reuse wins

The environmental, economic, and business case for transitioning from single-use to reuse in food service

Upstream

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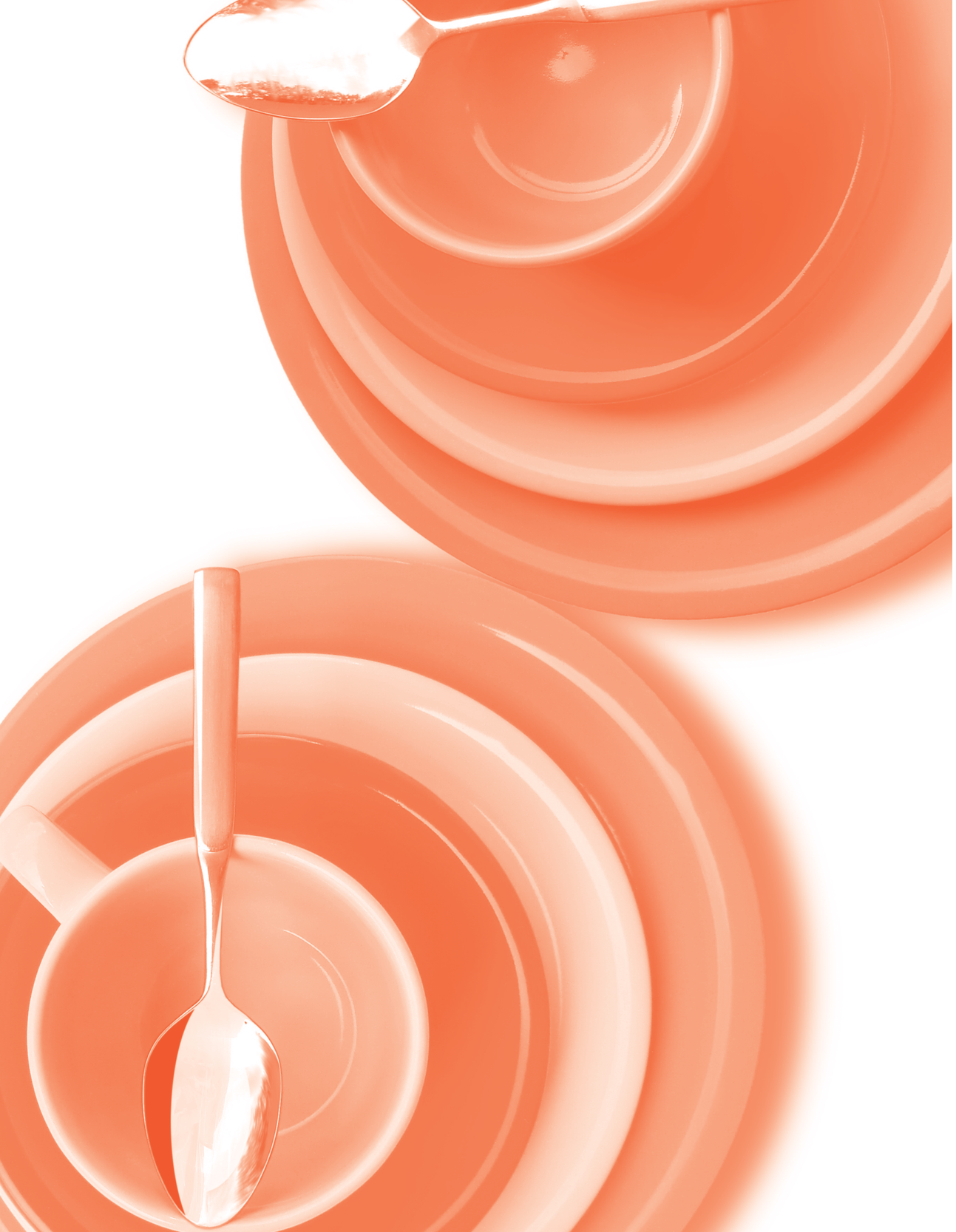

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Foreword

Most cities today are foodie paradises. Much of the world's cuisine is at your fingertips, and food delivery companies put it all within reach in 30 minutes or less. There's so much to choose from, and it's so convenient.

But all this convenience comes with a cost. Take the trendy fast-casual dining experience, where you sit down at a restaurant for a delicious meal, but you end up throwing a pile of garbage away when you're done.

Or how about when you sit down at a coffee shop, and even though they have real mugs behind the counter, everyone is drinking out of throw-away cups with plastic lids.

Or when you order takeout food to your home or office, and the order automatically comes with plastic cutlery, napkins, ketchup packets and other disposable items you don't actually need, not to mention the bags and single-use containers that come as a matter of course.

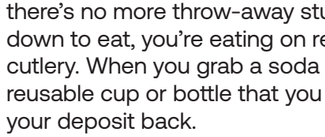
Now think about these same actions repeated billions of times a day by billions of people living all over the world – day after day, year after year. **In addition to the plastic pollution and disposal costs, every time we toss a single-use item, we're also throwing away all the natural resources – the trees, the oil, the water, and the energy – it took to make and get that product into our hands.**

But there's a better way than throw-away. Imagine you're going to catch a ballgame, or heading out to a concert, or you're taking your family to the zoo or aquarium. Now imagine there's no more throw-away stuff. When you sit down to eat, you're eating on real plates with real cutlery. When you grab a soda or a beer, it's in a reusable cup or bottle that you can return to get your deposit back.

Now imagine taking this idea to an entire city – no more throw-away when you sit down to eat, and all the restaurants and food delivery businesses use reusable to-go cups and containers that are part of a community-wide system run by innovative new businesses or the city itself.

This is not some Utopian dream of the future. This is happening right now. All over the world, businesses, institutions, and communities are ditching disposables and creating 21st century reuse systems that are convenient, sustainable and more fun than the old throw-away model.

This report contains the environmental and economic rationale for moving to reusables in food service. It brings into clear focus the choices we need to make to solve plastic pollution, reduce climate impacts, and build more just and sustainable communities. We're excited to imagine and co-create this future with you.



Matt Prindiville, CEO, UPSTREAM

All over the world, businesses, institutions, and communities are ditching disposables and creating 21st century reuse systems that are convenient, sustainable and more fun than the old throw-away model.

Executive Summary

Plastic pollution is growing exponentially, and the U.S. is the largest polluter. It is estimated that the ocean currently contains 150 million metric tons of plastic, and most of it is packaging. A third of all plastic packaging produced ends up in the environment – approximately 31 million tons annually. Out of that total, 11 million tons enters our oceans each year. That's the equivalent of 34 pounds of plastic for every foot of coastline in the world. It's visible on our shores and in our waters, and it's ecologically devastating.

The COVID-19 pandemic has exacerbated the problem. Consumption of single-use plastics has increased by 250-300 percent since the pandemic began, resulting in a thirty percent increase in waste which is attributed to personal protective equipment (PPE), packaging, and disposable foodware. During the pandemic, online shopping and takeout food orders and delivery increased by 78% in the U.S.

Growing public concern over this crisis has led to some progress, but the problem is still growing. Unless we change course, plastic pollution is expected to triple in the next 20 years.

Most of the plastic in the ocean and littering city streets is food and beverage packaging that originates from restaurants, cafes, and grocery and convenience stores. Without a shift in how we package and consume food and beverages, the situation will get worse.

But trying to solve the plastic pollution problem by targeting plastics alone misses the point because all single-use products create waste and cause unnecessary harm to the environment and public health. The problem isn't just plastic, it's the throw-away culture.

Eliminating plastic but failing to change the single-use, disposable paradigm results in "regrettable substitutions" that can be just as harmful, if not more so, than plastic. Examples of single-use alternatives to fossil-fuel based plastics that also cause environmental harm include:

Bio-based plastics (compostable and non-compostable): made from agricultural products that require significant inputs of energy, water, and fertilizers, can create dead zones in waterways, ozone depletion, ocean acidification, particulate emissions, land use impacts, and toxic exposure. Bio-based plastics also behave exactly like traditional plastics in the environment, never biodegrading and harming wildlife through ingestion and entanglement.

Aluminum: known for being highly recyclable, but causes air pollution, land-use exploitation, and significant carbon emissions in the mining, smelting, and production phases. Recycled content aluminum products on average contain 30% or greater virgin aluminum.

Paper: three billion trees are logged each year to create paper packaging products. Trees provide a range of environmental benefits, including habitat and biodiversity, soil health, clean air, and removing carbon from the atmosphere.

Wood: often bamboo, used as an alternative to plastics utensils, comes from monoculture plantations that rely on forest clear-cutting and use fertilizer, herbicides, pesticides, and intensive management practices that can deplete topsoil, increase erosion, and contaminate water resources.

Plastic pollution is growing exponentially, and businesses and policymakers are starting to take action. But trying to solve the problem by targeting plastics alone misses the point. The problem isn't just plastic. It's our throw-away culture that's driving plastic pollution and a host of other environmental problems. Solving this requires a paradigm shift from single-use to reuse.

In addition, it's generally accepted that recyclable materials are better environmental choices for packaging. But with food service packaging, this is not always the case. Research that compared 18 years' worth of peer-reviewed Life Cycle Assessments (LCAs) found recyclable food serviceware had lower environmental impacts than landfill-bound packaging in only 56% of the comparisons. That's because many products that are technically recyclable often don't get recycled, particularly food serviceware that is usually too dirty to be recycled.

Today, recycling struggles to be profitable. U.S. communities – unable to export dirty paper and plastics to China – now face a $2-4 billion shortfall between the costs of collection and sorting. No longer able to sell materials for recycling, many communities have to pay to have them recycled. U.S. plastics recycling is expected to drop from 8.4% in 2017 to 6.6% in 2020.

The plastics industry has known for decades that the economics of recycling plastic – which is primarily sourced from inexpensive virgin feedstocks – coupled with the technical challenges would make plastic recycling unworkable at scale. The myth of plastics recycling has been perpetuated and sold because, as one industry insider stated, "selling recycling sold plastic."

Recycled content is a good thing for products made from the same materials. Generally, products with more recycled content are better for the environment when compared to products made of the same materials without recycled content, such as a glass bottle with and without recycled content.

Unfortunately, compared to standard packaging, single-use bio-based plastics and single-use compostable packaging are not always better for the environment either. Across numerous environmental impact measures – global warming impact, land occupation, eco- and human toxicity and aquatic impacts – compostable food serviceware has greater environmental impact than the alternatives. Compostable packaging often doesn't end up in compost facilities, either, because it isn't accepted by commercial composters or because the infrastructure doesn't exist. Even when it does get composted, the environmental impacts from producing, using, and disposing of compostable products typically outweigh the advantages.

The bottom line is that we can't recycle or compost our way to a sustainable future. We have to work upstream to redesign the systems that generate all the waste in the first place.

Finding One:
Reusable food serviceware beats single-use alternatives by every environmental measure.

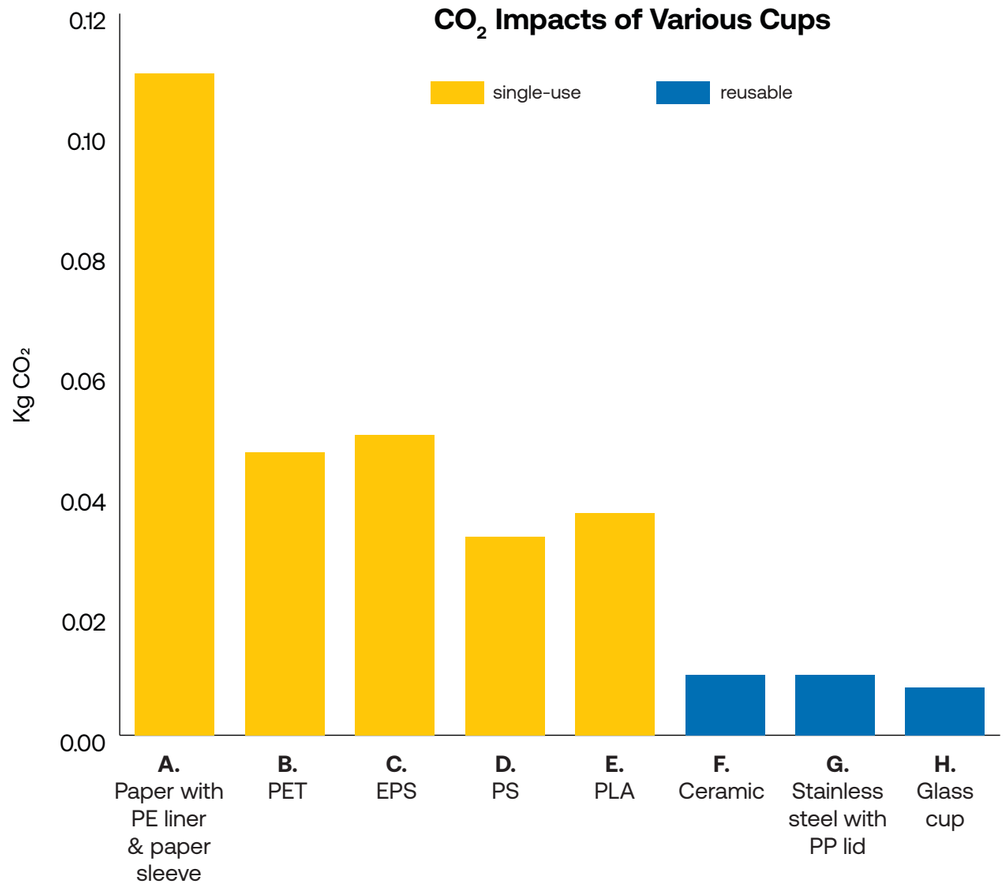
LCAs reviewed for this report show that reusable food serviceware achieves environmental benefits over the disposables they replace. For cups, it's between two and 122 uses, for plates and clamshells, it's between three and 50 uses, and for utensils, only two uses of a reusable are required. Since most reusable products last upward of 200 uses – and generally with steel, glass, and ceramic over 1,000 uses – reusables out-perform disposables on every metric, and the benefits to the environment accrue with each use past the break-even point.

Reusable cups and plates are better in almost every one of the 14 standard LCA environmental measures. All reusable cups (ceramic, stainless steel, glass) have lower CO2 footprints than the single-use options (paper, PET, EPS, PP, PLA, laminated cardboard) when reused.

Reuse protects the climate. Over their lifecycle, reusable food serviceware has lower greenhouse gas (GHG) emissions compared to disposable alternatives.

- With disposables, the largest greenhouse gas impacts occur in the resource extraction and manufacturing phases, mostly plastics from fossil fuels, paper from trees, bioplastics/biomaterials from crops, and aluminum from mining.
- The GHGs from single-use-disposables dwarf those from reusables once the reusables have been used a certain number of times (the break-even point). This varies according to different types of reusable products, the materials they're made from, the efficiency of the washing machines used, and the sources of energy for the regional electricity grid.
- The main energy impacts of reusables come during washing. With the increasing efficiency of dishwashers, the benefits have increased over time and continue to do so.

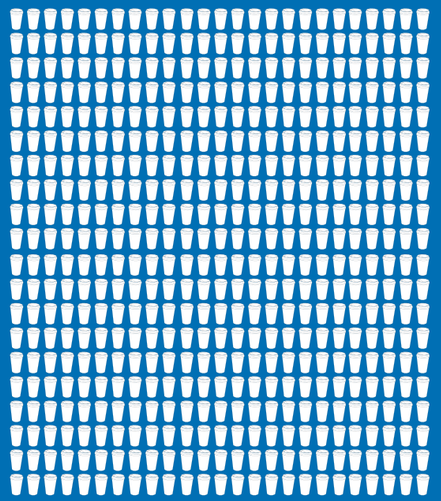
The good news is that transitioning from single-use to reuse is happening already, and it's better for the environment and the bottom line.



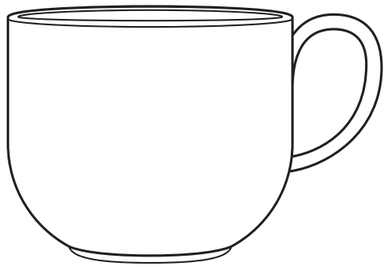
Reuse saves water. Over their lifecycle, reusable products, food serviceware, and packaging generally use less water than using disposable alternatives.

