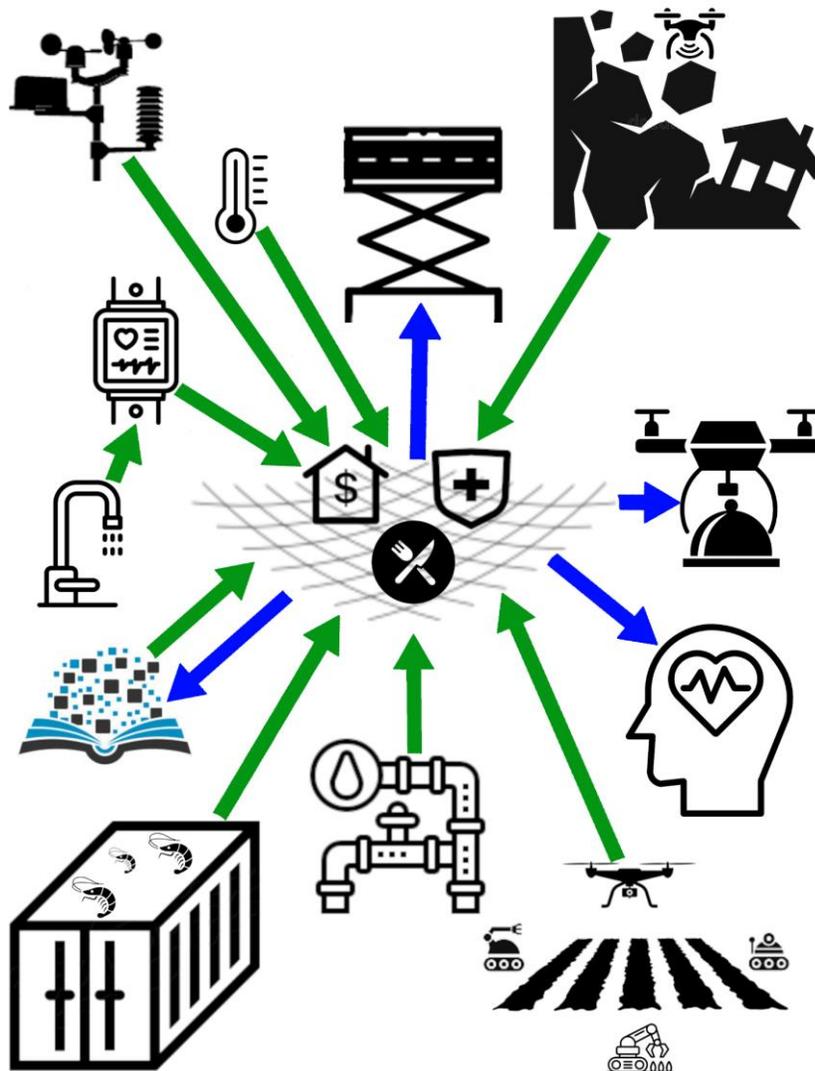


Calibra's drone-supported emergency **city services** perform surveillance, rescue, and reconstruction work with police, firefighters, and EMTs. MudDrones monitor conditions, warning of impending mudslides. Robot-deployed mobile warped walls re-route mudslides, avoiding lock-ins because immobile fixed-walls prevent sustainable development. Preventing floods and water contamination, bioswale runoff areas reduce the amount of stormwater that enters the sewer system. Monitored by SeguroNet, "super sewers" are large containment areas storing excess runoff following an extreme weather event.

Calibra's education system provides project-based, real-world learning, evaluating risks, trade-offs, and compromises, demonstrating that imperfect solutions are progress, too. Hands-on outdoor activities help students love and preserve their environment. Futuristic A.I.-assisted *Iniciador* electronic primers offer self-paced learning, news, and participation in climate change impact scenario planning, adaptation assessment, and climate education.

