THE FORTNIGHTLY CLUB

of

REDLANDS, CALIFORNIA

Founded 21 January 1895

Meeting Number 1988

December 14, 2023

4:00 P.M.

WHAT IS THE CIRCULAR ECONOMY AND CAN IT SAVE THE PLANET

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WHAT IS THE CIRCULAR ECONOMY AND CAN IT SAVE THE PLANET

BY

Richard Corneille

SUMMARY

The circular economy is starting to be implemented world-wide as a model to address climate change and to increase resiliency and sustainability. Most scientists and economists believe we are now living beyond what our world's natural resources can provide. As we are finding out, our linear take-make-use-waste economy is not sustainable. Simply stated in the circular economy we redesign everything so it can be regenerated and made over again and waste is designed out. The EU defines the circular economy as a model of production and consumption which involves sharing, leasing, reusing, repairing, refurbishing, and recycling exiting materials and as long as possible to extend their life cycle. Governments need to provide regulatory direction and incentives and companies need to lead in the implementation of the circular economy. Companies need to produce goods that are not only sustainable, but regenerative. The paper discusses examples of implementing circular economy principals in various sectors of the economy, government actions needed, and financial impacts. Based on the research into the circular economy conclusions are presented at the end of the paper.

INTRODUCTION

This paper discusses what the circular economy is and why it is being implemented world-wide to address climate change. The paper first discusses some solid waste facts, since eliminating waste is a primary goal of the circular economy. It then describes how we got here in the U.S. with an exponential increase in the use of cheap fossil fuels and a huge population growth, but also with over-consumption, increasing waste, and growth in the use of plastics. The paper then presents our current linear economy. Most scientists and economists believe we are living beyond what our world's natural resources can provide. As we are finding out, our linear take-make-use-waste economy is not sustainable. The circular economy is then described in detail. Simply stated in the circular economy we redesign everything so it can be regenerated and remade over and over again (1), and waste is designed-out. Examples of implementing the circular economy principals in various sectors of our economy are then presented. Examples in manufacturing technical products, fashion and clothing, construction, electronic waste and batteries, packaging and containers, and the food industry. Finally, financial investing in the circular economy is reviewed and government regulatory laws and actions are discussed. Conclusions are presented at the end of the paper.

This paper was researched by reading several books as shown in the bibliography, and gathering information in articles and on websites. Footnotes for references are indicated with a number in parentheses corresponding to the number of the reference shown in the bibliography.

SOME SOLID WASTE FACTS

The amount of solid waste generated in the U.S. has increased by one-third over the last 40 years. On average Americans produce 7.1 pounds per capita each day (2). This equals about 100 tons in each person's lifetime! This is 50 percent more waste per capita than countries like Germany, Austria, or Denmark, and 250 percent more than Japan. The U.S. is 5 percent of the world's population, but we produce 25 percent of the world's solid waste.

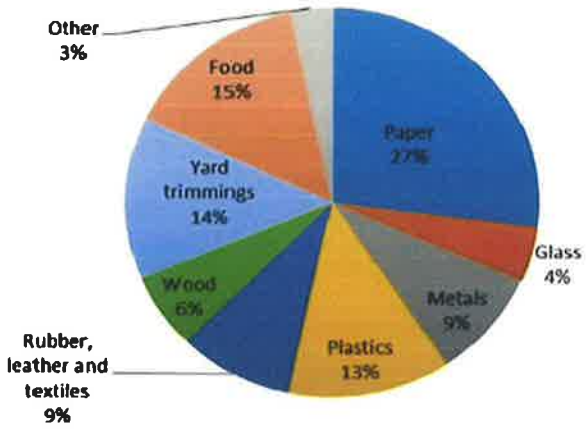
We dispose of our solid waste in landfills, waste to energy facilities, and by recycling and composting. In the U.S we generate about 390 million tons per year (MTPY) with 270 MTPY or 69 percent buried in landfills. We burn 26 MTPY or 7 percent in waste-to energy facilities, and 94 MTPY, 24 percent, is recycled or composted (2). The cost for solid waste collection, handling and disposal is huge. New York City alone pays over $300 million per year in exporting wastes collected to landfills in Pennsylvania, Ohio, and South Carolina. Fortunately, recycling offsets some of the landfilling costs, but is not an overall money maker for solid waste agencies. Recycling facilities are a $100 billion industry and generate 540,00 jobs in the U.S. (1).

According to CalRecycle, the agency which oversees all solid waste programs in California, we generate about 80 million tons per year with half going to landfills and 40 percent being recycled. The CalRecycle goal is to recycle 75 percent of all waste. In 2018 China implemented the National Sword policy, declaring it would no longer accept many recyclables including paper and plastics, which upended the markets for recyclables in California. However, this has had a longer-term positive benefit because it spurred the long overdue investing in the development of domestic markets for recyclables.

According to data in the Redlands City's 23/24 budget for the Solid Waste Division, the City's total generation of waste is 67,000 tons per year with 36 percent recycled or composted. This equates to

about 5 pounds per capita per day. The City owns and operates a landfill called the California Street Landfill. It is located between California and Nevada Streets and north of Palmetto Avenue in the northwest part of the City near the wastewater treatment plant. The City's 9,600 tons of mixed recyclables are delivered to a company, CR&R, for sorting and processing in a materials recycling facility (MRF). Green waste is taken to One Stop Landscaping in Santa Timoteo Canyon for composting. Permitting with CalRecycle is underway for the co-composting of mixed green and food waste at One Stop. Redlands total Solid Waste Division Budget is $20 million per year.

Knowing the composition of our trash is important in understanding what we can reduce, reuse, remake, recover, or recycle. The following is a pie chart of the percentages of material we throw away before recycling or composting for a typical US residence (2).



Note that paper waste, which includes containers and packaging, are the largest portion of our trash followed by food scraps, yard waste, and plastics.

HOW DID WE GET HERE?