- Similar to GHG emissions, the largest water use occurs in the resource extraction and manufacturing phases for the different types of disposable materials.
- The water use from single-use-disposables during the production phases is generally greater than that from reusables.
- The main water impacts of reusables come during washing. But these impacts can be greatly reduced with highly-efficient commercial dishwashing systems. Even with washing, reuse systems still use less water throughout their lifecycle than single-use.
- The water used in the growing phase of bio-based plastics make them a less favorable choice among single-use food serviceware options.
- Single-use cups require significantly more water over their lifecycle than ceramic mugs and almost as much water as stainless steel travel mugs. In a study for Starbucks, ceramic reusables reduced water consumption by 64% over the entire lifecycle compared to the disposable paper cup.

Using 500 paper cups consumes nearly 370 gallons water



Using and washing one ceramic cup 500 times consumes only 53 gallons of water.



8 of the top 10 most-commonly found plastic pollution items during International Coastal Cleanup come from single-use food and beverage packaging.

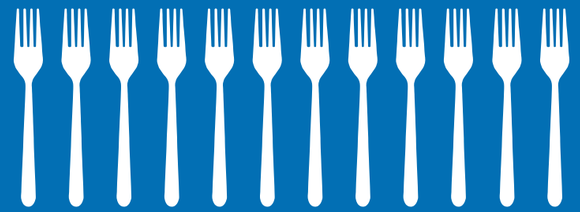
Reuse prevents the unnecessary exploitation of our natural world. Every time we use and throw away a single-use item, we also throw away all the natural resources – the trees, oil, water and energy – used to make and get that product into our hands.

Reuse stops waste before it starts and reduces costs for businesses and local governments to manage all the waste. Every time a reusable product is used, the number of single-use items in the waste management system is reduced. Businesses save money not having to buy single-use products and pay for waste hauling, while local governments (and therefore ratepayers and taxpayers) save money because they have less waste to manage.

Reuse prevents litter and saves communities money. Litter cleanup costs more than $11.5 billion each year in the U.S., and a significant portion – roughly 20 billion pieces – is comprised of disposable food serviceware. Policies aimed at driving consumers to use reusables, such as plastic bag bans and fees, can dramatically reduce litter.

After only two washes stainless steel cutlery breaks even with disposable cutlery for environmental impacts.

After that, every use increases the environmental benefits.



Reuse protects our oceans and helps curb plastic pollution. Eight of the top 10 most-commonly found plastic pollution items during International Coastal Cleanup come from food and beverage packaging. Many of the most-commonly found plastic pollution items can be eliminated with reusables.

Reuse protects our most vulnerable communities that live near extraction, processing, and waste disposal sites. Communities located adjacent to oil and gas drilling, mining, manufacturing, and waste incineration facilities are subject to significant health and economic harm. The economic benefits of reusables work the same way as their environmental benefits. The upfront costs are higher, but after just a few uses, the reusable breaks even and then starts to save businesses money.

Finding Two:
Transitioning from single-use to reusable food serviceware can save businesses significant amounts of money.

The economic benefits of reusables work the same way as their environmental benefits. The upfront costs are higher, but after just a few uses, the reusable breaks even and then starts to save businesses money.

Reuse saves businesses money for on-site dining 100% of the time (including schools, food courts, college and corporate campuses, and large-scale venues). Clean Water Fund's *ReThink Disposable* program has demonstrated the short-term payback of switching to reusables in over 166 cases of providing technical assistance to businesses and gathering cost impact data. In 100% of restaurant case studies and eleven institutional dining programs, the program documented costs savings. The average savings for a small business are between $3,000 and $22,000, with environmental benefits that include eliminating 110,000 to 225,000 packaging items per business and 1,300-2,200 lbs. of waste, all on an annual ongoing basis.

Generally, concerns about added dishwashing and labor costs don't add up in practice. Fine dining and many casual restaurants already serve all their food on reusable food serviceware. Most fast casual businesses already use some mix of reusables in their operations (for preparing food). Numerous case studies demonstrate that these businesses can transition to reuse without increased labor or need to expand dishwashing capacity. The majority of fast casual restaurants do have installed dishwashers - either three-sink or commercial dishwashers. Meanwhile, food service operators usually don't consider the costs of disposing of significant amounts of disposable food serviceware, the ongoing costs for disposables versus one-time purchases for on-site reusable food serviceware, or the labor costs in managing single-use packaging. Dishwashing is a serious challenge in the typical fast food restaurant, where all packaging is disposable, no commercial dishwasher is installed, and high volumes of customers are served. But retrofits or external dishwashing services can help solve the problem. Future fast food businesses should not be designed for the throw-away model. Such change can be driven by policy and innovation.

Transitioning to reuse increases both customer satisfaction with the dining experience and operator satisfaction with the presentation of their food. It can build brand loyalty and provide community benefits, such as decreased litter cleanup costs.

Reuse saves businesses money for on-site dining 100% of the time.

Average savings for a small business:

$3000 - $22,000 cost savings

1,300-2,200 lbs. of waste eliminated

110,000 to 225,000 packaging items eliminated

Finding 3:

A new reuse service economy for take-out and delivery is emerging with significant opportunities for entrepreneurs, investors, and customers.

Companies across the globe are providing restaurants and cafes with reuse services for take-out drinks in reusable cups. From lending libraries and deposit systems that are free to the customer, to customer-subscription services, these options are growing all across the globe.[1]

Similarly, new services are emerging to provide meals for take-out or delivery in reusables – with dishwashing and logistics services, which can replace a restaurant's existing inventory management for disposables.

Reusable cup systems are being innovated at large venues like arenas and stadiums with a number of companies offering services in U.S. markets – including mobile dishwashing at events.

Innovators are also changing home delivery for groceries, personal care products and sundries with reusable container systems and services. In addition, new companies are innovating touch-free bulk shopping at grocery stores with standardized containers on site to simplify the process for consumers.

Reuse creates jobs. A new reusables economy is springing into action in response to the backlash against single-use plastics. Innovative new businesses are providing jobs in the collection, cleaning, and distribution of reusable products and changing the way products are delivered to consumers.

As these services grow and iterate, we will learn what drives success. But the benefits are clear. Reuse eliminates waste before it starts. It is better for the planet by almost every measure. Eliminating waste saves government and businesses money and makes the dining experience more enjoyable.

We should accelerate the change away from our current throw-away culture by enacting policies, investing in solutions, and supporting businesses that recognize our planet and its inhabitants are not disposable.

[1] Check out Upstream's Reuse Service Business Directory to learn more.

Key takeaway:

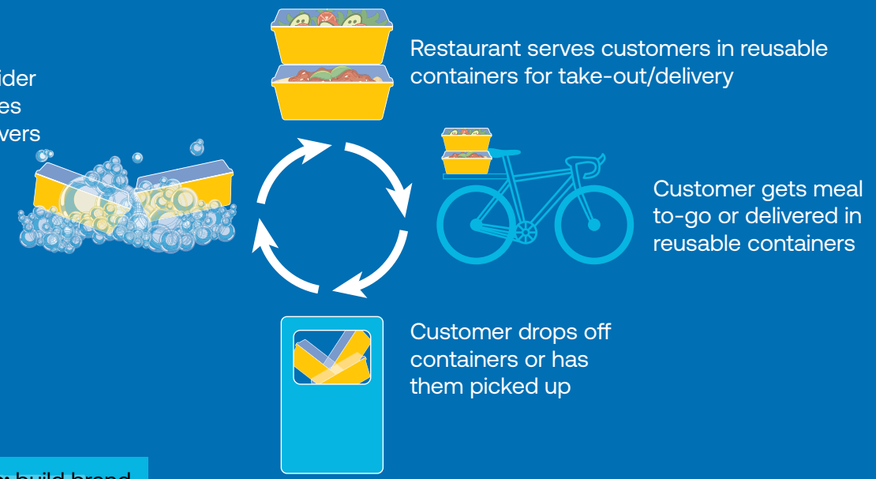
The Future of Food Service is Reusable

Today, much of institutional and fast casual dining – and virtually all takeout and delivery – happens using disposable food-serviceware. And all those takeout containers, bags, boxes, condiment packets, plastic utensils, cold and hot cups and lids, and napkins add up. **Nearly one trillion disposable food service products are used each year in the United States.**

Unfortunately all these disposables come with costs – costs to the environment from natural resource extraction to climate impacts to plastic pollution; costs to food-service businesses from the ongoing procurement and on-site waste management of disposables; and costs to governments and taxpayers from solid waste costs and litter cleanup. These costs also represent lost opportunities to create better systems for getting consumers what they want without all the waste.

But the good news is that there's a new reuse economy emerging for food service that has the potential to completely disrupt our current disposable food-service paradigm and replace it with something better.

How reuse services for take-out and delivery work



Business benefits: build brand loyalty; increase customer and employee satisfaction; generate customer behavior data; and create many new opportunities for entrepreneurs and investors to create and scale new reuse businesses

Environmental Benefits: less climate pollution, energy use, water consumption, resource extraction, waste generation, litter generation and plastic pollution

Community benefits: less waste (and associated costs), less litter (and cleanup costs), new jobs created in the reuse service economy

The New Reuse Economy for Food Service

REUSE FOR ON-SITE DINING

Whether you're dining at McDonald's or a trendy new fast casual eatery, disposables for on-site fast-food dining are the norm. This is because a prevailing misconception is that disposables are cheaper than reusables.

But this argument doesn't hold up in practice. Data from hundreds of case studies shows that making the switch from single-use to reuse for on-site dining always ends up saving money - 100% of the time. And that's after accounting for any capital costs for purchasing or leasing additional dishwasher capacity and any added labor costs.

REUSE FOR TAKE-OUT AND DELIVERY

With take-out and delivery, it might seem like the only options are between disposable paper or plastic, but scores of new businesses are emerging to offer reuse B to B (to C) services and solutions to hack all this take-out packaging waste. Their services are easy to use, accessible, affordable, fun and convenient, and are revolutionizing how businesses do take-out by offering a circular system for collection, washing and sanitizing, and restocking reusable food-serviceware. Food-service businesses can contract with these "reuse service-providers" for the amount and types of reusable to-go ware they desire.

Food service by the numbers:

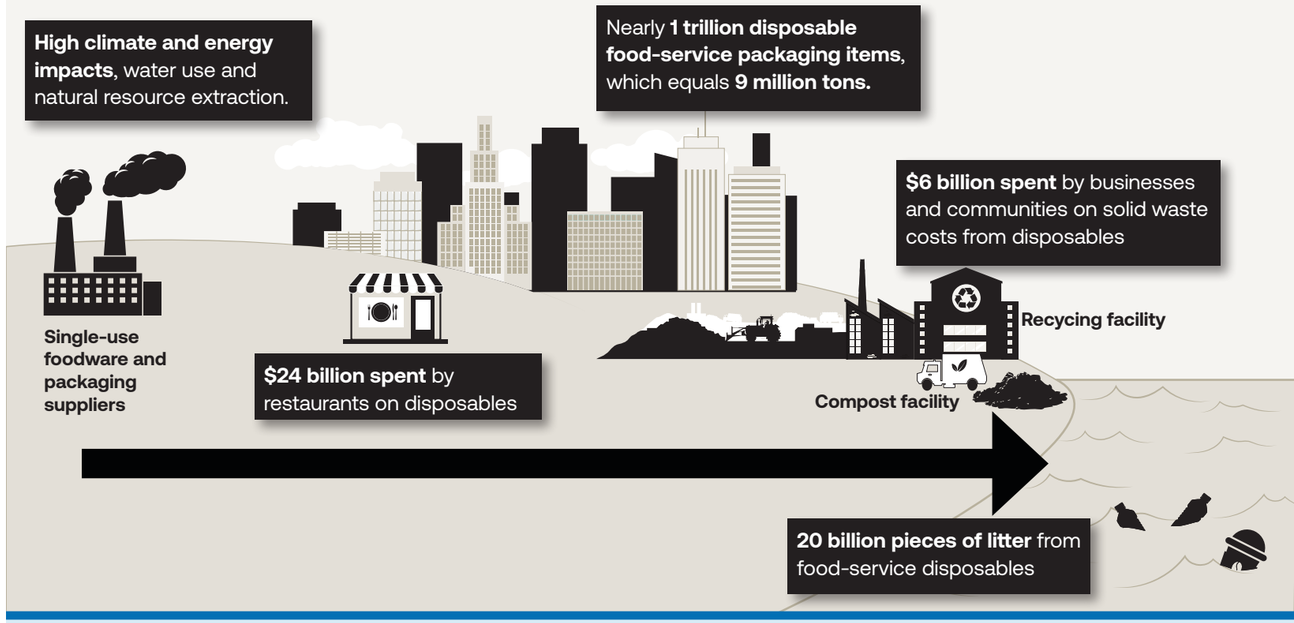
TODAY'S "ONE-WAY, THROW-AWAY" ECONOMY:

- Nearly 1 trillion individual pieces of disposable foodware and packaging used by US restaurants and food service businesses. This breaks down as 21% for on-site dining and 79% for take-out and delivery.[1]
- $24 billion spent by restaurants and food-service businesses on disposables each year.[2]
- Nearly 9 million tons equals the total weight of all the disposables used - equivalent to the weight of 25 Empire State Buildings.[3]
- $6 billion spent by businesses and city governments on solid waste management costs attributable to disposable food packaging.[4]
- Roughly 20 billion pieces of litter are from disposable food-service packaging.[5]

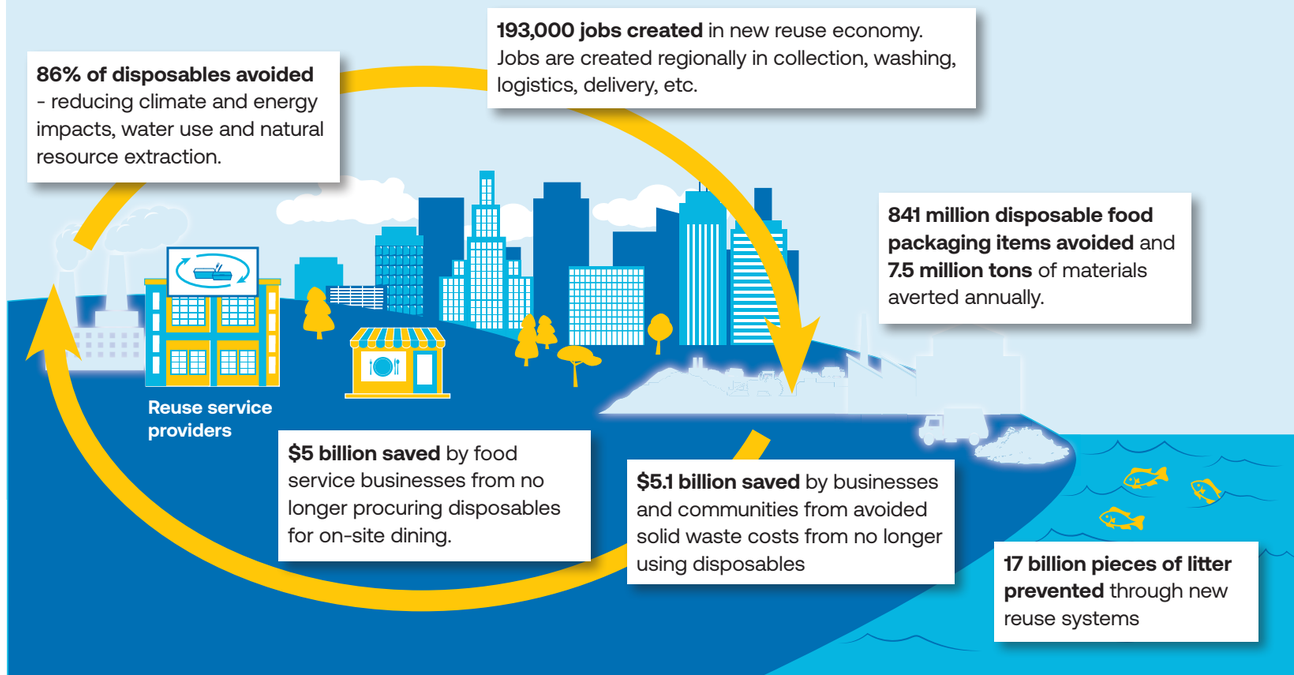
TOMORROW'S NEW REUSE ECONOMY:

- 86% of disposables avoided through 100% of on-site dining being disposable-free and new reuse services for take-out and delivery expanded to all US cities and urban areas.[6]
- 841 million disposable food packaging items avoided meaning that 7.5 million tons of materials would be averted annually.
- $5 billion saved by food service businesses from no longer procuring disposables for on-site dining.
- $5.1 billion saved by businesses and city governments on solid waste management costs attributable to disposable food packaging.
- 17 billion pieces of litter prevented through new reuse systems. The reusable products (cups, containers, cutlery, bags, etc) have value - like a deposit, or a charge if not returned - that ensures these products make their way back into the system.
- 193,000 jobs created in the new reuse economy for food service. These are community-based systems. They create infrastructure and jobs in the community that cannot be outsourced. And they keep money in the community instead of shipping it out to where the disposable packaging gets manufactured or where the materials to make disposables get mined from the planet.[7]

Today's "one-way throw-away" food service model



Tomorrow's new reuse economy for food service



Section 1:

The Problem

Single-use alternatives to plastic trade one environmental problem for others

Public concern around plastic pollution is at an all-time high. A recent nationwide survey showed two thirds of Americans are either very concerned or extremely concerned about plastic in the environment.[8] Businesses and governments are reacting to public concern and scrambling to find solutions.