SeguroNet’s innovative, comprehensive climate change adaptation extends beyond changing precipitation patterns and mudslides to build resilience and address interrelated climate change impacts including food insecurity, pollution, decreased biodiversity, and rising physical and mental health issues. This holistic safety net monitors health and environmental conditions, infrastructure (e.g. “super sewers”), and agriculture production; and provides direct action during extreme climate events. SeguroNet aggregates data to determine when to activate Heat Health and Emergency Action Plans, and measures outcomes to evaluate adaptation effectiveness and aid future predictions.

2. SeguroNet Community Safety Net Adaptation



SeguroNet’s SmartWatches connect Internet of Things (“IoT”) devices, monitoring temperature, barometric pressure, precipitation, and air and water quality, providing a mesh of continuous data for analysis and pattern identification. SmartWatches monitor individual well-

being, providing feedback and contacting necessary support services, including mental and physical healthcare, and nutrition after natural disasters. Undernutrition and scarce nutritional foods trigger SeguroNet's SmartMeals drone-delivery food support.

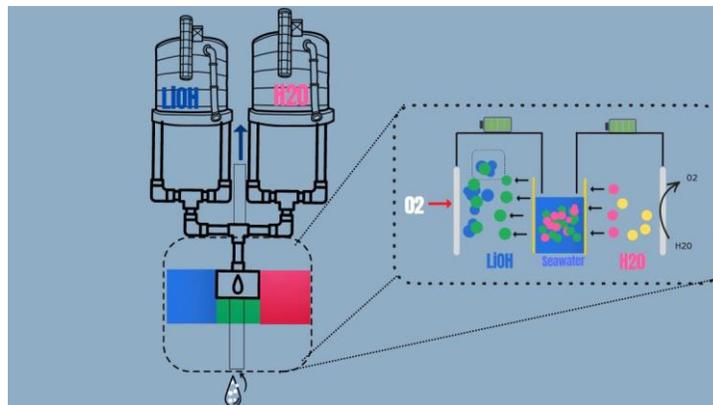
Citywide, drones and robots monitor weather, temperature, sewage, extreme climate events, and water quality levels providing data to plan environmental response actions, disaster efforts, agriculture, and healthcare needs. GreenGas analyzers identify CO₂ available for carbon-capture so the raw material becomes an innovative, marketable resource rather than a pollutant. In traditional and urban/vertical farming, AgDrones and AgRobots increase food security, exterminating identified pests; monitoring soil moisture, temperature, and plant health (including nutrient and starch levels preventing malnutrition); removing diseased plants, and providing supplemental pollination. Recycled-shipping-container ShrimpBoxes provide nutrient-rich protein for humans and native species. ShrimpBox A.I. monitors algae growth and optimal shrimp harvest times, increasing production and reducing waste. Mangrove carbon sinks' rich biodiversity provides healthy kelp and other nutrient-rich sealife.

Through *Iniciador* primers, citizens access citywide conditions and request needed aid, including water to support agriculture or cooling equipment repair funds.

Initially, Calibra abolished mining, economically devastating the world's leading copper- and lithium-producing city. Ultimately, **switching to green mining mitigation** stabilized the economy, and mining became carbon neutral by 2050. Calibra tightened mining regulations, increased mining taxes, mandated environmentally safer processes including renewable energy, set extraction limits, adjusted cut-off grades, and implemented green mining technologies.

Our groundbreaking Lithi-Fil seawater filtration system revolutionized lithium mining, cost-effectively isolating lithium ions from seawater without evaporation, which endangers groundwater supply. Instead, our eco-friendly innovation alternates voltage cycles using lithium-ion battery electrodes. Oceans contain 5000 times more lithium than land sources.