The increase in greenhouse gases, which case global warming, has been largely driven by the exponential increase since WW II in the combustion of fossil fuels in vehicles, to produce power, to make products, for construction of buildings and infrastructure, to heat and cool our houses, etc. Cheap fossil fuels have allowed us to greatly increase our standard of living. In addition, our world population has increased from 2 billion in 1950 to over 8 billion today. Every child born in the U.S. today will generate 16 tons of green house gases a year for the rest of their life (16), so the emissions from the increase in population is huge. Both cheap fuels and an exploding population has contributed to conspicuous over-consumption of everything and the resultant depletion of natural resources, pollution, and waste.

As mentioned above, the US produces the most total amount of waste and on a per capita basis of any country in the world. How did we get to be the king of waste? Well right after World War II Americans were encouraged by our leaders, including President Eisenhower, to "buy anything" to increase consumption. Then we were encouraged to throw away perfectly good items in order to replace and upgrade them with items that were "bigger, bolder, and better." The age of television was just starting,

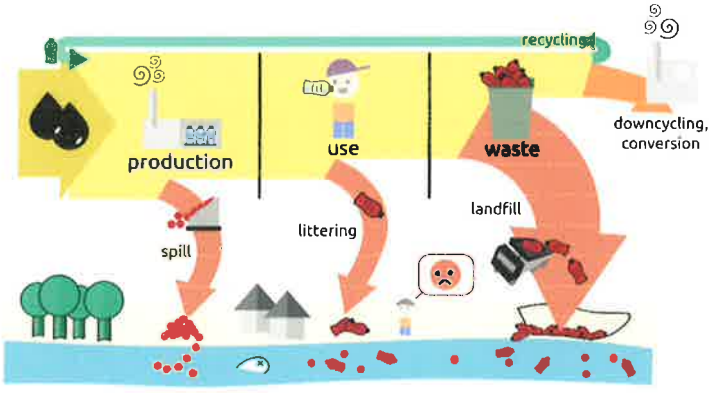
so viewers were a captive audience for marketeers. Edward Hume notes in his book Garbology "during the Great Depression and during WWII the American Dream included hard work, diligent saving, and conserving resources to pave the road to a good life." "However, this idea faded in the 50's and was surpassed by the notion that the highest expression and measurement of the American Dream lay in material wealth itself, the acquisition of stuff"(2). Consumer engineering and aggressive advertising were born including statements like "wearing things out doesn't produce prosperity, buying things does". Making products for disposability rather than durability became the norm. The concept of planned obsolescence was practiced (and still is) for the design of products in all fields, justified by being good for the economy and efficient.

Another major phenomenon since the 50's was the increased availability and marketing of plastic goods. Plastics have been a large contributor to our waste disposal problems and pollution of our oceans. Remember the 1967 movie The Graduate when Benjamin is told for a job "it's plastics". The uses for plastics have increased exponentially and have made our world much better with a huge variety of uses. Plastics are made from hydrocarbons so their manufacturing process releases a significant amount of greenhouse gases. Ron Burgess in his 2017 Fortnightly paper titled "Fantastic Plastic and Its Dark Side" explored the pros and cons of plastics in detail. Of the 300 million tons of plastic produced each year only 9 percent is currently recycled (1). About 8 million tons of plastic ends up in the ocean each year where it accumulates in giant patches called gyres, with the most famous one called the Great Pacific Garbage Patch (1). It is projected that by 2050 there will be more plastic in the ocean than fish! Fortnightly member Dr. George Christison in his January 2023 paper told us that microplastics are ubiquitous and we all have them in our bodies, even new born babies. Un-recyclable single-use plastic packaging and containers are a major contributor to our solid waste disposal streams.

THE LINEAR ECONOMY'S ROLE

Our economy is based on a **take-make-use- and dispose** model (3) and has been for over 70 years. This model has greatly increased our prosperity, but has disrupted every living system on our planet, as well as the social foundation for the disadvantaged. The linear economy can be described as follows and shown graphically in the following figure:

1. Material and resources are extracted or **taken** from the earth
2. They are processed to **make** a product
3. Products are bought and **used** by a consumer
4. When the product no longer serves the consumer's purpose it is **wasted**



Waste is a necessary huge component of the linear economy. As mentioned above, it is often designed-into the product via planned obsolescence and by using cheap materials. This assures a never-ending demand for a product and product upgrades. It also creates a never-ending demand for the limited resources from the earth. Companies, like Apple, have campaigns to lure consumers to trade-up to the latest and greatest before the consumer's existing product needs to be replaced.

Gross domestic product (GDP) has long been a leading indicator of economic health and progress in a nation. It measures the value of new goods and services that a nation produces. An increasing GDP year over year is what each country strives for. The linear economy concept supports GDP growth because it doesn't recognize the cost of resource depletion and waste. GDP is measured without regard to the quality of the products produced, how the resources were obtained (did they harm the planet), the energy used in producing the product, health impacts, and were the products useful in improving the quality of life (4).

Advocates of the linear economy claim the system is capitalism at its finest. It is an optimally efficient free market. However, Ron Gonen in his book The Waste Free World states "What could be less capitalistic than private companies relying on taxpayers to fund disposal of their product, at the conclusion of one life cycle of a product's use?"(1). In addition, every taxpayer regardless of whether they used the product or not shares in the cost of disposal. Consumers have also unknowingly subsidized growth industries that have benefited from the take, make, use and dispose economy. Consumers have paid unnecessary costs for extraction and disposal of materials that have polluted our land, air, and water.

It should be noted that in nature there is no waste. In the natural world nature breaks down and captures value at each stage of decomposition. Nature only makes waste which is biodegradable- for example to compost for soil building, which supports the growth of additional plants and trees. In nature one creatures waste becomes another creature's food through death and renewal (4)

We have come to realize in the past decade that our planet is being desecrated more rapidly than predicted. The linear economy has been a major factor in degrading and eroding the environment and resources which we rely on for our livelihoods, health, food, water, recreation, and quality of life. An estimated two thirds of greenhouse gas emissions come from these linear processes of extraction and mining, manufacturing, and disposal of consumer products (1).