But there is no consensus regarding the solutions to plastic pollution. Is it more recycling? Should we invest in bio-based plastics? What about compostable packaging? What's the role of reusables?

If you're a purchaser of single-use plastic food serviceware – like a concert hall, a college campus, or a sports stadium – how do you know what's actually going to move the needle? Or if you're a politician or a community organizer, how do you know what types of policies to prioritize?

Most changemakers focus on strategies to reduce single-use plastic. Communities and states across the globe are taking action to ban single-use plastics[9], taking aim at the products that end up in the ocean, like bags, straws, bottles, utensils, cups and food serviceware.

But when single-use plastic products are banned on their own, other single-use products take their place. Inevitably, they are replaced by other disposables that often have different, but substantial, environmental impacts. **These "regrettable substitutions" often require cutting down more forests, extracting more metals, or growing more agricultural products – all with significant impacts on climate, air and water quality, public health, and the ability to sustain a planet with a growing population of consumers.**

The bottom line is that any product designed to be used for a matter of minutes and then thrown away is not a sustainable option, regardless of whether the product is made from plastic, paper, metal, or plants.

The real culprit isn't just single-use plastics – it's "single-use" itself.

But imagine a world without all the waste. Imagine if we treated the planet, its inhabitants and our communities as "indisposable" – and designed our production and consumption systems accordingly. This is the culture change that business leaders, policymakers, and community activists at the center of the reuse movement are accelerating. Through policy advocacy, business and community engagement, and sparking innovative new models, these leaders are showing that we can move from a throw-away society to a culture of stewardship.

The bottom line is that any product designed to be used for a matter of minutes and then thrown away is not a sustainable option, regardless of whether the product is made from plastic, paper, metal, or plants. The real culprit isn't just single-use plastics – it's "single-use" itself.

Reusable food serviceware is not only safer for public health (i.e. less toxic and less likely to fill our ecosystem with harmful microplastics) and for the environment, it's better for business. This report considers both the environmental case for transitioning from single-use to reuse and the economic advantages that result.

We have reviewed the technical data comparing single-use with reusable food and beverage packaging – e.g., Life Cycle Assessments (LCAs). The data create a consistent, clear understanding that reusables designed for hundreds and often thousands of uses beat disposables in every environmental impact category.

What's more, we've shown that transitioning from single-use to reuse isn't just better for the environment. It can also save businesses and communities money and create opportunities for entrepreneurs and investors to build and scale the new reuse service economy.

By showcasing some of the success stories and early adopters of reusable food service models, this report demonstrates that the transition to reuse is not only feasible, it's desirable for food service businesses and their customers as well.

The Impacts of COVID-19 on single-use plastic consumption.

Since the COVID-19 pandemic began, consumption of single-use plastics has increased by 250-300 percent.[38] And thirty percent of the increase in waste produced in 2020 is attributed to personal protective equipment, packaging, and disposable foodware.[39]

The plastics industry is working hard to convince policy makers and health advisors that single-use plastic packaging provides protection against COVID-19.[40] But available evidence indicates that the virus spreads primarily from inhaling aerosolized droplets, not from touching surfaces – and the U.S. Centers for Disease Prevention and Control suggests that wearing masks and practicing good hygiene is enough to prevent any possibility of transmission from contact with surfaces.[41]

Even though odds of contracting the virus from surfaces are extremely low, based on how long the virus lasts on surfaces and typical consumer and worker behavior – disposable products are not safer than reusable ones. In one study, the virus was shown to be infectious for up to 24 hours on paper and cardboard and between 2-3 days on plastic and stainless steel.[42] In another study, the virus was not found to be infectious on print or tissue paper, whereas it was infectious up to 1 day on cloth, up to 4 days on glass, and up to 7 days on plastic and stainless steel.[43] COVID-19 can be found on both disposable and reusable materials, and plastic is one of the materials on which it remains active the longest.

For businesses and customers worried about surface transmission of COVID-19 (even though the latest research confirms there's no evidence of this happening), hygiene and sanitation should guide their choices. The FDA Guidance on Best Practices for Retail Food Stores, Restaurants, and Food Delivery Services during the COVID-19 Pandemic focuses on social distancing, foodware washing and sanitizing, cleaning and sanitizing, and personal protective equipment (PPE) for workers. The National Restaurant Association's Guide to Reopening re: COVID-19 adheres to FDA guidance, focusing on cleaning, disinfecting, and social distancing. They don't promote single-use products.

Public concern about plastic pollution is born out of a desire to protect the world's oceans. Pictures of turtles with straws in their noses and marine life entangled and engulfed in single-use plastics provide visible evidence of the damage our throw-away culture has inflicted on the environment. If we only move from single-use plastic to other single-use products, we will not accomplish very much. But if we seize this moment to shift from single-use to reuse, we can extinguish the throw-away culture and create something better in its place.

Single-use food service packaging is a key culprit in the waste and plastic pollution crisis. It is estimated that the ocean currently contains 150 million metric tons of plastic, and most of it is packaging.[10] Approximately 42% of the non-textile plastics produced globally since 1950 have been used for packaging, and a whopping 32% winds up in the environment.[11] As much as 23 million metric tons of plastic waste enters the ocean each year, most of it generated in the U.S.[12] That's the equivalent of 26 pounds of plastic for every foot of coastline in the world. It's visible on our shores and in our waters, and it's ecologically devastating.

Without changing course, the problem will get significantly worse. Plastic production, currently 300 million tons per year, is projected to double by 2040.[13] If that trend continues, there will be more plastic in the ocean (by weight) than fish by 2050.[14]

If we seize this moment to shift from single-use to reuse, we can extinguish the throw-away culture and create something better in its place.

If we want to turn off the tap for plastics entering the ocean, we need to find solutions to single-use food and beverage packaging, as it is one of the most significant sources of plastic pollution in the environment.[15] In the U.S., beach and street litter consists primarily of packaging products originating from grocery and convenience stores, cafes, and restaurants.[16]

In addition, consumption of take-out, fast food and food delivery is increasing significantly. Pre-COVID estimates for growth in single-use product demand were 3.4% between 2018 and 2023.[17] With an additional boost from COVID-19, the global online food delivery market is expected to grow by 12% between 2020 and 2023.[18] In the U.S., online shopping and takeout orders increased 78% during the pandemic – the largest increase world-wide compared to several countries, including China and India.[19]

Without new reusable service models, this growing industry will generate a dramatic increase in food serviceware, mostly plastic.

Regrettable substitutes for plastic

Sustainability-minded decision-makers in the public and private sectors continually struggle with the challenges of choosing sustainable single-use packaging products. The problem of plastic polluting the marine environment is well known, but plastics also pose huge climate and public health threats.

Plastic is harmful throughout its lifecycle – from the hazardous air emissions linked to petroleum extraction (over 170 toxic chemicals are used in fracking); to carcinogens and chemicals that harm human reproduction and development during the manufacture and consumption phase; to more hazardous air emissions from waste incineration and treatment.[20] And it is generally low-income communities, communities of color, and communities living on the fenceline of extraction and processing facilities that bear the brunt of these impacts.[21] In climate terms, the 2019 production and incineration of plastic produced an estimated 850 million metric tons

of greenhouse gases – equal to the emissions from 189 five-hundred megawatt coal fired power plants. This will rise to 1.34 gigatons – equivalent to more than 295 coal-fired power plants – on the current trajectory.[22]

But when choosing to eliminate single-use plastic, well-intentioned decision-makers face the question of what should replace it. Paper? Aluminum? Bio-plastic? Plant-based fiber? The truth is that every material choice comes with negative environmental impacts. This review of the alternatives to plastic showcase the tradeoffs and demonstrate why banning plastic, but not other single-use options, should not be considered a win for the environment.

Alternative Materials

Bio-based plastics are generally derived from plants, in the form of corn, sugar, starch, or other crops. Not all bio-based plastics are designed to biodegrade. Most are designed to behave like traditional petroleum-based polymers, with strong molecular bonds to withstand degradation – for example, the bio-based PET used for Coca-Cola's partially bio-PET *Dasani* water bottle. The bioPET in this bottle has the same molecular PET structure as petroleum-based plastic, the only difference being that the monomer from which the polymer is manufactured is plant-based.

It is commonly assumed that a package made from plants will have lower environmental impacts than those derived from fossil fuels. This is not always true. Fossil fuels are used to grow and process the plants used as the feedstocks for bio-based materials, and then again to convert those materials into plastic. While biobased plastics can sometimes consume less fossil fuel than plastics made from petrochemicals, they can have a wide range of other environmental impacts associated with industrial agriculture.

Some bioplastics are designed to be compostable and others are not. Here we refer to plastics designed to degrade in a commercial compost setting as "compostable plastics."

Generally (depending on transportation distances and energy sources), compostable plastic food serviceware can have somewhat lower Global Warming Potential (GWP) when composted. But most are landfilled or incinerated, not composted – in which case the GWP is higher. Even when composted, compostable plastic has higher impacts for eutrophication (e.g., dead zones in waterways due to oxygen depletion), water use, acidification, ozone depletion, particulate emissions, land use impacts and toxicity.[23]

Generally, compostable plastic food serviceware can have somewhat lower Global Warming Potential (GWP) when composted. But most are landfilled or incinerated, not composted – in which case the GWP is higher.

"Regrettable substitutes" to single-use plastic

Recently, a few large purchasers began switching from single-use plastic to **single-use aluminum** as a choice for disposable cups and containers.[24] International beverage companies have begun to offer an aluminum alternative to plastic water bottles. The 2020 Superbowl used 50,000 aluminum cups produced by Ball Corp. to replace plastic for serving beer.[25]

A strong argument for aluminum is that it can be continually recycled. Aluminum beer and soft drink cans were recycled at a rate of 49% in 2017 in the U.S.[26] Recycled aluminum consumes just 5% of the energy and releases 5% of the greenhouse gases compared to virgin aluminum.[27]

But even when aluminum contains recycled content (on average about 73%), there is still a significant amount of virgin aluminum in each can or cup.[28] That virgin aluminum is highly impactful. The mining and transformation of raw bauxite into aluminum is energy intensive and releases perfluorocarbons that are 9,200 times more harmful than CO_2 in global warming impacts.

On top of that, bauxite is extracted using strip mining that causes significant soil erosion and water pollution.[29] Because aluminum is so energy-intensive to produce, it has a higher carbon footprint (11.09 tons of CO_2 emission per ton) than plastic bottles (2.2 tons).[30]

Although aluminum is more recyclable than plastic, the non-recycled-content part of aluminum has a higher upfront climate burden: the carbon emissions are five times greater and the perfluorocarbons released pose an even more significant climate threat than carbon.

Three billion trees are logged every year to produce **paper packaging**.[31] Six and a half million trees a year go into coffee cups alone.[32] More than half the paper used globally is for paper packaging, with volumes increasing.[33] Only about half the pulp for paper packaging is recycled, and much of it is not or cannot be recycled after use, particularly food serviceware due to contamination.[34]

Trees provide a range of environmental benefits, including habitat and biodiversity, soil health, clean air, and carbon sequestration.[35] While trees are technically "renewable," the logging and paper industry overall degrades habitat and ecosystems and emits significant amounts of CO_2.[36] In most cases, the GWP for single-use paper products is greater than comparable single-use plastic products.

Paper that is responsibly-sourced and made with high recycled content rather than all or mostly virgin fiber can have lower impacts on climate, forests, wildlife, and more. But many pulp and paper companies do not operate sustainably or ethically, and the industry is a significant driver of deforestation, climate emissions, and human rights abuses.[37] There are also technical limitations with recovered fiber, which becomes shorter and weaker with subsequent re-pulping during recycling. Therefore, virgin input can never be eliminated.

The bottom line is that reliance on single-use paper products causes deforestation, soil erosion, and water pollution. Paper-based food serviceware is often coated with toxic chemicals and produces greater GHG emissions over their lifecycle than comparable plastic products.

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Some jurisdictions recommend **wood** utensils and plates, primarily bamboo because they are compostable.[44] Bamboo is a forest product primarily sourced from China. It was popularized in green building because bamboo grows quickly and is therefore considered renewable. But rapidly renewable products are often associated with significant environmental impacts.

Numerous studies of the impacts of bamboo forestry in China point to the devastating impacts on biodiversity from a monoculture of bamboo plantations, reduced ecosystem services, and increased susceptibility to pests, disease, and weather events. **Where forests are clear cut for bamboo, it results in biodiversity loss, heavy soil erosion, and sedimentation and eutrophication of nearby water resources.** Use of fertilizer, herbicides, pesticides, and intensive management practices decreases soil fertility and increases water pollution.[45] Few LCAs have been conducted comparing bamboo to plastic utensils. Some suggest the benefits of bamboo are entirely dependent on production and transport scenarios.[46]

Environmental Attributes

Recyclable, Recycled, and Compostable

One approach to choosing packaging formats is to focus on a material's functional environmental attributes related to "end of life" management (e.g., recyclable, compostable, or recycled). Efforts to ensure products can be recycled or composted are borne out of a focus on diverting waste from landfill that has been a policy priority in the U.S. since the 1980s.

This focus on recycling and composting has been the topic of considerable debate in recent years. The plastics and paper industries have promoted these options for decades to legitimize the continued sale of single-use products.[47] The plastics industry has known for decades that the economics of recycling plastic (a cheap virgin material) and the technical challenges would make plastic recycling unrealistic. It's a myth that they perpetuated because, as one industry insider stated, "selling recycling sold plastic."[48] Combined with support from the environmental community and regulators, focus on diversion from landfill turned attention away from source reduction (i.e., preventing the generation of waste – through reduction in the quantity of products or packaging or through reusable and refillable products – resulting in less waste to manage).

Solid waste and product policies often specify that products must be compostable or recyclable, without consideration of what happens to these products once they enter the waste stream. The benefits of recycling and composting are based on a series of assumptions that may not match the reality of how these systems operate and the impacts of the materials that flow through them. A "reality test" must be applied: do these items get recycled or composted in the local waste stream? In most cases, food serviceware does not.