3. Lithi-Fil Seawater Filtration Innovation

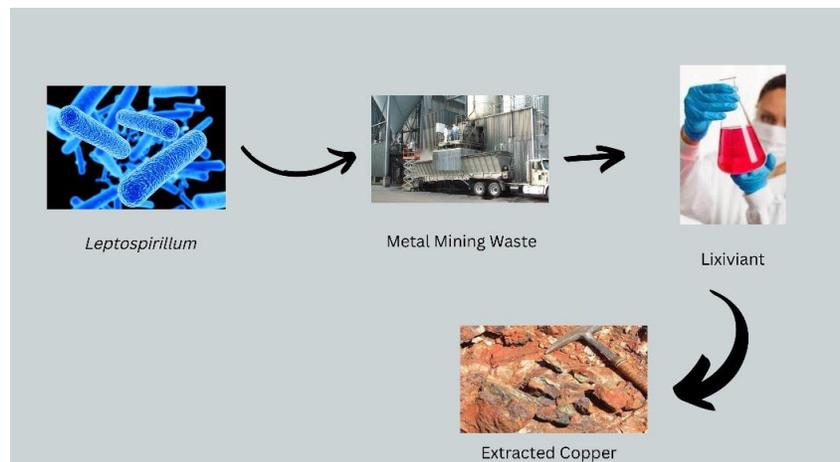


Mining site pollution mitigation includes adding lime to neutralize soil acidity; topsoil and vegetation to restore previously-mining-stripped mountains, preventing mudslides, and reducing

surface water contamination. When high CO₂ levels warmed seas, pushing the cold, northerly Humboldt Current's upwelling of nutrient-rich sealife farther out to sea, endangering Atacama desert penguins, genetic engineers developed innovative cold-hardy mangroves. Funded through mining taxes, CO₂-reducing mangrove carbon sinks increased shoreline biodiversity and maintained food sources for native species and citizens. Climatic microrefugia provide safe spaces for endangered plants and animals adapting to climate change.

Atacameños showed engineers how to use Tatio Geysers' rapid-metal-eating *Leptospirillum* bacteria to dispose of abandoned metal mining waste, and engineers discovered that excess reagent Lixiviant efficiently extracted lower-grade copper from waste rock without harmful impact.

4. Innovative *Leptospirillum* Eco-friendly Copper Extraction Mitigation



Our comprehensive **green mining mitigation and SeguroNet adaptation keeps residents safe and healthy** by monitoring support needs via SmartWatches, providing supports ranging from agricultural micro-loans to drone-delivered SmartMeals, and evaluating conditions to activate Heat Health and Emergency Disaster Action Plans to minimize extreme climate change impact. Drones monitor for mudslides to keep buildings and residents safe, and ensure nutritious, efficiently-produced food. Weather pattern monitoring identifies extreme events to begin immediate mitigation. Green mining, including renewable energy ventilation systems, dramatically decreased CO₂ pollution, reducing respiratory issues. Innovative carbon-capture-produced nanodiamonds, which detect and target-treat cancer cells without high toxicity, and universal healthcare increase citizen resilience. Calibra licenses its patented processes, and awards adaptation strategy grants to developing cities because every dollar spent in adaptation today saves five dollars in future losses and damages, according to the head of adaptation research at the London School of Economics.

After initially abolishing mining, triggering immediate economic disaster, the switch to government-regulated green mining and the associated significant investment was Calibra's **biggest risk** for our mining-dependent city. Futuristic technological advances including Lithi-Fil,

GreenGas analyzers, carbon-capture-produced mining tools, bio-engineered cold-hardy mangroves, efficient renewable energy sources, and patent licensing revenues stabilized the economy and reduced economic risk. The long-term benefits of fewer severe weather events, increased mental and physical health, and new economic opportunities outweighed the transition and workforce retraining costs.

Calibra's community-first culture helped residents balance significant health and environmental benefits with SeguroNet's potential for data privacy intrusion, a **trade-off** Calibra accepted. **Compromise** was critical to Calibra's success. Balancing competing interests of indigenous Atacameños and mining companies, our mitigation strategies restored and preserved the desert, and collaborative decision-making led to the discovery of Lixiviant, our valuable eco-friendly copper-extraction innovation.

Calibra's **engineering** includes civil engineers creating buildings, roads, and utilities. Environmental engineers design bioswales, super sewers, and carbon sinks. Chemical engineers develop Dura-namel, and green mining innovations *Leptospirillum*, Lixiviant, and Lithi-fil. Nuclear engineers operate fusion plants. Hardware and software engineers maintain SeguroNet and *Iniciador* electronic primers.