THE CIRCULAR ECONOMY

The circular economy is a model that is based on designing out waste, keeping materials in use for as long as possible, and regenerating natural systems (3). The rest of the paper defines exactly what the circular economy is, how it works, its benefits, and examples of how it is being implemented.

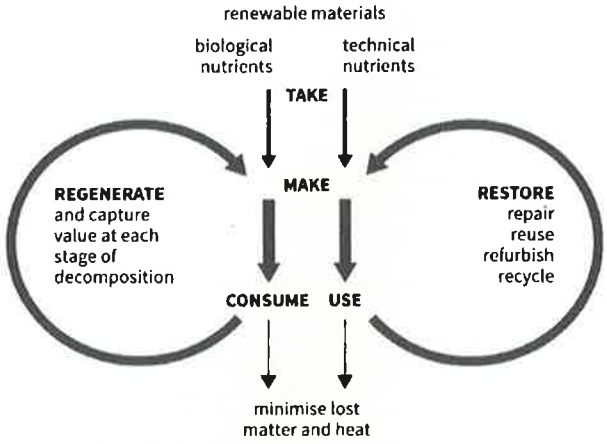
The idea for a circular economy was coined by Allan Knesse in a 1988 article titled "The Economics of Natural Resources". However, the basic idea was first discussed in a 1966 book by Kenneth Boulding titled Circular Flow of Material and Energy where he proposed a shift away from the expansionist "cowboy economy" to a "space economy" where everything is engineered to be constantly recycled.

The EPA (7) defines the circular economy as "an economy that uses a systems-focused approach and involves industrial processes and economic activities that are restorative or regenerative by design, enabling resources used in such processes and activities to remain at their highest value for as long as

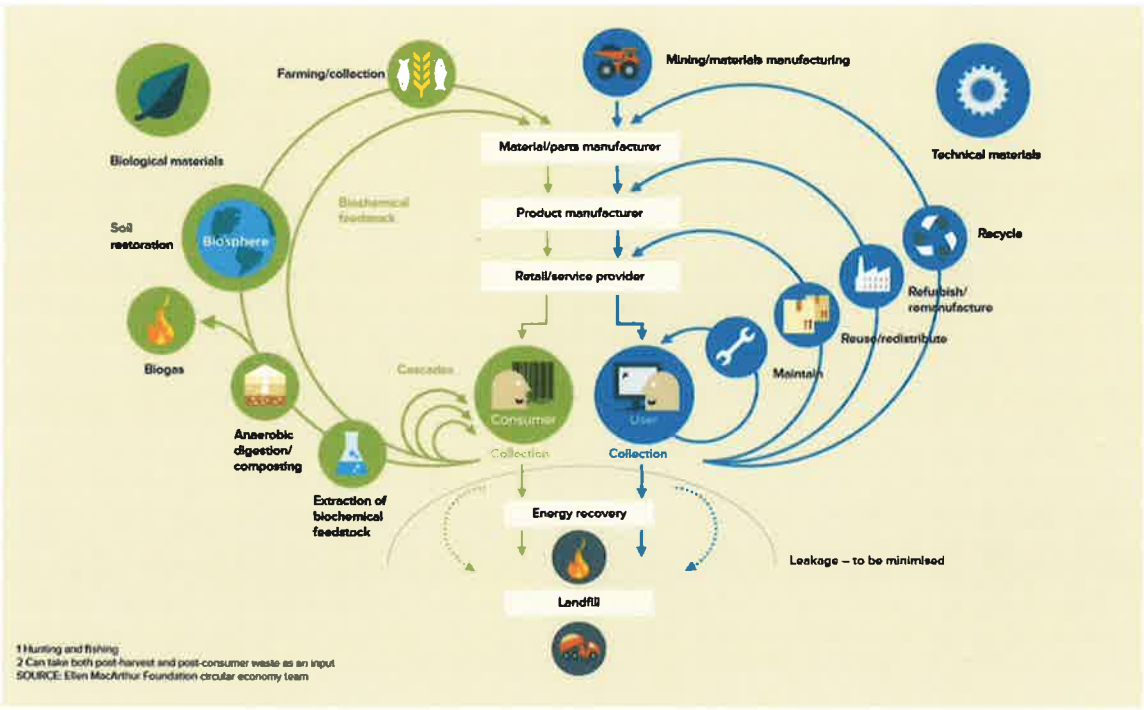
possible, and aims for the elimination of waste through superior design of materials, products, and systems". The European Parliament defines the circular economy more simply "as a model of production and consumption, which involves sharing, leasing, reusing, repairing, refurbishing and recycling existing materials and products as long as possible. In this way the life cycle of products is extended".

As show on the following circular economy diagram, recyclables become the raw materials for the design and manufacturer of new products. A retailer sells the product to a consumer who uses the product. The product is repaired, reused, repurposed, and finally recycled. In this process the manufacturer provides and charges for a service to keep their product in use as long as possible, rather than just selling a new product. They receive compensation or revenue for repairing, reusing, or repurposing a product prior to recycling. They then can use the recycled product materials to build new products.

There are two types of major materials in the circular economy: **technical** and **biological**. Technical materials are those that cannot be grown, like metals, glass, and plastics. One major issue in making technical materials circular is the products we currently use are not often designed to allow for sharing, reuse, repair, or remanufacturing (3). Technical materials cannot be regenerated, but can be restored. Biological materials can be regenerated and grown from the earth. Examples of biological materials are timber and plants. The following figure from Doughnut Economics by Kate Raworth shows a simple circular diagram with biological regenerate material on the left side and on the right technical materials that are restorable (4). Taking new resources is minimized, as is waste, so making new products are from regenerative materials and restoring technical materials.