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Recycling - the crisis and the myth that we can recycle our way out of the problem

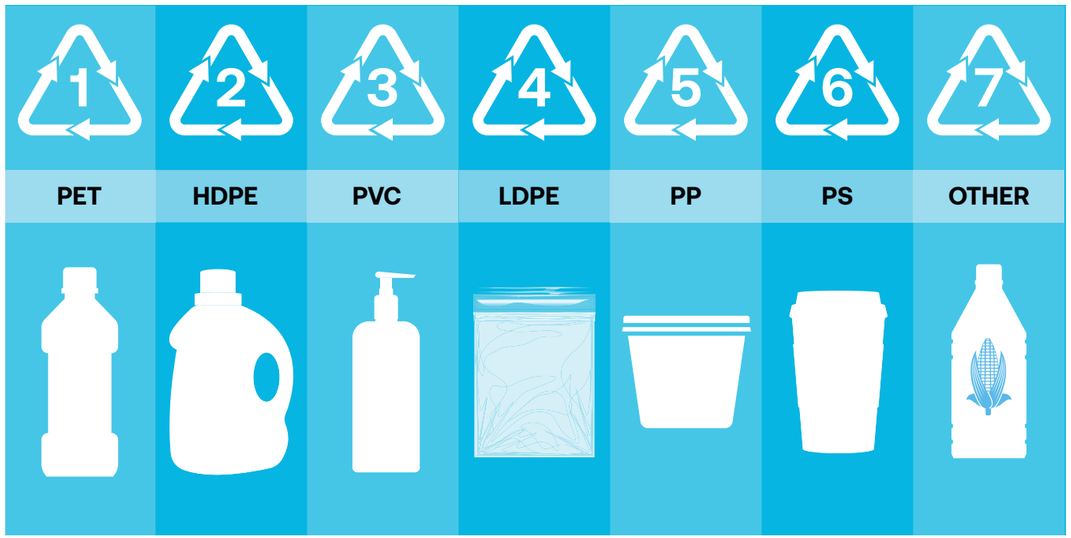
THE CRISIS

Recycling is in trouble in the U.S. Years of declining values for recycled materials coupled with the challenge posed by China rejecting our low-value recyclables had already stressed community recycling programs and U.S. markets to the breaking point. With the addition of the coronavirus pandemic and the overproduction of oil and gas, which led to low-cost virgin feedstocks, the markets for recycled materials have all but collapsed. Several factors have converged to create the current recycling crisis.

Consumer goods companies and retail food service businesses have failed to design packaging to have value in recycling markets. In the U.S., the only plastic materials that have historically been economically recoverable at scale are clean PET and HDPE plastic – mostly bottles.[49] Laminated multi-plastic and multi-material packaging, such as Tetra Pak® (plastic coated paper cartons) and resin-lined paper cups, are hard to separate and recycle. Small plastic pieces like straws, utensils, and cup lids are challenging to recover and bale, contaminate other commodity streams, and often fall through sorting screens.

Recyclers need clean, higher-value materials. Instead, single-stream, commingled recycling,[50] food contaminated packaging, and multi-material packaging create "dirty" streams of low value materials for recycling. As packaging over recent decades has shifted to lighter and harder to recycle plastics, the struggle to maintain recycling programs has increased. In response, many industrialized countries exported their hard-to-recycle product waste to Asia for recycling. China was accepting 45% of the world's plastics, 89% of which was single-use food serviceware.[51] But in 2018, China stopped accepting other nations' waste for recycling unless it met very low contamination rates. With China no longer acting as a dumping ground for low-value materials, municipal recovery programs all across the U.S. started sending contaminated paper and plastic to landfills and incinerators.[52] Meanwhile, U.S. exports to countries like Malaysia, Vietnam, and Mexico are surging.[53]

PLASTIC RESIN IDENTIFICATION CODES



The price of virgin gas and oil has plummeted, further increasing the cost of recycled materials relative to virgin materials. Since 2017, the commodity prices on recyclables have declined an average of 41%.[54] Initial studies suggest that U.S. communities are facing a $2-4 billion shortfall between the costs of collection and sorting.[55] In 2020, a glut of oil caused by overproduction made prices for virgin plastic so cheap that markets for recyclable plastics bottomed out. Since January 2019, the value of recovered PET #1 bottles dropped by 59% and polypropylene dropped 57%.[56]

No longer able to sell materials for recycling, many local jurisdictions have to pay to have materials recycled. With huge budget deficits due to the coronavirus pandemic, many jurisdictions are ending their recycling programs altogether.[57] In 2017, only 8.4% of plastic waste generated in the U.S. was recycled.[58] In 2020, U.S. plastic recycling is expected to decrease to 6.6%.[59]

Food-contaminated packaging is almost always too dirty to recycle. Today, most food and beverage packaging either ends up in a landfill, an incinerator, or the environment.

THE MYTH

It's been generally accepted that recyclable materials and recycled content are better environmental choices for packaging. But with food serviceware, this may not always be the case. A 2018 report from Oregon Department of Environmental Quality (DEQ), which conducted a deep dive into 18 years' worth of peer-reviewed Life Cycle Assessment (LCA)[60] research on packaging, challenges the notion that "recyclable" and "recycled content" reliably result in lower impact products.[61]

Recyclability does not necessarily mean the package is better for the environment. Recyclable food serviceware had lower environmental impacts in only 56% of studies conducted in the last 18 years. Recyclable food serviceware is only preferable to non-recyclable products if they are actually recycled. That often doesn't happen with food serviceware. Oregon DEQ concludes that specifying recyclability as an attribute should be based less on whether something can be technically or theoretically recycled, and more on whether it should be or will be recycled.

Food-contaminated packaging is almost always too dirty to recycle. Today, most food and beverage packaging either ends up in a landfill, an incinerator, or the environment.

Recycled content is a good thing when comparing virgin vs. recycled content products made of the same materials. For most materials, a product made with recycled content generally has lower environmental impact than a product made from the same material without recycled content, such as virgin glass versus glass with recycled content. This is true for steel, aluminum, paper, and a variety of plastic resins. Increasing the recycled content of a material is almost always good.[62]

However, when comparing different materials within a single-use packaging system (for example, juice delivered in a glass bottle with recycled content, versus a plastic bottle with no recycled content), items with greater "recycled content" are not necessarily the lowest impact option.[63] In 61% of all the comparisons reviewed by Oregon DEQ, the packaging material with higher recycled content often had a worse environmental footprint than a different packaging material without recycled content.[64]

Recyclable food serviceware had lower environmental impacts in only 56% of studies conducted in the last 18 years. Recyclable food serviceware is only preferable to non-recyclable products if they are actually recycled. That often doesn't happen with food serviceware.

Debunking the compostable food serviceware myth

Compostable food serviceware can be made of bio-plastic, paper, and plant-based fibers. Many bioplastic compostable products are made from PLA, which is usually derived from corn. Most compostable plastic cold cups and cutlery are made from PLA.[65]

Unfortunately, compared to conventional plastics, compostable products are not always better for the environment.

General environmental impacts: The environmental impacts from producing, using, and disposing of compostable products typically outweigh the advantages. Compostable food serviceware has greater environmental impacts than the alternatives across numerous measures – global warming impact, land occupation, eco- and human toxicity, and aquatic impacts. It doesn't matter whether the compostable product was composted, landfilled, or incinerated.[66] This is typically because most food serviceware marketed as compostable is produced with agriculturally derived feedstock (sugarcane, corn, potatoes, etc.) that require extensive use of fossil fuels related to pesticides, fertilizers, and farming equipment.[67] The final act of composting the package does not offset the impacts of the fossil fuel inputs.[68] Compostable food serviceware (if composted) typically results in higher environmental impacts when compared to other food serviceware that is non-compostable, even if that other food serviceware is landfilled.[69]

GHG emissions: Compostable products often produce more GHGs than alternative single-use products due to emissions released during the agricultural phase. Growing crops to make materials consumes significant amounts of fossil fuels.[70] Additionally, compostable packaging products that end up in landfills release methane, a GHG that traps more heat than carbon dioxide by thirty-fold.[71] Compostable products produce more GHGs across their life cycle due to emissions released during the agricultural phase.[72]

Ecotoxicity: Growing crops for biomaterials can increase acid rain, contaminate soil and water resources with fertilizers and pesticides, and cause nutrient overloads (dead zones) in waterways. While bio-based and compostable materials are constructed from renewable resources, such as corn and potato starch, growing these materials can cause air and water quality impacts. The water consumption in the growing phase of bio-based plastics also makes them a less favorable choice among single-use food serviceware options.

While the terms "compostable" and "biodegradable" are often grouped together, for waste management purposes they have different definitions.[73]

Biodegradable describes materials that can ultimately decompose with the help of bacteria and fungi and turn into water, carbon dioxide, and biomass as a result. Biodegradation is a process that occurs without human interference and within no specific time frame.

Compostable is "human-controlled degradation." Items that are compostable are also biodegradable, but they break down in a much shorter time frame determined by the composting facility – usually around 80 days. One purpose of composting is to produce nutrient rich soil for agricultural production.[74]

Many compost facilities don't want compostable plastics, and many don't accept any compostable food serviceware, because of the contamination it causes. Less than half the programs in the U.S. that collect organics accept compostable plastic.[75] When compostable packaging is accepted, non-compostable "look-alike" plastic packaging also enters the compost stream, causing contamination. Compostable food serviceware does not function as intended in many compost facilities and can contaminate the final compost product.[76] This is because currently marketed compostable food serviceware, particularly compostable bioplastic, does not degrade within the 60-90 days required by commercial composters, even when certified as meeting current ASTM standards.[77]

Unlike food waste and yard trimmings, compostable packaging does not add valuable nutrients to compost.[78] For this reason, **many composters no longer accept any compostable packaging – plastic, paper or otherwise.[79]** Composters serving Oregon ask their residents not to place plastic compostable food serviceware in the compost and to use reusables to save money and decrease the amount of items in the waste stream.[80] Many commercial compost facilities in California do not accept compostable bioplastic, and some don't accept any compostable food serviceware at all.[81]

No Conclusive Evidence That Compostable Food Serviceware is Necessary to Increase Food Waste Diversion

There is a credible argument that if food waste diversion increases with the use of compostable food serviceware, the nutrient value of the compost stream from food service can increase. However, the 2018 State of Oregon review of LCAs on compostable food serviceware found no evidence that the increase in food waste recovery that resulted in some studies from using compostable FSW could not have been achieved without the compostable food serviceware. "Food waste recovery is possible without compostable FSW (for example, compostable FSW is rarely used throughout Oregon). This suggests that more research is needed to fully ascertain the benefits of co-collection of compostable FSW and other organic waste."[82]

The environmental impacts from producing, using, and disposing of compostable products typically outweigh the advantages. Compostable food serviceware has greater environmental impacts than the alternatives across numerous measures – global warming impact, land occupation, eco- and human toxicity, and aquatic impacts.

Compostable food serviceware (if composted) typically results in higher environmental impacts when compared to other food serviceware that is non-compostable, even if that other food serviceware is landfilled.

Chemical food packaging additives provide another contamination issue. Many compostable paper and fiber-based food serviceware products – such as bakery paper, paper plates, and paper or fiber clamshells – are coated to provide grease and moisture barriers with chemicals known as per- and poly-fluoroalkyl substances (PFAS).[83] Often referred to as "forever chemicals," PFAS are among the most persistent and toxic chemicals invented and can migrate out of the packaging into food. They have long been used in Teflon™, GoreTex™, stain treatments for carpets, and firefighting foam. It is estimated that one-third of Americans' drinking water is contaminated with PFAS, and that may be a significant underestimate since lack of regulation of these chemicals results in a lack of testing.[84]

When food serviceware ends up in compost, PFAS chemicals can then migrate into that compost, which is then used on crops that can absorb these chemicals.[85] Therefore PFAS-contaminated compost pollutes food crops.[86] **PFAS chemicals have been tied to health issues such as liver damage, impacts to the cardiovascular, endocrine, and immune systems, decreased fertility, and lower birth weight.**[87] As of January 1, 2020, the Biodegradable Products Institute began testing products to ensure they are PFAS-free before certifying them as compostable and claims that all products listed on their site meet this standard.[88] But chemical additives in food packaging remains a concern as the replacements for PFAS may not be fully disclosed or evaluated for health and environmental impacts.

Bottom line: we can't recycle or compost our way out of the environmental impacts of our throw-away culture. Many products that claim to be compostable or recyclable don't pass the reality test. They may not be collected at all for recycling or composting; they may be collected but then get diverted to landfill or incineration; or they may be exported, littered, or dumped. Even if they do pass the reality test and are successfully composted, the LCAs, on balance, show that these products only sometimes deliver real sustainability benefits. ♦

Bottom line: we can't recycle or compost our way out of the environmental impacts of our throw-away culture.

Section 2:

The Solution

For the planet, reuse beats single-use every time

There is a universal acceptance that source reduction (e.g., preventing waste) should be the number one priority for addressing waste. It's built into the slogan "Reduce, Reuse, Recycle" that dates back to 1970[89] and has been part of the world-wide lexicon about environmental protection ever since. Reducing single-use and transitioning to reusable and refillable are ways to achieve source reduction and to prevent waste before it starts.

Waste prevention is considered by the U.S. EPA to be the best waste management option for achieving climate goals.[90]

Many of us intrinsically understand that reuse is better than single-use from an environmental standpoint. But what does the science say? The research shows that reuse generally beats single-use across every environmental metric.

LCAs: Weight of the evidence shows reuse wins

LCAs document environmental impacts of a product during different lifecycle phases – from cradle (extraction), through manufacturing and consumption, to grave (disposal). The impact categories can be broad reaching, potentially including: energy consumption, water consumption, global warming potential, consumption of non-renewable resources, contribution to ozone build-up, soil and water acidification, human toxicity, ecotoxicity, eutrophication, impacts on land use, and effects on biodiversity. They are widely used in industry and business to compare various materials and products and their environmental footprint.

LCAs are far from perfect.[91] Every LCA includes assumptions – from the number of uses for a reusable product, to the sources of energy used, the transportation miles involved, the production processes, and how the product is managed once it becomes waste. Many LCAs give credits for recycling or composting in the end of life treatment because the materials are technically recyclable or compostable. The assumptions fail to recognize the reality that recyclable materials are often diverted to landfill and incineration due to food contamination and local compost options may not be available.[92] Assumptions can be used selectively and altered to skew the results. In many cases, the research is funded by the industries whose profits rely on the outcomes.

The vast majority of LCA studies of food serviceware show that reusables are better for the environment than single-use food serviceware.

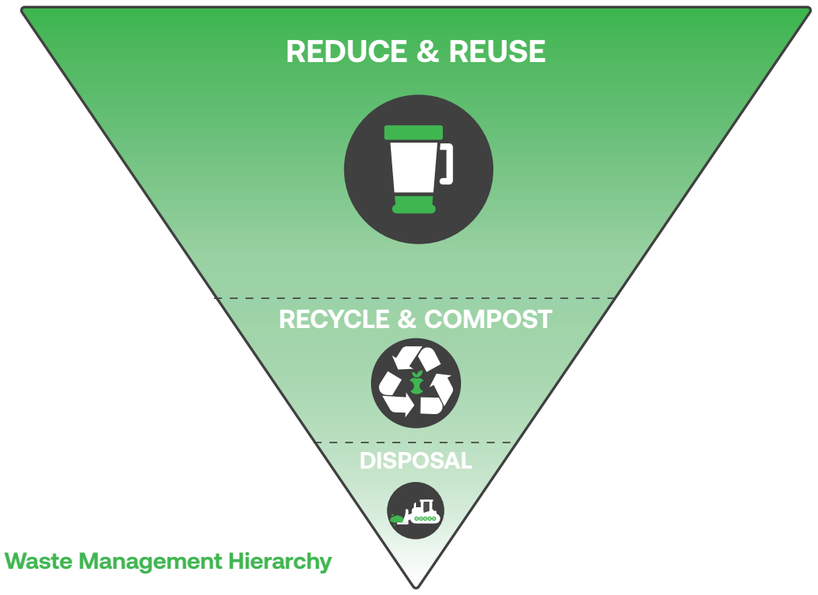
Despite the fact that the plastics and consumer goods industries can use LCAs to tell the story they want to tell – by picking and choosing the parameters of the study and failing to look at a full spectrum of impact categories that might reveal the tradeoffs – the vast majority of LCA studies of food serviceware show that reusables are better for the environment than single-use food serviceware.

Lifecycle assessment does not consider the impacts of plastic pollution in the environment, toxic effects of microplastics released to the marine environment, or impacts of litter on marine or terrestrial ecosystems. **In a review of 21 LCAs, none considered the impacts of improper disposal – e.g., waste not going to landfill, recycling, or incineration – nor did they consider litter or marine plastic pollution.**[93] Efforts are underway to develop impact assessment methods for plastics in the marine environment.