Come join thriving Calibra-by-the-Sea, where we're engineering a balance between how nature works and how people think!

word count: 1493

References

ADEVCOM. "Región de Antofagasta." *Energiaregion.cl*, 2022, energiaregion.cl/region/ANTOF. Accessed 25 Nov. 2022.

Agencia de sostenibilidad Energética. "Antofagasta." *Comuna Energética*, 2014, www.comunaenergetica.cl/producto/antofagasta/. Accessed 25 Nov. 2022.

American Museum of Natural History. "What's a Mangrove? And What Does It Do? | AMNH." *American Museum of Natural History*, 2020, www.amnh.org/explore/videos/biodiversity/mangroves-the-roots-of-the-sea/what-is-a-mangrove.

Bamboo U, Marketing. "Is Bamboo a Safe Construction Material in Natural Disasters like Earthquakes?" Bamboo U, 25 Aug. 2022, <https://bamboou.com/is-bamboo-a-safe-construction-material-in-natural-disasters-like-earthquakes/>.

Blue Bacteria Stock Photo - Download Image Now - Bacterium, Biological Cell, Black Color. iStock, 7 November 2017, <https://www.istockphoto.com/photo/blue-bacteria-gm871002084-145335639>. Accessed 30 November 2022.

Burke, Sharon, and Andrea Cameron. "Wargaming Climate Change: Who Plays for the Red Team?" *War on the Rocks*, 8 Nov. 2022, warontherocks.com/2022/11/wargaming-climate-change-who-plays-for-the-red-team/. Accessed 27 Nov. 2022.

Cairns, Rebecca. "This Giant "Water Battery" under the Alps Could Be a Game-Changer for Renewable Energy in Europe." *CNN*, 1 Aug. 2022, www.cnn.com/2022/08/01/world/water-battery-switzerland-renewable-energy-climate-scn-hnk-spc-intl/index.html. Accessed 25 Nov. 2022.

California Water Boards. "13123/Eagle Mountain Pumped Storage Project | California State Water Resources Control Board." *Www.waterboards.ca.gov*, 1 Apr. 2020, www.waterboards.ca.gov/waterrights/water_issues/programs/water_quality_cert/eagle_mtn_ferc13123.html. Accessed 25 Nov. 2022.

Charles, Dan. "'Water Batteries' Could Store Solar and Wind Power for When It's Needed." *NPR.org*, 14 Oct. 2022, www.npr.org/2022/10/14/1126523766/water-batteries-could-store-solar-and-wind-power-for-when-its-needed.

Carlson, Matthew. "Power Your Home with a Water Battery." *Hackaday*, 8 Oct. 2021, <https://hackaday.com/2021/10/08/power-your-home-with-a-water-battery/>

Carter, Troy. "Bamboo Skyscrapers." *Medium, Rizome*, 25 Mar. 2020, <https://medium.com/rizome/bamboo-skyscrapers-eded5b234726>.

Colarossi, Jessica. "City Trees and Soil Are Sucking More Carbon out of the Atmosphere than Previously Thought." *Boston University*, 16 Feb. 2022, www.bu.edu/articles/2022/city-trees-and-soil-are-sucking-more-carbon-out-of-the-atmosphere-than-previously-thought/.

Coordinador Eléctrico Nacional. "Infotécnica Región de Antofagasta." *Coordinador.cl*, 2022, infotecnica.coordinador.cl/geo/region/antofagasta-3. Accessed 27 Nov. 2022.

---. "Infotécnica Región de Antofagasta: Comuna de Antofagasta." *Coordinador.cl*, 2022, infotecnica.coordinador.cl/geo/comuna/8. Accessed 27 Nov. 2022.

---. "Reporte, Estadísticas Y Plataforma I Coordinador Eléctrico Nacional (CEN)." *Coordinador Eléctrico Nacional | Servimos a Chile Con Energía*, 19 July 2021, www.coordinador.cl/reportes-y-estadisticas/. Accessed 27 Nov. 2022.

Cukier, Kenneth, and Tim Cross. *Babbage from the Economist*. The Economist, 8 Nov. 2022, Babbage at COP27: Part two-adapting to a changing climate. Podcast.