The Ellen MacArther Foundation (6) developed the butterfly economy diagram and is a leading charitable organization promoting the circular economy. Its mission is to accelerate the transition to a circular economy driven by design, eliminating waste and pollution, and keeping products and materials in use for as long as possible (3). Who is Dame Ellen MacArther? She is from England and in 2005 she was the fastest solo sailor to sail around the world in 71 days. She is still the fastest woman to do this. She was awarded the Most Excellent Order of the British Empire for this feat. In 2010 she launched her charitable foundation. The Charity promotes the concept of "cradle to cradle" thinking rather than "cradle to grave". The Foundation's most recent detailed butterfly economy diagram is shown below. It very descriptively shows the biological/renewables flow management on the left side. This includes the concept of cascading from a higher value product to lower value products and use as a biochemical feedstock. On the right side are the repair, maintain, reuse/redistribute and refurbish/remanufacture stock management for the technical materials.



The six R's on the diagram below define the circular economy's sustainability hierarchy from most favorable to least favorable. The six R's are the foundational principals of the circular economy.

The main purpose of each **R** is as follows (3):

-REFUSE: Say no to what you don't need

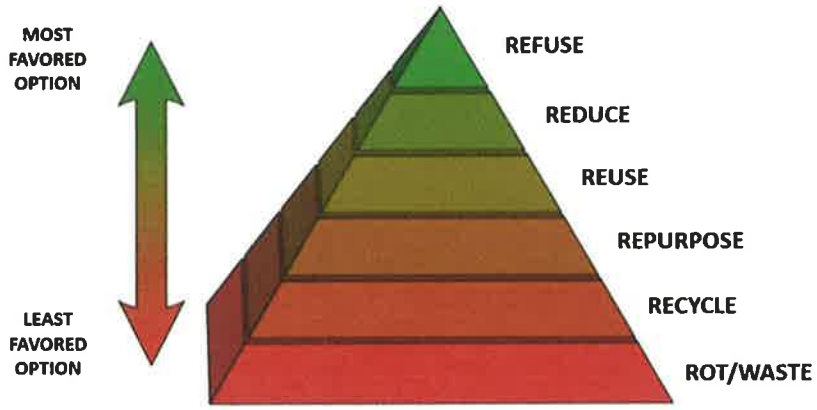
-REDUCE: Use less/conserve

-RESUSE: Extend product life cycle

-REPURPOSE: Find other uses (retool, reimagine uses, reuse parts)

-RECYCLE: Materials rebirth

-ROT: return organic material to soil or to biogas



There is opportunity with circular technical production to both upcycle (a strategy to reuse the product in a way which holds more value than the original product) or downcycle (reusing the product in a way that holds less value than the original product (3).

The circular economy goals for lifecycles goes beyond sustainability to be regenerative. A product sustainable life cycle is one which produces no less (or not more) value, energy, or materials at the end of its cycle than it had originally when it was produced (3). A regenerative product life cycle not only does what is sustainable, but offsets the negative impacts of the past ways we did things.

IMPLEMENTING CIRCULAR ECONOMY PRINCIPALS

The following are a few examples of where circular economy principles are being implemented in various sectors of the economy.

Manufacturing Technical Products

Many durable and non-durable goods manufacturers and retailers are implementing circular economy principals. About 30 percent of Global Fortune 500 companies have carbon neutral goals and 50 percent are on track to achieve many of them by 2030. As discussed later, government regulations are requiring many larger companies to implement circular principals. However, many companies of all sizes are converting to circular methods because their customers, particularly millennials, are demanding that they be sustainable. They also find that it to their economic advantage to do so. They understand that their supply chains are vulnerable to global warming. Also, their access to the raw materials they need for their products are becoming limited.

While start-ups are leading the way in product innovation, many of the largest enterprises on the planet are also are making breakthroughs in innovation. These companies include the following (1): consumer goods giants; Unilever, Procter & Gamble, Nestle, Coca Cola, and Pepsi; IKEA in furnishings; Google, Dell, and HP in computing; carmakers Ford, GM, and Renault; and food behemoths Kroger, Starbucks, and McDonalds. All of these companies have sustainability officers, most of whom are in the Board Room.

Steelcase is an example of company that has been implementing a circular economy sustainable model for years. They started their Eco Services in 2008 and Circular by Steelcase Label in France. Each year in France 250,00 tons of office furniture end their useful life. The first priority is to repair and resell the

furniture under the Circular by Steelcase Label. The second is to repurpose discarded items to use as parts to repair used furniture or make new products. The last priority is to recycle the materials like melting the metal, chipping the wood, and grinding the plastic to make raw materials to build new furniture. In France 20 percent of public agency office furniture must be reconditioned or contain a percentage of recycled material. Steelcase has even made a carbon neutral chair where all GHG emissions, including third party emissions, are offset by the use of renewable energy, forest management offset or electric transportation.

The right to repair products is the law in most European countries. California just passed into law SB 244, "the right to repair law" which makes it easier and more affordable for consumers to repair mechanical products and electrical devices by requiring companies to stock parts for seven years, making any special repair tools available, and repair manuals needed to fix a product with a sales value of greater than $100. You-Tube has thousands of free fix-it videos. There is a new service called repair cafes where handy men are providing services to help people repair products or have specialists available to fix it. Often these services are free with retired people with repair skills running the repair cafes. *Keeping products in service for as long as possible is one of the key principals of the circular economy.*

Fashion and Clothing

The fashion industry is a very large $3.7 trillion industry that is extremely wasteful, but is one of the hardest to incorporate into the circular economy. About two-thirds of the material for clothes are various forms of synthetic materials, which are plastics, including polyester, nylon and acrylics all made from oil (3). Of the plant-based materials, cotton makes up the bulk of the material at about 27 percent of the total. Animal materials like wool and silk make-up only 2 percent of clothing manufacture. Many clothes are made with combinations of materials, which makes recycling the fiber almost impossible. The making of all types of clothes requires huge amounts of petroleum products, water, and wastewater generated, much of which is toxic due to the fabric dyes. In addition, the "fast fashion" trend of cheap material, poorly made clothing has shortened the length of time clothing is used before it is discarded. About 73 percent of all clothing made today ends up in a landfill with only 1 percent recycled (1). In fact, 20 percent of clothes made today are not even sold, but directly discarded.