In addition, LCAs don't account for the human health impacts of chemicals migrating from food serviceware into food and beverages. LCA experts believe that LCA isn't the appropriate tool for assessing these impacts. But in choosing food serviceware, the presence of potentially harmful chemicals added directly or indirectly to food serviceware must be considered.

In sum, most LCAs fall short when it comes to evaluating the environmental impacts of disposable food serviceware, especially through the lens of plastic pollution and human health. **Despite the limitations of LCAs, they are the primary technical methodology used to assess environmental impact. They provide measures of sustainability that, while imperfect, can be reliable when viewed through a "weight of the evidence" lens. And the weight of the evidence for food serviceware LCAs shows that reusables are better for the environment than single-use.**

This report reviews LCAs that evaluate the environmental impacts of reusable versus single-use food serviceware products. The studies include those identified by the Oregon Department of Environmental Quality's packaging and materials attributes research,[94] the United Nations Environment Program Life Cycle Initiative, and additional studies identified via literature review.



Waste Management Hierarchy

The LCAs included in this review fall within these parameters:

- the study was published since 2000;
- the study compares the environmental impacts of reusable vs. single-use products used for the same purpose;
- the products are used in food service for on-site dining or take-out meals (cutlery, cups, containers, plates); and
- the full study was published such that assumptions and data were fully transparent.

The break-even point where "reuse wins" happens every time

The point at which the impact per use for a reusable product falls below that of a disposable product used for the same purpose is the environmental "break-even point." After that point, the reusable product is considered environmentally superior. The break-even point for a reusable product will depend on various considerations, such as the weight and material composition of each product, how they are manufactured and then disposed, and how often the reusable product is washed.

The break-even points are usually far below the expected lifetimes of reusable products. **Each additional use beyond the break-even point accrues environmental benefits.** For example, according to existing LCA data, reusable plastic (polypropylene) plates or clamshells need to be reused 50 times to have lower impact than PLA; between three and 39 times to be lower than polystyrene foam; and 14 times to outperform Bagasse.

Reusable ceramic cups need to be reused between ten and 70 times to be more sustainable than paper; 100 times to outperform the paper and PE cup with PP lid; 70 times to be more sustainable than polystyrene foam; and two times to be more sustainable than polystyrene. Glass cups need to be reused 36 times to be more sustainable than paper cups with a lid. Reusable polypropylene cups need to be reused more than ten times to be more beneficial than single-use polypropylene and 20 times to outperform a paper and PE cup with PP lid. A reusable stainless steel cup must be used approximately 35 times to be better for the environment than a paper and PE cup with PP lid. **LCAs generally do not account for the additional burdens posed by disposable cup accessories, such as lids, sleeves, and carry trays.**

There are few studies of disposable versus reusable utensils available. Dennison compared the energy footprints of reusable spoons made from stainless steel versus PS and PP spoons. **He found that the reusable stainless steel spoon only had to be used twice to result in energy consumption equal to two PS plastic spoons, whereas the stainless steel spoon had to be used four times to equal the energy footprint of four PP plastic spoons.**[95]

These break-even points demonstrate that within a short period of time, a reusable product can be the more sustainable choice. In as few as two uses and only as many as 122 uses, reusable food serviceware achieves environmental benefits over the disposables they replace. For cups, it's between 2 and 122 uses, for plates and clamshells, it's between 3 and 50 uses, and for utensils, only two uses of a reusable are required.[96] Since most reusable products last upward of 200 uses – and generally with steel, glass, and ceramic over 1,000 uses – reusables out-perform disposables on every metric and the benefits to the environment accrue with each use past the break-even point.

In as few as two uses and only as many as 122 uses, reusable food serviceware achieves environmental benefits over the disposables they replace.

Summary of break-even points for reusable and disposable foodware

Clamshells & Plates

		Disposable			
		PLA	EPS		Bagasse
Reusable	PP	Broca: plates (2008)	Copeland: clamshells (2013)	Gallego-Schmid: clamshells (2019)	Harnoto: clamshells (2013)
	PP		15	3-39	14
	Ceramic	50			

Cups

		Disposable									
		1.		2.	3.	4.	5.	6.	7.	8.	9.	10.
		Starucks GHG Emissions (2000)	Bramberg Energy impacts (2011)	CIRAIG GHG Emissions (2014)	Woods & Backshi BATT (2013)	CupClub (2018)	Garrido (2007)	CupClub (2018)			Fontenis (2020)	Potting (2015)
Reusable	Ceramic	70	10	100	70	122		90-97				2
	Glass	36										
	Stainless Steel			35								
	PC			70								
	PP			20		100	10	72	78	94	41 recycled 21 landfilled	

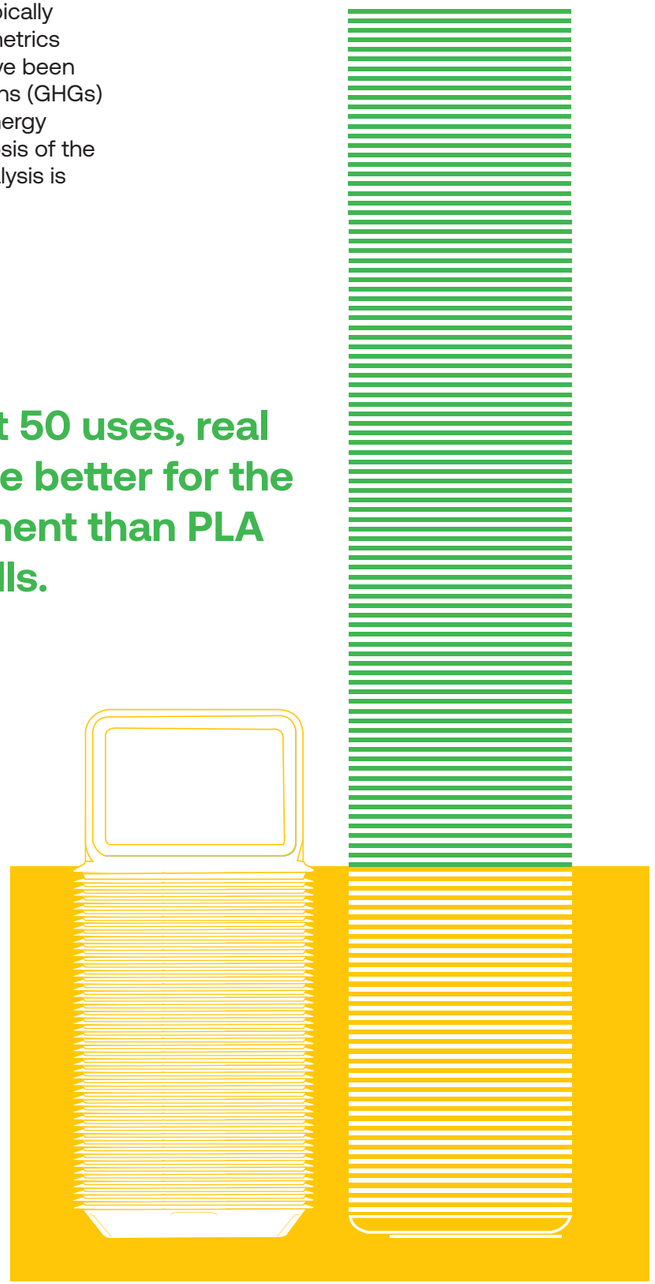
Disposable cups key

1. Paper
2. Paper + PE + PP Lid
3. EPS
4. EPS with PS lid
5. PP
6. Paper lined with PE and PLA + PS/PLA lid + corrugated sleeve
7. Paper lined with PLA + PLA lid + corrugated sleeve
8. Paper lined with PLA + lid + corrugated sleeve-80% composting
9. Paper lined with PE / recycled vs landfilled
10. PS

LCAs Show the Environmental Benefits of Reusable Products

Not all the LCAs compare reusable and disposable food serviceware across all 15 of the environmental impact categories typically used in LCAs. The main environmental metrics by which food serviceware products have been compared are Greenhouse Gas Emissions (GHGs) and Global Warming Potential (GWP), energy inputs, and water consumption. A synopsis of the food serviceware LCAs used for this analysis is provided in Appendix C.

After just 50 uses, real plates are better for the environment than PLA clamshells.



LCAs Show Reuse Wins

Plate/ Clamshell Studies

	Reusable				Disposable					
	Ceramic/ Porcelain	PP	Glass	Stainless Steel	Paper	Bagasse	PP	EPS	PLA	Aluminum
Pro Mo	🏆					🔍	🔍	🔍	🔍	
Broca	🏆								🔍	
Copeland		🏆					🔍			
Harnoto		🏆				🔍				
Gallego		🏆					🔍	🏆		🔍

Cup Studies

	Reusable				Disposable				
	Ceramic	PP	Glass	Poly-carbonate	Paper	PET	PP	EPS	PLA
Pro Mo			🏆		🔍		🔍	🔍	🔍
Starbucks	🏆		🏆		🔍	🔍			
Bramburg	🏆				🔍				
CIRAIG	🏆				🔍				
Garrido		🏆					🔍		
Potting	🏆							🔍	
Pladerer		🏆			🔍	🔍		🔍	🔍
Lingart	🔍				🏆			🏆	
Vercalsteren				🏆	🔍				🔍
Woods	🏆	🏆			🔍			🔍	

🔍 = included in study

🏆 = included in study & found to have least environmental impact

Reuse is better across almost every environmental measure

Woods and Bakshi (2014)[97] intended to provide a comprehensive and current study for U.S. consumers as to whether disposable or reusable cups are the most environmentally conscious choice. This study concluded that the results almost entirely favor reusable cups.

ProMo, an industry trade group for the disposable plastic tableware production sector in Italy, evaluated disposable dishes made from PP, PS, PLA, cellulose pulp, and reusable porcelain dishes; and disposable drinking cups made of PP, PS, PLA, polyethylene (PE) laminated cardboard, and reusable glass cups.[98] For every environmental impact, under every end-of-life scenario, the reusable product had much lower impact, with the exception of water resource depletion.[99] Overall, ProMo found that reusable glass and ceramic tableware has by far the lowest environmental impact by any environmental measure considered. Among disposable options, PP and PS options have lower impact than PLA and cellulose pulp.[100]

Martin et. al. reached similar conclusions in comparing a ceramic cup (with and without a lid) to a ceramic mug – both washed by hand and washed by dishwasher – to a paper cup with and without a polystyrene lid through production, use, and disposal phases. The ceramic mug and ceramic cup had the best outcomes in 14 impact categories (out of 15) when using a dishwasher.[101]

Summary of findings:

Reusable cups, clamshells, and dishes are better for the environment across almost every environmental impact measure.

Among disposable options, polypropylene (PP) and polystyrene (PS) have lower impact than polylactic acid (PLA) and cellulose pulp.

Pladerer, C. et. al.[102] evaluated PET, PS, PLA, and paperboard cups versus reusable PP cups at three-month long soccer tournaments and a nine-month long domestic league soccer season. Results favored the reusable cups even when soccer fans took the reusable cups home with them. The results indicated that all reusable cup scenarios had lower environmental impacts compared to *all* the disposable cups examined.

Vercalsteren, An. et. al.[103] compared a reusable polycarbonate cup (PC) with three single use cups – PP, polyethylene-coated cardboard (LC) and PLA – used in small indoor and large outdoor events. The study concludes that the reusable PC cup system has the most favourable score at 20 or more uses.

Reusable glass and ceramic tableware has by far the lowest environmental impact by any environmental measure considered. Among disposable options, PP and PS options have lower impact than PLA and cellulose pulp.

Reuse protects the climate

CUPS

As of 2017, over 500 billion disposable cups were used across the world every year[104] – 80 billion in the U.S. alone.[105] About half (250 - 300 billion) are plastic-lined paper cups.[106] Projected growth rates for foodservice disposables in 2017 were 3% per year through 2021, making the consumption rate by 2019 approximately 530 billion globally and 85 billion in the U.S. Stacked end to end, 530 billion cups would go to the moon and back 85 times.

Over their lifecycle, reusable cups have lower GHG emissions or GWP[107] compared to disposable alternatives. The main impacts of reusables come during the dishwashing phase, whereas with disposables, the biggest impacts occur in the resource extraction and manufacturing phases.

With the increasing efficiency of dishwashers, the water impacts of reusables have decreased over time. With hot cups, reusable emerges as the better alternative as long as washed in an efficient fully loaded dishwasher, or hand-washed in cold water.[108]

Both Bramberg et. al.[109] and Martin et. al.[110] show lower break even points due in part to more efficient dishwashing systems. Water consumption can increase the energy and GWP footprint because of the energy used in water delivery systems. The water and energy efficiency of dishwashing machines and the sources of energy for the regional electricity grid affect the energy consumption and thereby impact the carbon footprint of the cup options. The reusable cup is the better option for 68% of the residential population of the U.S. based on cleaner sources of energy. For the remaining 32% of the nation's population with the most carbon intensive

electricity mixes, the results depend on the efficiency of the dishwashers.[111]

The number of accessory items that accompany disposable cups can add to the GHG burden. When a ceramic cup was compared to a paper cup lined with PE plus a paper sleeve in the Starbucks study, the ceramic cup showed clear reductions in GHG emissions (226 lbs. reduced annually at a usage rate of two cups per hour, or up to 1,130 lbs annually at a rate of 10 cups per hour of operation.)[112]

Stacked end to end, 530 billion cups would go to the moon and back 85 times.

Reuse protects the climate

Summary of findings:

Over their life cycle, reusable products, food serviceware and packaging have lower GHGs compared to disposable alternatives.

With disposables, the largest greenhouse gas impacts occur in the resource extraction and manufacturing phases – mostly plastics from fossil fuels, paper from trees, bioplastics/biomaterials from crops, and aluminum from mining.

The GHG emissions from disposables exceed those of reusables after the break-even point. This varies according to different types of reusable products, the materials they're made from, the efficiency of the washing machines used, and the sources of energy for the regional electricity grid.

The main energy impacts of reusables occur during washing. With the increasing efficiency of dishwashers, the benefits have increased over time and continue to do so.

Cups:
Among the reusable options, glass appears to be the clear winner, but ceramic and stainless steel are comparably close.

Among the disposable cups, paper with a PE liner and paper sleeve was the most impactful and laminated cardboard was the least.

Plates and Clamshells:
PP clamshells produce about 68 times less carbon emissions than Bagasse if used 360 times, but most won't last that long with repeated washing in a commercial system.

1,000 single-use plates range between three to seven-fold higher in CO2 impacts than porcelain used 1,000 times; PP has lower impact than PS, PLA, and cellulose.

Reusables generally win over the disposable options, but each study reaches different conclusions about which reusable option is best. The CIRAIG study[113] compared a paper cup with PE liner, a paper cup lined with PLA, and an EPS cup against three reusable cups (a ceramic cup and travelers' mugs made of stainless steel with PP lid, and PC). Over a one year span, all the reusable cups were associated with fewer GHG emissions than the single-use cups. As shown in the following table, ceramic was the winner, followed by stainless steel.

The Pro.mo study[114] found the GWP of reusable glass cups is significantly lower than any of the single-use alternatives including PP, PS, PLA, and laminated cardboard. PLA was the worst of the single-use options, and laminated cardboard was the best.

The Martin LCA compared a ceramic cup with plastic lid against a paper cup with PE lining and PS lid and found that the ceramic mug washed by hand, when the lid is added, is the worst choice. Whereas, when washed in the dishwasher, the ceramic cups are a better choice than the paper alternative.[115]

The number of accessory items that accompany disposable cups can add to the GHG burden.

Searching for the best cup option

With studies that don't consistently evaluate the same types of cups, it is difficult to compare them to decide which reusable cup and which disposable cup has the least climate impact. To gain more insight, we reviewed each of the LCAs for reusable versus single-use cups to determine the CO_2 emissions associated with each type of cup. We limited the review to cups typically used for "to-go" or take-out and selected the 16 oz. size unless size was unindicated. These emissions are expressed in terms of kilograms (kg) of CO_2 equivalent (CO_2e). Most of these disposable products end up in landfill in the U.S. The reusable products are reused based on the assumptions in each study.