Department of Defense, Office of the Undersecretary for Policy (Strategy, Plans, and Capabilities). *Department of Defense Climate Risk Analysis*. 2021.

Department of the Army, Office of the Assistant Secretary of the Army for Installations, Energy and Environment. *United States Army Climate Strategy*. Feb. 2022.

Department of Energy, <https://www.energy.gov/>.

Dieterich, Robert. "24-Hour Solar Energy: Molten Salt Makes It Possible, and Prices Are Falling Fast." *Inside Climate News*, 16 Jan. 2018, insideclimatenews.org/news/16012018/csp-concentrated-solar-molten-salt-storage-24-hour-renewable-energy-crescent-dunes-nevada/.

"Diversity in Chile | Abroad Guide | Diversity Abroad." *Diversity Abroad*. N.p., n.d. Web. 2 Dec. 2022. <https://www.diversityabroad.com/articles/travel-guide/chile>

Earth Observatory. "Flooding in the Chilean Desert." *Earthobservatory.nasa.gov*, 11 Apr. 2015, earthobservatory.nasa.gov/images/85685/flooding-in-the-chilean-desert.

Editor at SurferToday.com. "The Health Benefits of Sea Water." *Surfertoday*, 2019, www.surfertoday.com/surfing/the-health-benefits-of-sea-water.

Foer, Jonathan Safran. *We Are the Weather: Saving the Planet Begins at Breakfast*. Thorndike Press, 2020.

France 24. "Chilean Scientist Plans to Clean up Mining with "Metal Eating" Bacteria." *France 24*, 9 Oct. 2021, www.france24.com/en/live-news/20211009-chilean-scientist-plans-to-clean-up-mining-with-metal-eating-bacteria. Accessed 25 Nov. 2022.

Fritz, Angela. "The "Driest Place on Earth" Is Covered in Pink Flowers after a Crazy Year of Rain." *Washington Post*, 29 Oct. 2015, www.washingtonpost.com/news/capital-weather-gang/wp/2015/10/29/the-driest-place-on-earth-is-covered-in-pink-flowers-after-a-crazy-year-of-rain/.

Global Energy Monitor. "Chile and Coal." *Global Energy Monitor*, 20 July 2021, www.gem.wiki/Chile_and_coal. Accessed 27 Nov. 2022.

Gobierno de Chile. "Gobierno Transparente." *Www.minenergia.cl*, 2022, www.minenergia.cl/transparencia/. Accessed 25 Nov. 2022.

Harper, Jo. "Swiss 'Water Battery' Boosts Europe's Energy Storage Plans – DW – 11/30/2022." *Dw.com, Deutsche Welle*, 30 Nov. 2022, <https://www.dw.com/en/swiss-water-battery-boosts-europes-energy-storage-plans/a-63923662>.

IPCC. *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, 2022.

Knight, Matthew. "Glowing Bacteria Could Power 'Bio-Light'." CNN, Cable News Network, 3 Dec. 2011, <https://www.cnn.com/2011/12/03/tech/innovation/bio-light-eco-system/index.html>.

Laboratory, Lawrence Livermore National. "Key Discovery for Future Design of Laser–Fusion Energy Reactors."

Leacock, Matt. "Daybreak: Models and Resources." *Medium*, 4 Oct. 2022, blog.daybreakgame.org/daybreak-models-and-resources-e491e31ebc6a. Accessed 25 Nov. 2022.

---. "Daybreak: Players and Powers." *Medium*, 4 Oct. 2022, blog.daybreakgame.org/daybreak-players-and-powers-97bb3500b1b5. Accessed 25 Nov. 2022.

---. *Interview with Matt Leacock by Nathan Bluestein*. 14 Nov. 2022. Consulted with Mr. Matt Leacock, co-designer of Daybreak a cooperative game about stopping climate change and designer of Pandemic, on his research into climate impact and what he learning in his design process.