So how can the circular economy be practiced in the fashion industry? There are three main ways: scaling-up the rental of clothes, increasing their durability so they can be refurbished and resold, and encouraging brand leadership (3). Just like renting a tuxedo for your wedding, companies are offering to rent all types of clothes. These include higher-end clothes from chains like Ann Taylor, Urban Outfitters, and the Banana Republic. For youth clothes, the company Borababi specializes in renting, so as children grow, parents can return the smaller sizes and rent the larger sizes. Renting also allows customers to have the latest fashion styles without having to dispose of last year's styles.

A company called Renewal Workshop works with twenty apparel brands, including North Face, to refurbish their damaged, unsold and returned clothes (1). They inspect, clean, and mend the clothes to a high-quality standard. They are sold to consumers through the North Face renewed line. Patagonia designs products to be easily repaired and reused. Once their products can no longer be repaired, they will reclaim their product and issue a voucher worth the amount of their product (3). Paul Polman, former CEO of Unilever and the founder of the IMAGINE Foundation, got over 50 companies to sign the Fashion Pact, which is a pledge of the fashion companies to get to net-zero impact by 2050. This shows that there is significant movement in the fashion industry to become circular.

I have to mention that my own daughter and grandchildren give me hope for the future with buying and donating used clothing. They all love to go to the second-hand and thrift stores when in Redlands to purchase used clothes. My 15 year-old grandson even goes to Good Will and goes through their clothing looking for vintage items. He then washes and mends them, takes a picture for his website on Depop. When people buy, he gets the money from Depop deposited into his bank account after the people receive their clothes. He says he has made $600 this year on $2,000 in sales. Nice profit! Obviously, Goodwill, the Red Cross, and the Salvation Army have been in business for years accepting and reselling donated clothes.

Construction

Concrete is the most widely used construction material in the world. Concrete contains a mixture of aggregate, sand, and cement. The production of cement is an extremely energy intensive process. It has been reported (1) that 8 percent of the world's greenhouse gases are the result of the manufacture of cement alone. Finding an alternative material to hold the sand and gravel together in concrete is being developed. By studying biomineralization of coral polyps, Calera company has developed a cement which mimics the coral polyps a process called Fortura. This cement sequesters carbon and uses much less heat than producing traditional cement (1). In addition, a process has been developed to produce aggregate and sand by sequestering carbon dioxide from industrial carbon emissions thus producing concrete aggregates that are carbon negative. Truly a regenerative circular process. This concrete has been used in the construction at San Francisco Airport. Concrete production is being scaled by locating plants in industrial areas where there is carbon dioxide emission sources and a large concrete market for construction.

About 600 million tons of construction and construction debris (C&D) is generated each year in the U.S. This is almost double the amount of municipal waste generated (3). Demolition waste is 90 percent of C&D with new construction only 10 percent. Fortunately, 75 percent of C&D waste is reused in some form with a significant amount used as aggregate for new structural concrete and in asphalt concrete for road construction. While aggregate can be fairly readily obtained from crushing concrete demolition waste, recovering cement has not been possible until now. Two Dutch companies, New Horizons Urban Mining and Rutte Group, have developed a machine that crushes concrete in such a way as to release the cement for reuse (1). They have cleverly called the recycled cement "Freement". This is a huge development in construction material reuse. *Reuse is one of the key operating principals of the circular economy.*

Should a building be demolished or should a new building be constructed? Both the demolishing of a structure and building a new one creates significant greenhouse gas emissions. A study has been made for the Preservation Green Lab (National Trust for Historic Preservation) about climate change impacts from new construction versus reusing and retrofitting an existing building. The major finding is that building reuse, rather than new construction, almost always offers environmental savings over demolition and new construction (7). In fact, the study says it takes 10 to 80 years for a new, energy efficient building to overcome, through efficient operations, the negative climate change impacts that were created during the new construction process. A Life Cycle Analysis methodology was used by the company Quantis with analyses in four cities (Portland, Phoenix, Chicago, and Atlanta) in different climate zones and 6 different building types. Cost savings from reuse ranged between 4 of 46 percent over new construction for buildings with similar performance levels (7). This shows that reuse and

refurbishment of buildings compared to new building construction is environmentally superior and cost-effective.

Electronic Waste and Batteries

Ron Gonen in his book The Waste Free World (1) names his chapter 8 on e-wastes "Gold Mine on Our Hands". E-waste has been the largest single waste component that has increased in the municipal waste stream. E-waste world-wide is 5 percent of our waste stream with an estimate of 50 million tons generated each year at a value of $62.5 billion (1). However, only about 15 to 20 percent of e-waste is recycled in the US, but 40 to 50 percent is recycled in Europe. E-waste consists of cell phones, computers, televisions, stereos, routers, etc.

Currently cell phones are the most frequently thrown away electronic devices. There is a huge upgrading of cell phones to the latest and greatest (Apple excels here), and cell phones cannot easily be repaired so they are trashed. However, this is changing. ERI is a technically advanced e-waste recycling company that in 2019 recycled 30 million tons of E-wastes at eight facilities around the US. ERI picks up for free E-wastes from 3.2 million people in New York City alone. They basically grind-up the E-waste which comes out in finely granulated bits which are then sorted by material (1). "Mining" precious metals from E-wastes is not only more economical, but more reliable and socially responsible. A Chinese study found that mining copper, gold, and aluminum from ore costs thirteen times more than the "mining" from E-wastes. This is the ultimate in the circular principle of recycling.

The ability to repair electronics and other products is increasing. A company called iFixit has repair and tear-down videos online for free and also sells spare parts for electronic devices (1). As mentioned previously right to repair laws make electronics repair more feasible. Fortunately, in Redlands, if you have an Apple device, the MacGuyzs will probably be able to fix it.