All reusable cups (ceramic, stainless steel, glass) have lower CO_2 footprints than the single-use options (paper, PET, EPS, PP, PLA, laminated cardboard) when reused. Among the reusable options, glass appears to be the clear winner, but ceramic and stainless steel are comparably close. Among the disposable cups, paper with a PE liner and paper sleeve is the most impactful and laminated cardboard is the least.

Summary of assumptions in the cups LCAs

Size: recent reports assume 16 oz.

Number of uses for reusables: Woods and Bakshi[116] state that non-plastic lasts for 1,000 uses or more but give a reality usage of 500 because people eventually become emotionally less attached to a product and start using other cups. Starbucks uses 1,000.

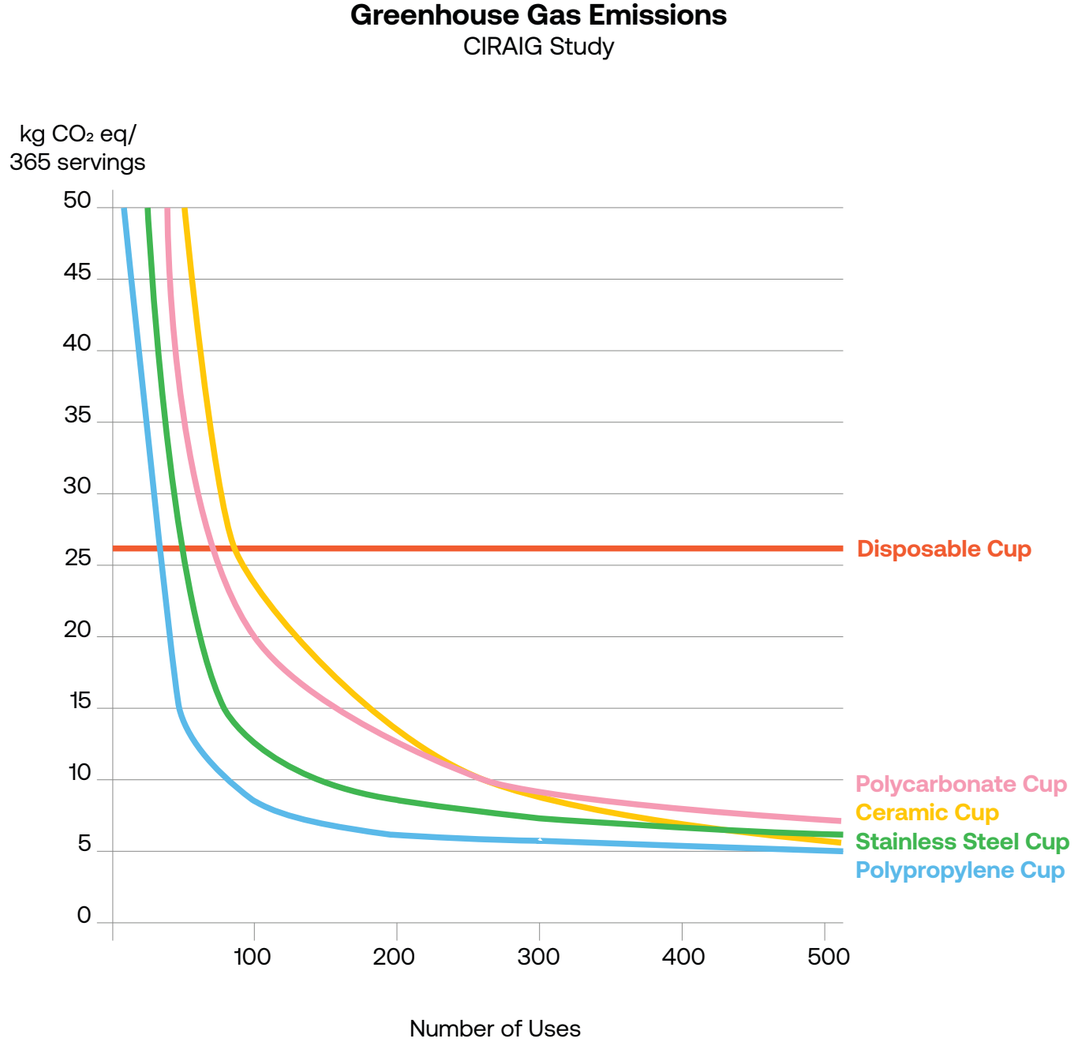
Washing energy: Woods and Bakshi based their review of energy based on subregional electric utility grids, not the national average. In 32% of the U.S population, reusables have higher climate impact due to older appliances and grid mix.

Mass of disposable cups: Woods and Bakshi assumed 4.4 to 5.0 g/cup for EPS, 292-700 g/cup for reusables.

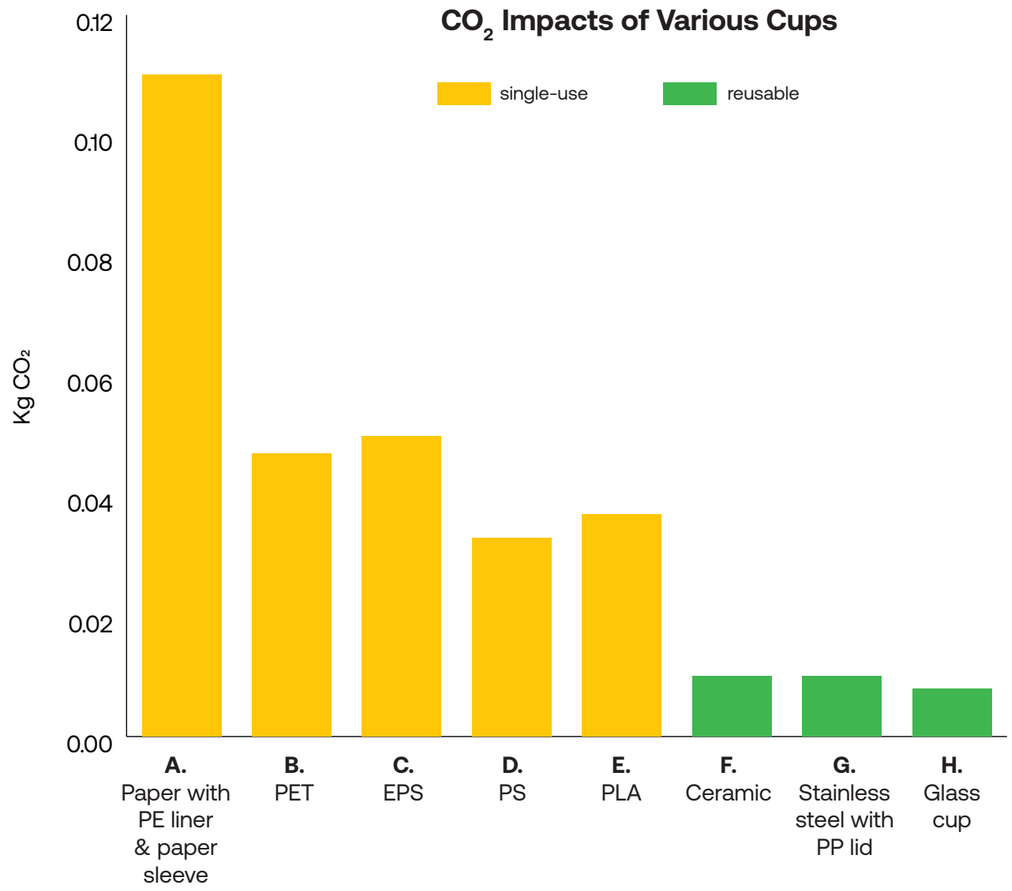
End-of-life management: for disposables, recycling is negligible in the U.S. for paper and plastic food serviceware. Therefore the Woods and Bakshi assumption was 11.7% incinerated and the remaining landfilled, based on EPA 2009 data. For reusables, ceramics and glass are assumed to be 100% landfilled.

Transportation: delivery of all products will vary from one study to another.

Warewashing: Woods and Bakshi assumed that 50-75% of commercial facilities have dishwashing (based on U.S. households.) A recent survey of Seattle restaurants found 76% had a commercial dishwasher onsite. The rest had a three sink system.[117] Of 201 *ReThink Disposable* participants, 47% have mechanized dishwashers, 53% use a three sink system.[118]



All reusable cups have lower CO_2 footprints than the single-use options when reused. Among the reusable options, glass appears to be the clear winner, but ceramic and stainless steel are comparably close. Among the disposable cups, paper with a PE liner and paper sleeve is the most impactful, and laminated cardboard is the least.




A.


B.


C.


D.


E.


F.


G.


H.

CLAMSHELLS

Only one study compared reusable to single-use clamshells. Harnoto evaluated a reusable PP clamshell compared to a Bagasse (made from sugarcane waste) compostable version for the UC Berkeley dining program.[119] The break-even point at which reusable clamshells have the equivalent GHG emissions to compostable clamshells was 5.5 uses. The CO_2 emissions of 360 compostable clamshells used once were 85.5 kg CO_2, while one reusable clamshell used 360 times caused 1.27 kg CO_2 emissions. The carbon impacts of the compostable Bagasse clamshells are therefore 68 times greater than reusable PP. However, during a pilot test, the average number of uses of a PP reusable clamshell before breaking was 43. Therefore, the GHG reductions benefits of a PP reusable clamshell might not be realized in its average lifetime.

PLATES

ProMo evaluated the impacts of 1,000 single-use PP, PS, PLA plates to one reusable porcelain plate used 1,000 times. The GWP of 1,000 plates expressed in kg/CO2e was 54 for PP, 69 for PS, 96 for PLA, 121 for cellulose pulp, and 18 for porcelain. The reusable porcelain plate had a much lower climate impact than all the single-use options, with the plant-based options – PLA and cellulose pulp – claiming the worst impacts.

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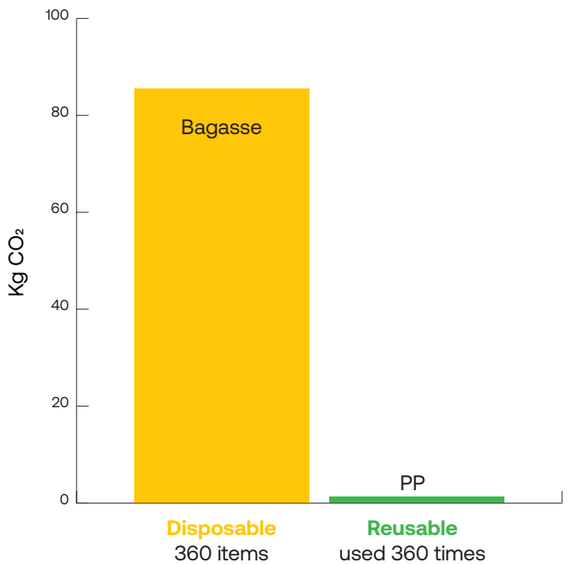
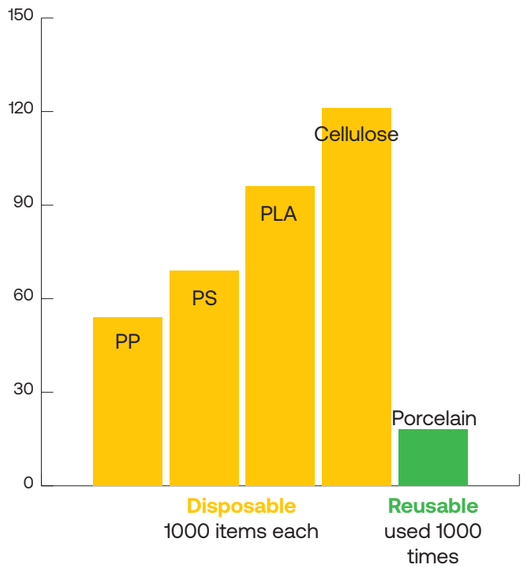
CO_2 Impacts of Clamshells



CO_2 Impacts of Plates



Most of the time, reuse saves water

CUPS

Single-use cups require significantly more water over their life cycle than ceramic mugs[120] and almost as much water as stainless steel travel mugs.

In the Starbucks study, ceramic reusables reduced water usage by 64% over the entire lifecycle, compared to the disposable paper cup. For single-use cups, most water consumption occurs during production of the paper (66%) and the PS lid (34%).[121] Whereas, the reusable cup's water footprint comes mostly from the washing phase. The CIRAIG study assumes that the dishwasher uses an average of 0.2 liters of water (0.05 gallons) per piece washed. Washing the travel mug by hand consumes 3 litres (0.79 gallons) of hot water, more than ten times as much energy and water as with commercial dishwashing.[122]

Five hundred paper cups consume nearly 370 gallons of water, versus one ceramic cup washed 500 times, which uses 53 gallons. The stainless steel travel mug uses 383 gallons, while the compostable cup uses 317 gallons, and EPS cups use 211 gallons of water.[123]

The table on the following page shows the break even points for the water consumption of various reusable cups compared to the single-use paper cup. The ceramic mug takes about 20 uses. The stainless steel and polycarbonate cups take about 250 uses to break even with the single-use options, which seems high, but it would take a coffee drinker a year of using a travel mug once per work day to break even on lifecycle water with a reusable travel mug.

For glass cups, the ProMo study found they consume 0.125 litres (0.033 gallons) of water per wash in a 16 dish capacity dishwasher.

Comparing the per-cup life cycle consumption of water for each type of reusable cup evaluated in these studies, once again, glass is the clear environmental winner, followed by ceramic then stainless steel. Of all the single-use products, EPS has the lowest water footprint.

Most of the time, reuse saves water

Summary of findings:

Over its life cycle, reusable food serviceware generally uses less water than using disposable alternatives.

Similar to greenhouse gas emissions, the greatest water use occurs in the resource extraction and manufacturing phases for the different types of disposable materials.

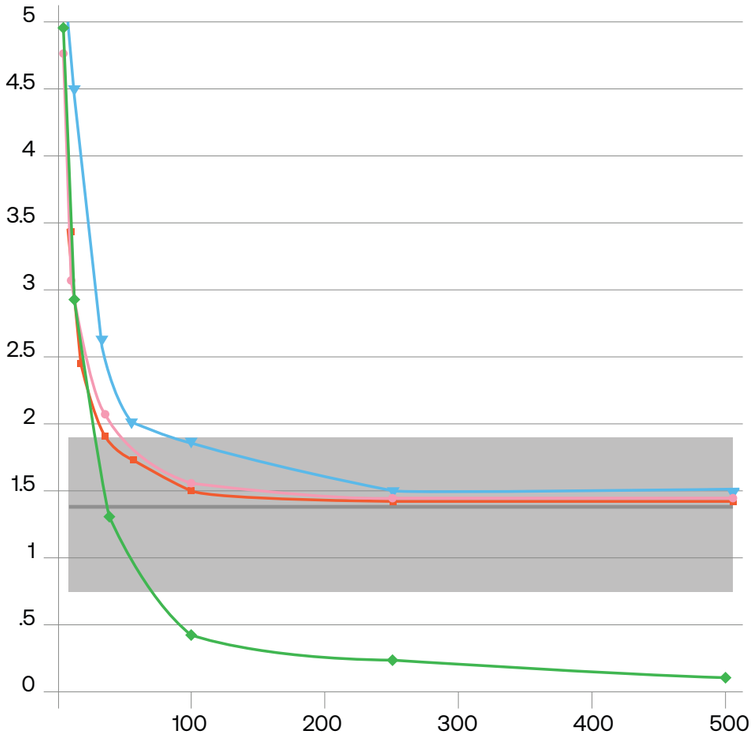
The water footprint of disposables during the production phases is generally greater than that of reusables once the reusables have been used and washed a certain number of times – the break-even point.

The main water impacts of reusables occur during washing.

The water used in the growing phase of bio-based plastics make them a less favorable choice among single-use food serviceware options.