Leary, Kyree. "Molten Salt Can Generate Electricity, Any Time of the Day." *World Economic Forum*, 18 Jan. 2018, www.weforum.org/agenda/2018/01/clean-energy-companies-are-looking-into-using-molten-salt-to-generate-electricity/. Accessed 25 Nov. 2022.

Lewis, Michelle. "Scientists Have Cost-Effectively Harvested Lithium from Seawater." *Electrek*, 4 June 2021, electrek.co/2021/06/04/scientists-have-cost-effectively-harvested-lithium-from-seawater/

Limited, Bangkok Post Public Company. "Chile Opens Vast Thermosolar Power Plant." *Bangkok Post*, 10 June 2021, www.bangkokpost.com/business/2129691/chile-opens-vast-thermosolar-power-plant. Accessed 25 Nov. 2022.

Mazapatera, Richard. "Why Is Earth's Driest Place Flooding and Snowing?" *Www.downtoearth.org.in*, 12 Mar. 2019, www.downtoearth.org.in/news/climate-change/why-is-earth-s-driest-place-flooding-and-snowing--63539.

McVeigh, Karen. "Blue Carbon: The Hidden CO2 Sink That Pioneers Say Could Save the Planet." *The Guardian*, 4 Nov. 2021, www.theguardian.com/environment/2021/nov/04/can-blue-carbon-make-offsetting-work-these-pioneers-think-so.

- Menapace, Matteo. "Daybreak: Antagonists and Impacts." *Medium*, 4 Oct. 2022, blog.daybreakgame.org/daybrek-antagonists-and-impacts-6c7818ce773c. Accessed 25 Nov. 2022.
- . "Why We Made Daybreak." *Medium*, 10 Oct. 2022, blog.daybreakgame.org/why-we-made-daybreak-e7f30b3112ba. Accessed 25 Nov. 2022.
- Ministerio de Energía. "Ministerio de Energía |." *Energía.gob.cl*, 2022, energia.gob.cl/. Accessed 25 Nov. 2022.
- Ministerio de Energía, Gobierno de Chile. *Estrategia Energía Local En Antofagasta*. 12 Apr. 2015.
- Miranda, Natalia A. Ramos. "In Chile's Atacama Desert, a Cautionary Tale for Bold Renewable Energy Vows." *Reuters*, 30 Oct. 2019, www.reuters.com/article/us-chile-energy-solar-idUSKBN1X9132.
- Murray, Cameron. "AES Andes Looks to Replace Coal Power Plant in Chile with 560MW Molten Salt-Based Energy Storage." *Energy Storage News*, 18 Oct. 2022, www.energy-storage.news/aes-andes-looks-to-replace-coal-power-plant-in-chile-with-560mw-molten-salt-based-energy-storage/. Accessed 25 Nov. 2022.
- Ocean+ Habitats. "Ocean+ Habitats." *Ocean+ Habitats*, Aug. 2022, habitats.oceanplus.org/chile. Accessed 25 Nov. 2022.
- "Peace, Dignity and Equality on a Healthy Planet." United Nations, United Nations, <https://www.un.org/en/>.
- Powell, Alvin. "Anti-Aging Research: "Prime Time for an Impact on the Globe."" *Harvard Gazette*, 8 Mar. 2019, news.harvard.edu/gazette/story/2019/03/anti-aging-research-prime-time-for-an-impact-on-the-globe/.
- Products, Electronic, and Electronic Products. "How Salt Water Batteries Can Be Used for Safe, Clean Energy Storage." *Electronic Products*, 17 Apr. 2017, www.electronicproducts.com/how-salt-water-batteries-can-be-used-for-safe-clean-energy-storage/. Accessed 25 Nov. 2022.
- "Seabox Subsea Water Treatment Technology." NOV, <https://www.nov.com/products/seabox-subsea-water-treatment-technology>
- SciTechDaily, 1 Dec. 2022, <https://scitechdaily.com/key-discovery-for-future-design-of-laser-fusion-energy-reactors/>.

Scientific American. "Why Not Split Harmful Carbon Dioxide into Harmless Carbon and Oxygen?" *Scientific American*, 9 July 2009, www.scientificamerican.com/article/splitting-carbon-dioxide/.