After a battery's first life in a car and before it is recycled, it can be reused, refurbished, or repurposed (9). Generally, an electric vehicle (EV) battery is replaced when it is at 70-75 percent of the original capacity or about every 10 years. A new company called ReJoule in Signal Hill is repurposing used EV batteries to be linked together for storage of solar energy. Used EV cars batteries generally have enough capacity left for down-cycling for storage.

The ability to recycle batteries is also increasing with new technology and innovation leading the way. Small battery recycling has been available in the US for some time, but EV car lithium battery recycling is just beginning and is scaling-up. There are currently 3.8 million EV's on the road in America and sales are increasing each year (9). EV batteries are projected to be the dominant number of batteries in the recycle stream in the future. JB Straubel, the former chief technical officer for Tesla, formed Redwood Material for all types of battery recycling in Carson City, Nevada. His company reclaims cobalt, lithium, nickel, and magnesium from EV batteries using a process called pyrometallurgical leaching. His company reports that the lithium recovery rate is 95 percent. However, due to the weight and preparation for transporting batteries, about 50 percent of the recycling cost is the transporting costs to the battery recycler, so many more battery recyclers are needed.

There are currently no State or Federal laws requiring the recycling of EV batteries. In California AB 2832 required policy recommendations be developed. A recent report by an Advisory Group made up of experts and stakeholders developed a report that recommends that a law be passed for either an

extended producer responsibility by the car manufacturers, or the auto dismantler/recycler (who removes the battery), is responsible for recycling. The disassembly of EVs is different from gasoline vehicles, so new equipment, training and recycling partners are necessary for dismantlers to handle EVs (9). It is now up to the California Legislature to pass an EV battery recycling law.

Packaging and Containers

Packaging and containers account for 32.5 percent of our municipal waste in the U.S. today (1). Think of all the products we receive in plastic containers- soda drinks, laundry detergent, juice, milk, etc. How about the polystyrene (in the U.S. called Styrofoam trade mark) that dominates take-out boxes at restaurants, trays, plates, cups and for wrapping of meat in supermarkets; noodles and Styrofoam for protecting products shipped in boxes; etc. Most of this plastic is not, and in most cases cannot, be reused or recycled. Also, with the increase in e-commerce from companies like Amazon taking over sales from brick and mortar stores the number of boxes required is expanding at a rate of 4 percent per year (1). While all containers and packaging material cannot be eliminated or substituted with recyclable material, a lot can.

New circular economy products or services are being offered to reduce plastic waste. For example, Blueland cleaning solutions sells a plastic container with their liquid cleaner that is designed for multiple reuses. The company then sells tablets that can be mixed in the reusable container with water to make the cleaning solution. There are also strips of dissolvable laundry detergent by Tide and True Earth that eliminate the large plastic liquid container for the detergent. The Feel Good Store here in Redlands refills various products in reusable containers. Customers go to the store and refill their containers with the product they want. A company called TerraCycle developed a refillable program called Loop with reusable plastic containers for food products. The idea here was that the container would be returned to the store you purchased from. Loop would pick-up the containers clean and refill then with the product and return them for sale. Major retailers Walmart and Kroger are working with TerraCycle to implement customer insights and expansion of the brands offered. Another example is MAC Cosmetics with a program called "back-to-MAC" which collects empty cosmetic plastic dispensers and packaging for reuse and recycling (11). Closed Loop Partners, is an end-to-end solutions provider that is assisting MAC with improving their program and expect to be able to collect a million pounds of cosmetic packaging each year.

New paper production including cardboard from recycled materials can be increased substantially. There are 4 billion trees cut down each year to produce the world's paper (1). To make one ton of virgin paper takes 24 trees, 17,000 gallon of water, and 32 BTUS of energy. An Australian company Pratt Industries is one of the major manufacturers of boxes in a closed loop-system with recycled paper. Their business plan is to build plants close to the source of where paper waste is plentiful. For example, they currently collect and process 400 tons per day of paper collected in New York City. They currently have over 100 plants in 26 states. They have built a $3 billion per year business.

McDonald and Starbucks are working with the Center for the Circular Economy for the replacement of plastic cups with totally recyclable paper cups. It is estimated that currently 250 billion cups produced globally end up in the landfill each year (1).

Food Production, Distribution and Use

There are two major issues for our food production, distribution, and use to scale-up to become a circular food economy. They are reducing food waste and increasing local food sourcing.

Overall, about 30-40 percent of all food in the U.S. is wasted. It is estimated that 40% of the food waste is from residences, 18% from restaurants, 13% from grocery stores, 8% from institutions (hospitals and schools), and 16% from agriculture (1). One reason for residential food waste is due to a misunderstanding of food labels with stamped "best by", "best before", or "best is used by". These dates are not scientifically based, but determined by manufacturers, not by Federal Law. They are not estimates of when food will go bad, but when a product is at its ideal flavor or quality, neither about health and safety. Families can reduce food wastes significantly by buying just what you need, storing it correctly, cooking the right amount, eating leftovers, and recycling remaining food scraps. I know my wife makes a lot of soup from left-over food bits and water from cooking vegetables. It is the law now in California that food scraps must not go in the trash, but be separated and ultimately composted.

Reducing food waste from grocery stores could include selling "homely" vegetables and fruit at reduced prices, rather than throwing them away. France has a law forbidding the throwing away of food from supermarkets requiring stores to pass it on to food banks or processed for pet food. The Mori Company has developed a process where a microscopic edible coating can be used on vegetables and fruits to extend their life by 2 to 3 times thus reducing the amount of plastic wrap, refrigeration in transport, and overproduction at farms to account for spoilage (1). Food overstocking is common. For example, only about a quarter of the fish in stores is sold in the U.S. due to spoilage, even though 90 percent of the fish is imported, much of it traveling to market from Asia (1).

An initiative implemented in the Oakland school district by the district's sustainability manager is putting receptacles for composting, recyclables, and unopened items next to trash cans in student lunch rooms. Of coursed "policing" is required to ensure compliance. Food is separated and unopen food is sent to homeless shelters and food banks. Colleges, hospitals and event centers should also follow suit and reduce food waste.