The Break Even Point of Reusable vs. Disposable Cups re: Water Consumption (m^3)

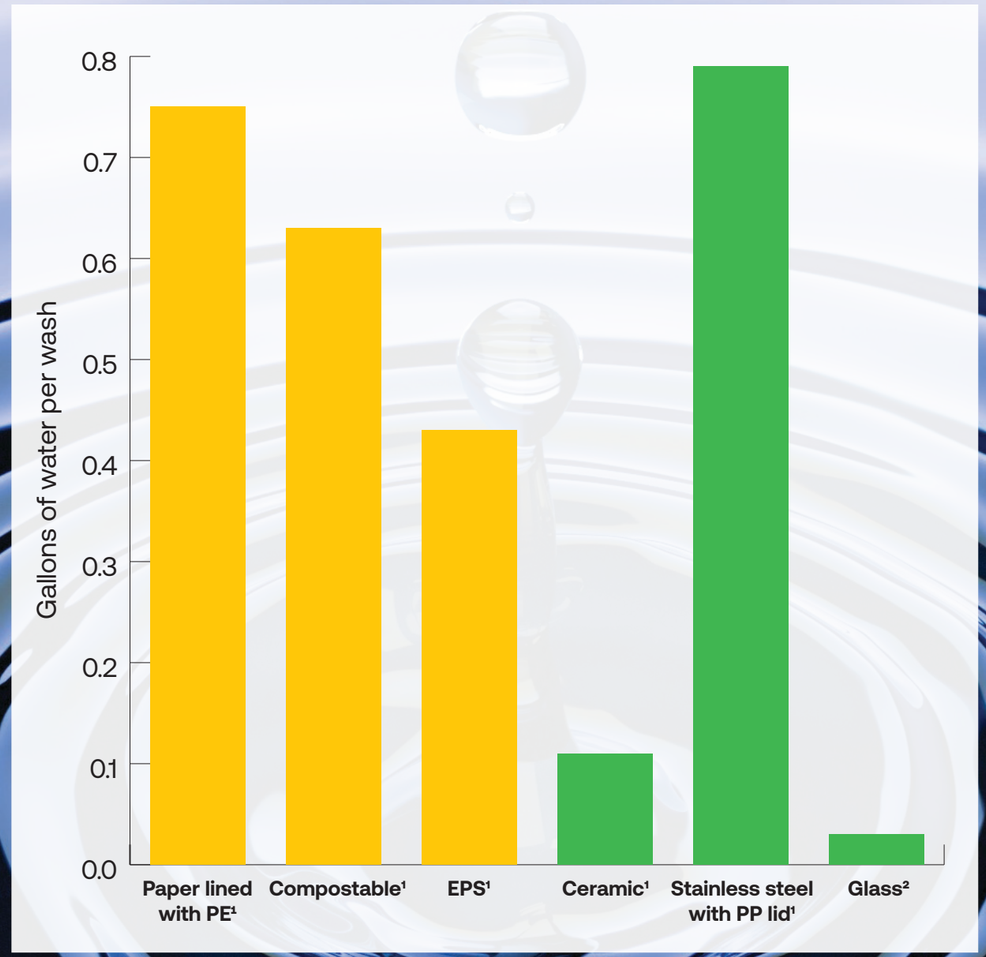
CIRAIG Study



The shaded area illustrates the variation range for disposable cups with lid, given their minimum and maximum size and material.

Single-use cups require significantly more water over their life cycle than ceramic mugs and almost as much water as stainless steel travel mugs.

The Water Footprint of Single-Use vs. Reusable Cups



[1]Ciraig Study
[2]Pro.mo Study

CLAMSHELLS

Harnoto found that reusable clamshells always use more water than compostable clamshells. The higher the usage rate, the higher the water footprint of the reusable option. Three hundred sixty compostable clamshells consumed 3,510 liters (927 gallons) of water throughout their life cycle, whereas 360 uses of one reusable clamshell required 12,300 litres (3,249 gallons) of water. Ninety-six percent of the water use in the life cycle of the single-use compostable clamshell is from the material acquisition and manufacturing phases, whereas for the reusable clamshell, 99% of the water use comes from the washing during the consumption phase.

Environmental Benefits of Reuse Not Considered in LCAs

REUSE STOPS WASTE BEFORE IT STARTS

The LCAs had a lack of data on the specific waste impacts of the products evaluated. However, the waste reduction benefits associated with any type of reusable product are clear. Reusables cut the number of single-use items that end up in the waste management system. The number of times a reusable product is used dictates the amount of waste reduced.

REUSE PREVENTS LITTER

More than $11.5 billion is spent every year in the U.S. to clean up litter on the streets, in storm drains and in rivers – and the most common objects found during clean-ups are food and beverage packaging.[124] Similarly, while the LCAs do not include data on litter, the litter prevention efforts of reuse are clear and well-documented. Litter reduction efforts like banning single-use plastic bags and cutlery and putting fees on single-use paper bags, cups or to-go containers can dramatically reduce litter. For example, in under one year California's state-wide bag ban reduced litter found on California beaches by 60%.[125] In San Jose, CA, with a ban on plastic bags and a ten-cent paper bag charge, plastic bag litter decreased by 89% in the storm drain system, 60% in the creeks and rivers, and 59% in city streets and neighborhoods.[126]

REUSE PROTECTS OCEANS AND HELPS SOLVE PLASTIC POLLUTION

Today, more than a third of all plastic packaging produced winds up in the environment, and single-use food and beverage packaging comprise two thirds of the top 20 most-commonly found plastic pollution items. Many of the most-commonly found plastic beach debris items can be eliminated by customers bringing their own reusables or businesses providing food, beverages and other consumable products in reusables (either themselves or by contracting with reuse service providers that handle the collecting, cleaning and stocking of the reusable containers).

REUSABLE PACKAGING IS GENERALLY SAFER FOR HUMAN HEALTH

Ample evidence suggests that food serviceware is a source of health-harming chemicals that migrate into food and beverages.[127] But this is a problem mostly with disposable food serviceware. Non-plastic reusable products such as ceramic, glass, and stainless steel are not generally associated with threats to human health from chemical migration. A large and increasing body of evidence from laboratory and human epidemiologic studies suggests that plastic food packaging presents threats to human health. This includes single-use plastics that contain phthalates and styrene, and reusable plastics (polycarbonate plastics) made with bisphenols.[128] Indirect food additives – adhesives, dyes, coatings, plasticizers, paper, paperboard, plastic, and other polymers that can reach food from the packaging or processing equipment – may contribute to human disease and disability.[129] Many chemicals that migrate are known endocrine disruptors that cause harm at critical stages of human development and in very low levels of exposure. Some of the food serviceware chemicals of greatest concern cited include two groups of plasticizers – bisphenols and phthalates – as well as per- and poly-fluoroalkyl substances (PFAS), and perchlorate.[130] ♦

See Appendix A for challenges posed by materials listed on page 55.

Reusable: The Clear Choice

IMPACT SCORE	Paper & paperboard	Fiber-based	Plastic	Bioplastic	Reusables
Net Score	-3	-4	-5	-7	+4
+5	Economic Impact / Health Impact / Environmental Impact				Not littered
+4					Most designed for 200-3,000+ uses
+3	Degrades in marine environment.				After 2-200 uses, better for environment than single use
+2	Can be composted	Degrades in marine environment.			No chemical migration or toxic exposure threat, except for plastic
+1	One of the cheapest options	Can be composted.	Cheap option (cost to manage waste is externalized)		Continued savings after payback period of 1-6 months
0	Waste management / litter costs	Can be twice the cost of plastic & paper	Waste management/ litter costs	More expensive than paper & plastic	Chemical exposure from production emissions
-1	Often coated with PFAS.	Waste management & litter costs	Monomers (styrene and bisphenols) and chemical additives	Waste management & litter costs	
-2	Recycled content can contain chemicals	Often coated with PFAS	Toxic emissions throughout lifecycle	Toxic emissions from agriculture (fertilizer, insecticides)	
-3	Cuts down trees – harms ecosystems & climate	Agricultural methods harm ecosystems & climate	Mostly not recyclable – goes to landfill and incineration	Chemical additives in products undisclosed; impacts unknown	
-4	Foodware can't be recycled – usually landfilled/ incinerated	Foodware usually landfilled/ incinerated	Production propels climate change, causes pollution	Higher GHG impacts than plastic	
-5	Dilutes compost quality	Not a benefit to compost/can add PFAS	Waste pollutes air & water resources	Contaminates compost & recycling – mostly landfilled & incinerated	
-6					
-7				Plastic waste pollutes air & water resources	

Section 3:

The Economics

Reuse saves businesses and communities money and creates jobs

Single-use alternatives to plastic trade one environmental problRestaurants in the U.S. spent $21.9 billion on purchasing food service products in 2019.[131] Going reusable presents innovative new business opportunities and ways to save money. Replacing just 20% of single-use plastic packaging with reusable alternatives offers an opportunity worth at least $10 billion.[132]

Reuse models offer major business benefits, including superior consumer experiences, user insights, business efficiency, brand loyalty and cost savings. Over 100 businesses have signed the Ellen MacArthur Foundation's New Plastics Economy Commitment to move "where relevant" from single-use to reusable packaging by 2025.[133] While those commitments come mainly from large brands, this section provides examples of change also coming from small restaurants – influenced by their customers and citizen activism – and entrepreneurs innovating new models for food delivery.

Summary: the economics of reuse over single-use are clear. The evidence shows that reuse beats single-use across a variety of metrics:

Reuse saves food service businesses money

Additional dishwashing and associated labor costs for reusables are minimal or non-existent

Reuse increases customer and operator satisfaction

Reuse builds brand loyalty

Reuse can offer valuable customer behavior data

Reuse saves communities money

Reuse creates new opportunities for entrepreneurs, investors and customers

Replacing just 20% of single-use plastic packaging with reusable alternatives offers an opportunity worth at least $10 billion.

Reusables Analysis: Universal Coffee Shop

The Starbucks Company/Alliance for Environmental Innovation Joint Task Force

Assumptions:

$0.15 Cost of disposable packaging (cup, lid and insulating sleeve)

$1.25 Cost of 16 oz. reusable ceramic cup (cup only)

1,000 uses: Lifetime of reusable ceramic cups

12 hours: Operation time of the coffee shop per day

Results

No. of reusable cups used per hour	Daily cost savings*	Annual cost savings†
2	$3.57	$1,285
4	$7.14	$2,570
10	$17.85	$6,426

No. of reusable cups used per hour	Annual water savings (gal.)‡	Annual GHG reduction (lbs.)‡	Annual solid waste reduction (lbs.)‡
2	1,631	226	252
4	3,262	452	504
10	8,155	1,130	1,260

Critical success factors

Excess Washing Capacity: The Starbucks-Alliance research indicated that the system had unused dishwashing capacity.
Storage: The store needs to have storage space for a small supply of cups near the service area and additional storage for dirty dishes before they are washed.

* = no. of reusable cups used per day (cost of disposable packaging(cost of reusable serviceware/1000.
† Multiply by 360 days. ‡ Based on the use of a 16 oz. cup with sleeve, by weight.

Reuse saves businesses money

Reusable cups save food business operators money. Over 20 years ago, a Starbucks study showed that using a ceramic mug 15 to 20 times and a glass cup approximately 25 times would result in cost savings. In terms of labor, the study also found that with increased use of reusable cups, dishwasher use and labor did not significantly increase – two common concerns when moving towards reusables.[134] The more the reusable cup is used, the lower the overall cost in comparison to the disposable cups it replaces.

The study showed how a typical or "universal" Starbucks café could save money and reduce water, climate, and waste impacts based on pilot tests conducted in Starbucks cafes. A café could save over $6,000 per year with 10 reusable cups used per hour, while significantly decreasing environmental impact.

Research conducted by CIRAIG for Recyc-Quebec found that ceramic mugs are less expensive than single-use paper cups for restaurants once they are reused 45 times (regardless of dishwasher type, based on a purchase price of $4.50 per mug). Two cost scenarios were evaluated: mugs used 500 times in a generic dishwasher and those used 100 times in a generic dishwasher. They did not find that dishwasher efficiency had a major impact on the cost to a restaurant but still recommend that restaurants opt for high-efficiency models in order to reduce their overall energy consumption.[135] (See graph on page 60).

The same is true for plates. At the Barn Restaurant in British Columbia, researchers evaluated the costs of switching from paper plates to ceramic plates.[136] The restaurant used 750 paper plates per week and spent approximately $1,325.52 on paper plates each year. Allowing for 30% of the plates to be replaced annually, and taking into consideration operational costs, the study found ceramic plates only cost $980.28 per year – an annual savings of $345.24.

Clean Water Fund's *ReThink Disposable* program, launched in 2012, has worked with nearly 300 food service operators in the San Francisco Bay Area and Los Angeles, helping them to identify

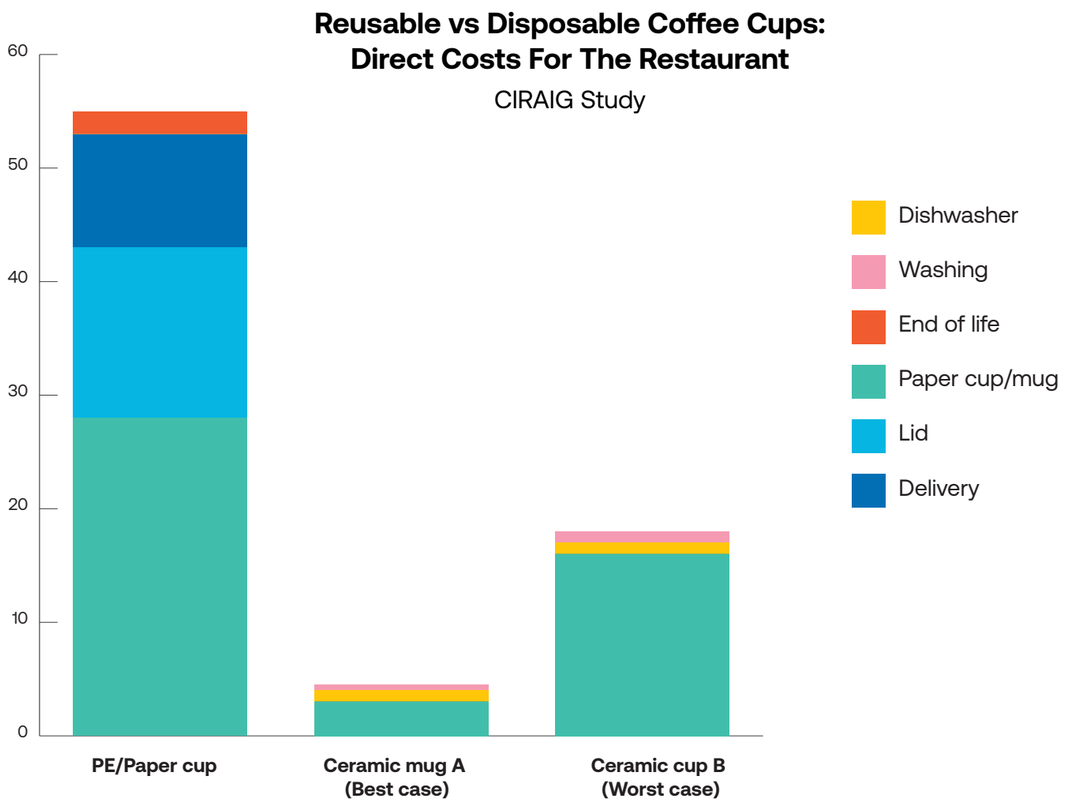
With increased use of reusable cups, dishwasher use and labor do not significantly increase.

opportunities to transition from single-use to reusable food serviceware or simply reduce packaging where it's unnecessary. To date, 100% of the 121 businesses and 11 institutional dining programs that have documented the cost impacts of switching from single-use to reusable saved money, accounting for the costs of new products, labor, and increased dishwashing.

Cost savings for small businesses fall between $3,000-$22,000, while the environmental impacts include an elimination of 110,000-225,000 packaging items and a reduction of 1,300–2,200 pounds of waste per business. While initial investments are needed to purchase reusable products, cost savings are usually realized within a few months and always within a year.[137]

Between 2017-2019, *ReThink Disposable* "unpackaged" the island of Alameda, a city in the San Francisco Bay. With 80 restaurants completing the certification process, the program resulted in 6,199,840 single-use food serviceware items eliminated, 32.34 2.45 tons/64,682 lbs. of waste eliminated, and $139,231 in cost savings per year.[138]

Of all the participating businesses in Alameda, only two opted to invest in leasing a mechanized dishwashing machine, and one business owner hired an additional part-time dishwasher to implement recommended practices. Even with these costs, the business owners still saved money annually from the avoided disposable food serviceware procurement.