Service, Robert F. "'Thermal Batteries' Could Efficiently Store Wind and Solar Power in a Renewable Grid." *Www.science.org*, 13 Apr. 2022, www.science.org/content/article/thermal-batteries-could-efficiently-store-wind-and-solar-power-renewable-grid.

---. "Seawater Could Provide Nearly Unlimited Amounts of Critical Battery Material." *Www.science.org*, 13 July 2020, www.science.org/content/article/seawater-could-provide-nearly-unlimited-amounts-critical-battery-material.

Something Borrowed. "8 Fascinating Uses of Diamond." *Something Borrowed Jewelry*, 4 July 2021, somethingborrowedpdx.com/what-are-diamonds-used-for/.

Stephenson, Neal. *Diamond Age*. Penguin Books Ltd, 2011.

Swan Lake Energy Storage. "SL Energy Storage." *Slenergystorage.com*, 2022, slenergystorage.com/. Accessed 25 Nov. 2022.

Terra, John. "The Future of Robotics: Everything You Need to Know in 2022." Simplilearn, 11 November 2022, <https://www.simplilearn.com/future-of-robotics-article>. Accessed 30 November 2022.

The Economist. "Global Food Security Index 2022." 2022.

The Editors of Encyclopedia Britannica. "Atacama Desert | Location, Weather, & Facts." *Encyclopædia Britannica*, 26 Sept. 2017, www.britannica.com/place/Atacama-Desert.

"The Future of the Energy Sector." Business Insider, Business Insider, <https://www.businessinsider.com/sc/future-of-energy-sector-2020-12>

Tokyo, University of. "New Device Purifies Saltwater over a 1000 Times Faster than Standard Industrial Equipment." *SciTechDaily*, 10 June 2022, scitechdaily.com/new-device-purifies-saltwater-over-a-1000-times-faster-than-standard-industrial-equipment/.

UnboxedMedia. *Climate Impact Asia: Food Security*. 16 Apr. 2020, episode 4.

United Nations. "The Ocean – the World's Greatest Ally against Climate Change | United Nations." *United Nations*, www.un.org/en/climatechange/science/climate-issues/ocean.

US, Guardian. "Guardian US." Embrace What May Be the Most Important Green Technology Ever. It Could Save Us All, <https://apple.news/A9dWnaLjHSCmZGYh0EbhPhg>.

US, Guardian. "Guardian US." Replace Animal Farms with Micro-Organism Tanks, Say Campaigners, <https://apple.news/AIztuwqZZRjSghmpQMx9hzw>.

"Water Battery Concept." Max Bögl Wind AG, 15 Feb. 2021, <https://www.mbrenewables.com/en/water-battery-concept/>

"Weatherspark.com." Antofagasta Climate, Weather By Month, Average Temperature (Chile) - Weather Spark, <https://weatherspark.com/y/26546/Average-Weather-in-Antofagasta-Chile-Year-Round>.

Weiner, Scott. "What's in a number? Looking at life expectancy in the US." Harvard Health, 7 February 2020, <https://www.health.harvard.edu/blog/whats-in-a-number-looking-at-life-expectancy-in-the-us-2020020718871>. Accessed 30 November 2022.

World Nuclear News. "Winning Bid Announced to Host UK Fusion Plant : New Nuclear - World Nuclear News." www.world-nuclear-news.org, 4 Oct. 2022, www.world-nuclear-news.org/Articles/Winning-bid-announced-to-host-UK-fusion-plant. Accessed 25 Nov. 2022.

Yu, Juezhi, Daliang Fang, Hang Zhang, Zhi Yi Leong, Jingtao Zhang, Xiaoxia Li, and Hui Ying Yang "Ocean Mining: A Fluidic Electrochemical Route for Lithium Extraction from Seawater" ACS Material Letters; ACS Publications. <https://pubs.acs.org/doi/10.1021/acsmaterialslett.0c00385?fig=tgr1&ref=pdf>

Zeihan, Peter. *The End of the World Is Just the Beginning: Mapping the Collapse of Globalization*. Harper business, 2022.