Local food sourcing is an effective way to reduce emissions from importing food from long distances. It also reduces the amount of food produced from industrialized farming by "big ag". Industrialized farming uses large amount of fossil fuels for equipment, chemical fertilizers, pesticides, depletes the soil by over-tilling and releases carbon (3). More locally sourced food is generally from smaller local family farms who practice regenerative farming. Regenerative farming uses organic methods including cover crops to protect soil, which provides little room for weeds, limited tilling of the soils, crop rotation, and natural fertilizers. The Three Sisters Farm in San Timoteo Canyon is a local example of organic regenerative farming. Transportation costs and emissions from big ag production or imported food is also reduced.

In Redlands we have several farmers markets with locally sourced food. The revived downtown Saturday morning market has been very successful. My daughter gets a weekly farm box with seasonal vegetable and fruits delivered. She sends an online order in with the food she wants, so there is a selection.

Finally, there are many opportunities for the capture of food wastes at each stage of organic material decomposition. Spent grain from the brewing of beer can be used as a feed stock for animals. Coffee

bean grounds, which are rich in cellulose lignin, nitrogen, and sugars are ideal for growing mushrooms which can be used as feed for cattle, pigs, and chickens, which in term produce manure to return to the soil (3). The City of San Luis Obispo sends its food waste to a privately run anaerobic digester facility and gets back biogas to fuel some residences (1). In Riverside liquid food wastes, mainly from restaurants, go to the city's wastewater treatment and pumped into an anaerobic digester that processes the plant's sludge and food waste together. The food waste enhances the production of bio gas, which is used to produce electric power used to run the treatment plant. *As mentioned previously, biological materials are totally able to be regenerated with capture of value at each stage.*

FINANCIAL AND INVESTING IN THE CIRCULAR ECONOMY

In 2019 the World Economic Forum made the circular economy a focus of the Davos Summit. Leading global business consultants Deloitte, McKinsey, and Accenture are all promoting the circular economy by highlighting circular economy innovations and services to make the transition (1). Accenture reported that the scale of the economic transition from 2021 until 2030 should lead to over $4.5 trillion of economic growth and that "it's the biggest opportunity to transform production and consumption since the First Industrial Revolution 250 years ago". The World Economic Forum estimates that there could be a $700 billion annual savings in the consumer goods sectors and a McKinsey projection concludes that the fashion industry could reclaim $500 billion in yearly losses- both without counting environmental benefits (1) by implementing the circular economy.

Blackrock is divesting its fossil fuel assets stating that "climate change has become a defining factor in a company's long-term prospects". Microsoft and Amazon have each committed $1-2 billion in carbon reduction, climate remediation technologies and innovation funding. There are an increasing number of so called ESG (environmental, social, and governance) funds available to investors. The idea is that businesses should be measured by more than just financial performance. However, a Harvard study showed that these high sustainability companies also "significantly outperform their counterparts over the long-term in the stock market and in accounting performance" (1). Companies are moving from doing "less bad" to doing good for the environment.

The European Union is well ahead of the rest of the world in providing financial support for implementing the circular economy. An independent public foundation called Sitra was initially funded by the Finland Parliament to ensure "competitiveness and growth for companies". Sitra is the prime source of funds in Finland for companies to become circular, but they also produce education materials and case studies (13). It is a major supporter of the World Circular Economy Forum which holds a yearly conference to promote the circular economy. This past year it was attended by representatives from 155 countries. The World Circular Economy organization states "a global transition toward a carbon neutral circular economy is an opportunity for all companies to develop new business, expand into new markets, and create sustainable growth"(13).

The U.S. is catching up to the EU with several major pieces of Federal legislation passed in the last couple of years that significantly increases funding to address climate change and to implement the circular economy. The Inflation Reduction Act (IRA) provides almost $400 billion in investment with $250 billion going to upgrade, repurpose and replace energy infrastructure and most of the remainder to provide business and consumer investment incentives for transportation, manufacturing, agriculture, and the

environment. McKinsey reports that the IRA is "the third piece of legislation passed that seeks to improve the U.S. economic competitiveness, innovation and industrial productivity. The Bipartisan Infrastructure Law, the CHIPS & Science Action, and the IRA have partially overlapping priorities and together introduce $2 trillion in new federal spending over the next ten years"(17)."

The Deloitte Economics Institute has prepared a report titled "The Turning Point: A New Economic Climate it the United States". They state "the world's current system of economic growth is creating untenable changes to our physical environment" (14). They go on to say "every corner of the economy will be impacted, and every organization and individual has a role in remaking the systems that underpin life". The report says without sufficient action on decarbonization that the U.S. economy will see losses of $14.5 trillion over the next 50 years and the loss of 900,000 jobs per year. However, the cost of the transformation to a circular economy is huge at $35 billion per year until 2050. This analysis accounts for locked-in climate damage. If this projection is correct, break-even point is not until 2048 (14), or over two decades from now.

GOVERNMENT REGULATORY ACTIONS

In a recent report by Ernst & Young on the regulatory landscape for the circular economy (15) the U.S. was ranked as having the lowest "basic" rating for implementing the circular economy. The European Union ranked as one of the highest with a "mature" rating by having a national circular economy policy. France and Germany have introduced their own national circular economy policies. Even China was also ranked "mature", Mexico was rated above the U.S. as "progressive" with a road map for implementation, and Canada also ranked above the U.S. as "initiated" with fiscal and extended producer responsibility policies.

The European Union and its member countries are driving the world-wide momentum of circularity focusing on reducing raw material consumption and increasing resource efficiency. While the foundation of the circular economy is recycling, policies are evolving toward extended producer responsibility (EPR), and front-end environmental design and traceability of materials in the manufacturing processes including supply chains (15). The EU has a Sustainable Products Initiative with new consumer rights and a ban on greenwashing. According to Wikipedia greenwashing is a form of advertising or marketing which is deceptively used to persuade the public that the organization's products, aims, and policies are environmentally friendly".

The U.S. federal government does not directly have circular economy polices or national laws (therefore the "basic" rating discussed above for implementing the circular economy). The EPA appears to be the federal agency with the most policies regarding the circular economy. The EPA is implementing a National Recycling Strategy. The Strategy has three strategic objectives: reduce contamination in the recycling stream, increase processing efficiency, and strengthen the U.S recycling system (16). EPA is also promoting sustainable materials management which is a systematic approach to using and reusing materials more productively over their entire life-cycles. *This life cycle perspective is what the circular economy is all about.* EPA states: "by looking at a project's entire life-cycle-from material extraction to end of life management- we can find new opportunities to reduce environmental impacts, conserve resources, and reduce costs" (7). Life Cycle Assessment is a technique that is also being promoted by EPA to make informed decisions through an understanding of not only costs but health and environmental impacts of products, processes, and activities.

As you might expect, in the U.S. California is leading the way in legislation to address climate change and implementing the circular economy. In the last couple of years there has been a large number of circular economy related bills signed by Governor Newson, for example the following:

-SB 343: "truth in labeling" for plastic and packaging products-manufacturer can't put the "chasing arrows" recycling symbol on items that are not actually recyclable

-AB 881: help the State measure how much plastic actually gets recycled and prohibits exports to other countries counted as being "recycled".

-AB 201: Labeling of compostable products as the ones that breakdown in actual composting conditions, and bans toxic PFAS "forever chemicals".

-AB 962: Makes it easier for beverage producers to create reusable bottle systems and reducing use of single-use beverage containers.

-SB 253: Companies with sales of $1 billion report how much GHG they generate in 2023 and by 2027 how much their entire supply chain creates.

-SB 261: Companies with $500 million in sales must disclose their climate-related risks and measures they have adopted to reduce this risk.

-SB1305: First in nation transparency and disclosure requirements for buyers and sellers of carbon offsets.

-SB 244: Right to repair law for products with a value of greater than $100 must provide repair manual, special tools, and spare parts for 7 years.

-AB 1373: Provides for a centralized guaranteed buyer for wind and geothermal renewal power.

-AB 599: Mandated zero emissions school buses by 2035.

-AB 1572: Water agencies can't provide potable water for ornamental lawns at businesses

-SB 1383: No food wastes disposal in landfills

-SB 54: Plastic pollution, prevention and packaging producer's responsibility act- cut plastic disposal in landfills by 25%, 65% of plastic recyclable and make 100% compostable.

-Air Resources Department Car Zero Emissions Mandate- all new cars and light duty trucks sold in California in 2035 will be zero emission vehicles

Many California cities have local ordinances that restrict products use, and items disposed in landfill. For example, an increasing number of cities have banned single-use plastics from restaurant take-out containers and plastic forks and knives and food wraps.

There is also a movement called C40 Cities, which is a global network of mayors united in climate action and curbing emissions from the greatest urban contributors- transportation, buildings, and wastes. In the U.S. cities like Austin, Boston, Chicago, Houston, Miami, New York, Philadelphia, New Orleans and Los Angeles are involved. In total 96 cities world-wide providing 20 percent of the global economy are involved.

CONCLUSIONS

Based on my research, I have drawn the following conclusions regarding the circular economy:

-The circular economy is being implemented world-wide as a model to address climate change and to increase resiliency and sustainability.

-Circularity will not happened without comprehensive Federal and State regulations.

-Federal funding like in the Inflation Reduction Act and the Bi-partisan Infrastructure Law are transformational in implementing a circular economy.

-Companies need to lead in implementing the circular economy and not continue to "do less bad" and greenwashing, but produce goods that are not only sustainable, but regenerative to reduce the negative impacts of the past ways we produced things.

-The EU and many other countries are well ahead of the U.S. in implementing circular economy processes.

- The conversion of the linear economy to the circular economy in the U.S. will take many years, large investments, and needs strong business, government and public support.

As the Pope said this year: "World leaders have a moral imperative to fight global warming. Our responses have not been adequate, while the world in which we live is collapsing and may be nearing a breaking point". **The circular economy offers a way to save the planet.**

APPENDIX A

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APPENDIX B

SUMMARY RESUME

Of

RICHARD CORNEILLE

Richard Corneille, PE

Summary Resume

Dick Corneille is a native of upstate New York. He attended the University of Vermont and graduated with a bachelor's degree in civil engineering in 1970 and obtained a master's degree in environmental engineering from Northeastern University in 1975. He is a licensed professional engineer in California.

He has worked as a civil engineer primarily for engineering consulting firms on numerous water, wastewater, and water recycling projects. Prior to coming to Redlands in 1978, he worked in Boston and for three years overseas in Saudi Arabia for Metcalf & Eddy.

In 1986 he accepted a job with the City of Redlands and served as the Director of the Municipal Utilities Department, responsible for the City's water and wastewater facilities. He rejoined the consulting engineering world in 1989 with the international environmental consulting engineering firm of Camp Dresser & McKee (CDM). He retired from CDM in January of 2012.

He was active professionally. He served as President of the San Bernardino-Riverside Branch of the American Society of Civil Engineers and on the Board of Directors of the California-Nevada Section of the American Water Works Association. He has also served for over 20 years as the Southern California representative for the American Academy of Environmental Engineers.

Locally he has served on the Board of Directors of the San Bernardino Valley Water Conservation District since 2005, and was President of the Board from 2012 through 2020. He was on the Board of Directors on the YMCA for several years.

He is very concerned about climate change and the impacts. He is a leader of a local climate action group called Accelerate Neighborhood Climate Action. The group provides education and activities in Redlands to lower carbon emissions, increase readiness, and ensure environmental justice.

He has been a member of the Fortnightly Club since 2013. He is currently Secretary of the Club. His previous papers for the Club were titled "Climate Change and Redlands Water Supply" 'Hydraulic Fracturing for Oil and Gas- Impacts on Water Supply", and "Climate Change is Real and Seriously Impacting our Earth- Can We Save the Planet".

He and his wife Colleen raised three children in Redlands – all of them RHS graduates.