100% of the 121 businesses and 11 institutional dining programs that have documented the cost impacts of switching from single-use to reusable saved money, accounting for the costs of new products, labor, and increased dishwashing.

Additional dishwashing and associated labor costs are minimal or non-existent

Food business operators' primary concerns regarding reusables include the cost of added dishwashing and associated labor. But all restaurants that serve food and/or beverages prepared on-site have some type of installed dishwashing – either a three-sink system or an automatic dishwasher – and may not be using their dishwashers to full capacity.

In Seattle, 76% of food service businesses surveyed had commercial dishwashing systems installed. In that study, most of the food serviceware used for on-site dining was reusable. Switching to all-reusable food serviceware wouldn't require dramatic shifts, as restaurants reported they used durable products at the following rates: plates (85.9%), cups (85.9%), drinking glasses (82.8%), utensils (75%), and bowls (67.4%).[139]

The data collected in Seattle aligns with the experience of *ReThink Disposable*. In the vast majority of cases, businesses that have worked with *ReThink Disposable* are fast casual and institutional dining services, most of which use a mix of disposables and reusables. Nearly all restaurants have been able to transition to reusables for on-site dining without changing their dishwashing set up or increasing labor costs. *ReThink Disposable* case studies provide examples of how food businesses and institutional dining programs managed with existing dishwashing capacity, with a few installing dishwashers.

Cost savings are usually realized within a few months and always within a year.

BUSINESSES USING THE THREE-SINK SYSTEM

Rene Rose Island Cuisine, Sunnyvale, CA

Prior to *ReThink Disposable* certification, this cozy 700 sq. ft. restaurant served dine-in customers on all-disposable food serviceware. Each order required up to five disposable plates and bowls due to the menu structure.

They achieved a full transition when they replaced disposable plates, bowls, baskets, and cups with reusables. They installed a bulk sauce dispenser and eliminated disposable ramekins and lids for dine-in customers, bought a napkin dispenser, and increased their stock of reusable cutlery. They organized their limited space to accommodate the reusables and maximize dishwashing space and used their existing three-sink system to wash the dishes.

Their labor savings include less trash to manage and less time shopping for disposables. Altogether, Rene Rose saved $22,122 per year after the two month payback period and reduced disposable items by a count of 151,607, achieving a 2,130 pound waste reduction per year.[140]

New York Pizza, Palo, Alto, CA

Before implementing the changes, the Palo Alto Downtown location of this pizza chain served their on-site diners pizza on paper plates with side dishes in disposable foil food trays, and plastic water cups and utensils were available at the self-service station. The changes implemented included serving pizza directly on metal pizza trays, side dishes served in reusable baskets with paper liner, and the plastic utensil and cups at the self-serve station were replaced with reusable silverware and durable cups. They eliminated disposable straws and installed a bus tub for collecting reusables.

Washing is conducted using the existing three-sink system, yet the business reported no additional labor costs nor any challenges keeping up with dishwashing needs.

This business reduced disposable food serviceware items by an average of 61%, preventing 135,354 disposable items and 2,955 pounds of waste annually, while saving $3,043 per year. The owner purchased all the reusable food serviceware needed to implement the program for only $170.[141]

BUSINESSES WITH DISHWASHERS

Lola's Chicken Shack, Alameda, CA

Owners wanted to eliminate the 52,430 disposable water cups they use each year for on-site service but were concerned about how switching to reusables would slow down service. Once the cups were purchased, washing them required only three additional loads and five extra gallons of water per day.

The payback period (including the cost of dishwashing) for the cups was 15 days. They save time and money by no longer having to order thousands of disposable plastic cups. With the 1,400 pounds of annual waste prevention due to reusable cups; a dispenser for straws; the reusable spoons that replaced stir sticks; and minimizing the use of food containers, less staff time is spent managing overflowing garbage cans.

The restaurant achieved a $3,205 cost savings and avoided using 65,022 disposable items per year.

University of San Francisco Cafeteria, San Francisco, CA

This campus eatery completes 5,000 transactions per day, with the bulk of service during the busy lunch hour. Even though the facility had a dishwasher, very little reusable food serviceware was available, so disposables were the default option.

The changes involved replacing disposables with reusables for cups at water stations, salad bowls with lids, and cutlery. Disposables were also minimized when they moved condiments, napkins, straws, and toothpicks into bulk dispensers, and introduced a charge of $0.25 on disposables to incentivize dining on reusable food serviceware.

The results included an annual reduction of 2,607,519 disposable food serviceware items and 26,962 pounds of waste, at an annual savings of $157,883. **The catering company, Bon Appetit Management Co., reported no additional labor was required.**

Nearly all restaurants have been able to transition to reusables for on-site dining without changing their dishwashing set up or increasing labor costs.

Berkeley Yacht Club

Six pilot Northern California yacht clubs participated in *ReThink Disposable*. Berkeley Yacht Club reduced their use of disposable food serviceware items by an average of 97% and prevented the use of 42,774 disposable items, weighing 1,123 pounds, from entering the waste stream each year. They earn an ongoing annual net cost saving of $2,799.

To address dishwashing, members use Platescrape, a water conservation tool that eliminates the need to pre-wash. Members help out by "scraping" their dishes before placing them in a dish rack for loading into the mechanized dishwasher.

RENTING AND INSTALLING A DISHWASHER

Honolulu BBQ, Alameda, CA.

This business made a full transition to reusables for on-site dining when it eliminated 14 types of disposable food serviceware. As a result, the restaurant annually avoids using 109,408 pieces of disposable food serviceware, eliminates 21,984 pounds of waste, and saves over $3,000 per year. The owners of Honolulu BBQ received Alameda County's 2019 StopWaste Business Efficiency Award for their source reduction effort.

The owners reported that the changes had no impact on labor costs. While the restaurant accomplished these savings using their three-sink hand washing system, the owner eventually used a dishwasher rental service costing $1,962 per year, which would cut the annual costs savings from over $3,000 to $1,272.[142]

Palo Alto Unified School District

Working with *ReThink Disposable*, the Palo Alto Unified School District phased out seven single-use food serviceware items used for breakfast and lunch across all 12 of their elementary schools, serving over 3,400 students. The District purchased reusable baskets, stainless steel sporks, durable clamshells, and funded a few other infrastructure updates for a cost of $22,831. They also hired two new part-time employees — a dishwasher and a van driver — at an annual cost of $27,000.

Even with the initial investment of $49,831 to set up and maintain the new reusable food serviceware operation, the District achieved an impressive saving of $25,000 per year, after an average five-month payback period. Every year, the school district will eliminate 436,540 pieces of single-use food serviceware and over 8,000 pounds of waste.[143]

The owners reported that the changes had no impact on labor costs.

Reuse increases customer satisfaction and builds brand loyalty

In addition to environmental benefits and cost savings, many of the case studies (*ReThink Disposable*, the Starbucks study pilot program)[144] report increased customer satisfaction.

Customers who participated in the Starbucks pilot project consistently stated that they preferred reusable cups. **Eighty-two percent of the Starbucks customers surveyed liked the idea of reusable cups**, and when asked what they liked most about them, 59% noted the environmental benefits.

In many of the *ReThink Disposable* case studies, the owner/operator felt that their customers' dining experiences were improved. These reports were based on a mix of customer-reported satisfaction and the owner/operator's satisfaction with the improved presentation of their prepared food and beverage, as well as the overall dining experience.

A company's environmental leadership can add value to its brand. Conversely, brands associated with plastic pollution drive consumers away.

The 2018 and 2019 Break Free From Plastic report "Branded," which identifies the world's top corporate plastic polluters using surveys of plastics polluting beaches and shorelines around the world, put the names of the top ten in the public spotlight.[145] Companies like Coca Cola, Pepsi, and Unilever went on the defense and upped their commitment to solving single-use plastic problems.[146]

While many companies are focusing on increasing recycling,[147] activist pressure on big brands identified as top polluters has led some to search for and invest in refillable and reusable solutions. Companies like Unilever, Nestle, and Proctor and Gamble have invested in Loop, a company that sells products in containers

designed to be returned and refilled. Coca Cola Co. is investing about $25 million to launch a returnable and refillable "universal bottle."[148]

Additionally, Coke and Pepsi are deploying touch-screen soda fountain machines – compatible with reusable cup systems – at restaurants, cafeterias, and venues. Starbucks and McDonald's are looking at cups and investing in innovation both in single-use materials and in moving toward reusables.

Brands that lead on switching to reuse are capitalizing on the increasing consumer support for moving away not only from plastic but from all single-use packaging. An August 2019 survey reported that 71% of 2,000 U.K. shoppers polled said they would buy food from a refill store if the option were available. Shoppers aged 16 to 24 were more than twice as likely to have shopped for food in refillables.[149]

Reuse also offers customer behavior data-gathering benefits. Apps and other digital platforms associated with consumer participation in reusable cup and container systems allow companies to gather data on user preferences, and system performance can be tracked via digital technologies like RFID tags, QR codes, sensors, and GPS tracking.[150]

Reuse saves communities money and offers additional benefits

Food and beverage packaging contributed significantly to the $1 billion in costs of taxpayer-funded waste management in that same year and litter cleanup costs of over $2 billion. The total litter cleanup cost in the U.S. (public and private sector) $11.5 billion.[151] By one estimate, food service packaging comprises 67% of street litter.[152]

In sum, reuse stops waste before it starts and reduces costs for businesses and local governments to manage all the waste. Each time a reusable item is used, the number of single-use items that end up in the waste management system is reduced.

And reuse creates new opportunities for entrepreneurs, investors and customers who are providing jobs and changing the way products are delivered to consumers. Section 7 of the report describes the new reuse economy and the pioneers and innovators leading the way. ♦

Section 4:

The Challenges

Reuse requires rethinking how we deliver and consume

Underestimating the cost of disposables

The restaurant industry has long been known to be a pressure cooker. It's a high stress environment fraught with thin profit margins, staff turnover, demanding customers, and fast paced kitchens. There isn't a lot of time to think about changes in operations and how to implement them. Packaging isn't high on most managers' priority lists. Many do not consider disposable food serviceware to be impacting their bottom line. But they are keenly aware of labor costs.

Many food businesses think switching to reusables will significantly increase labor costs, although the actual experiences of those that have made the switch, as described in the previous section, do not support this view.

RETHINKING IT.

Transitioning from single-use to reuse can save businesses money and provide a better experience for customers. With technical assistance and engagement, food-service businesses can make the transition and realize savings, and mentor and encourage others in the industry.

Throw-away is convenient

Throwing something away is easier than washing dishes or bringing a reusable cup or container with you. It's easier for a food vendor to buy a bunch of cups, stack them up, and hand them out. There's no need for questions like "for here, or to go?" and no need to train staff. Incorporating reusables into on-site dining operations and take-out services requires more logistics and continued employee training. Without training, staff may grab the disposable out of habit. Throw-away habits are part of our culture, and without retraining, disposables are often the default.

RETHINKING IT.

Many new reuse systems and third party reuse services are available to make it easier to offer take-out and delivery of prepared meals and beverages in reusables. These systems make it more convenient for customers by relieving the burden on them to bring their own cups or containers.

Health codes may need to change

In the food industry, state health codes set the standard for how to wash food serviceware and whether or not a customer's personal cup or container can be filled. The state codes, based on guidance from the federal Food and Drug Administration's Food Code, dictate the standards that food businesses must meet. The FDA maintains links to every state's health code.[1]

Many food businesses think switching to reusables will significantly increase labor costs, although the actual experiences of those that have made the switch do not support this view.

1 https://www.fda.gov/food/fda-food-code/state-retail-and-food-service-codes-and-regulations-state

The federal code allows refilling of customer's beverage cups and food containers according to certain specifications that prevent cross-contamination. Even though local health codes largely mimic the federal code, many businesses won't fill personal cups or containers, citing concerns about health code violations.

RETHINKING IT.

In California, the state retail food code permitted filling a customer's personal cup and also allowed filling a food container as long as it was done in a manner that avoided contamination. Not many people knew what that looked like. Some health inspectors told food businesses not to do it. In 2019, the state legislature enacted AB 619 (Chu) in order to remove the confusion and pave the way for reusable cup and container systems to thrive. Local activists and municipal partners should ensure that state health codes enable rather than hinder reusables.

COVID-19 has exacerbated the confusion over the safety of reusables, particularly BYO cups and containers. UPSTREAM's fact sheet on Reusables in Food Service During COVID-19 and other resources about the safety of reusables are available on the UPSTREAM website.

Concerns about product loss

Food businesses lose reusable utensils and even food containers and cups to customers inadvertently tossing them into the recycling or trash bin. They are also discarded by staff or stolen.

RETHINKING IT.

One solution that has been found to work by numerous restaurants working with *ReThink Disposable* program is to strategically place less demand on the customer to sort disposables from reusables. In some cases, product loss was avoided by moving the trash and recycle bins away from the dining area to the "back of the house" and installing customer self-bussing bins in the dining area. Customers place everything in the bus bin – the plates, cups, and utensils, along with food waste and trash. The staff sort everything and can increase collection of food waste for compost, collect recyclables, and solve the product loss problem.[153] Another effective option is to leave compost bins for customers to discard their food waste before placing their used dishes in the bus bin. In this case, clear signage that the bin is only for food waste is essential in the avoidance of product loss.

Meal delivery

The North American online food delivery market reached a value of $18.8 billion in 2018. Prior to coronavirus, the industry was projected to grow to $37.7 billion by 2024, with an annual growth rate of 12.3%.[154]

Increased demand for single-use food serviceware will follow this growth in the take-out food sector, unless convenient and functional systems for reusable food serviceware are developed to disrupt the trend. Bringing reusables into this space is challenging, especially with third party apps like GrubHub and UberEats, as they are not the ones preparing and packaging the food.

RETHINKING IT.

New companies are coming online to fill this need. Dispatch Goods, for example, delivers restaurant-prepared meals to customers in reusable stainless steel containers. There is ample opportunity in this space for disruption, since these platforms are "sticky"– once customers sign up, the vast majority (80% according to Mckinsey) stick with the same platform. With 82% of the meals ordered online going to the home (only 16% to the office),[155] drivers repeatedly go to customers' homes, creating an opportunity for pickup and redistribution of reusables.

Due to COVID-19, delivery of prepared meals is 300 times more popular than before the pandemic.[156] Third party apps and driver services typically charge restaurants commissions ranging from 10-25%. To survive, restaurants are having to rethink how they offer delivery to their customers. Some are offering delivery independently; big chains are partnering with third party apps and offering free delivery to customers; others are adding the cost of delivery into the meal cost.[157] Some entrepreneurs are turning these changes into opportunities for reuse systems. ♦

Delivery of prepared meals is 300 times more popular than before the pandemic.

Section 5:

The Entrepreneurs

Reuse systems led by innovators are showing the way forward

The number of innovative new companies jumping into the zero waste/reuse/circular economy sector is growing exponentially. An incredible array of innovations is making it easier than ever for cafes, restaurants, professional offices, temporary venues and events, and college campuses to bring reusables into food and beverage services. UPSTREAM's online directory of reuse service providers tracks these innovators. These are just a few of the models of reuse services that are available.

Reusable to-go cup services and incentives

The 80 billion single-use cups consumed in the U.S. per year are a significant source of litter – varying from #2 to #4 of the top 10 littered items in several studies.[158] Grabbing a coffee or boba-tea on the go doesn't have to involve a bunch of single-use packaging that carries not only the beverage but also a big environmental footprint.

Many new models for reusable cups on the go are being iterated in cities all across the globe.

The Lending Library

Companies that offer the "lending library" system provide an option that is free to the customer. No deposit is required. The retailer cafe or restaurant offers a cup provided by a third party service to customers, who borrow the cup and return it to a participating business. The costs are covered by the retail operator.

Vendors include CupClub in London, GO2CUP and Green Caffeen in Australia, or Vessel and Muuse in the U.S. – to name a few. In this model, the customer must download an app and provide credit card information. If the cup isn't returned within a specified period, the customer is charged for the cup.

The Deposit System

An alternative is the deposit system, in which the customer pays an upfront deposit that is refunded when the cup is returned. This option is offered by a number of companies like AgainAgain in New Zealand, ReCircle in several Swiss cities, Shrewsbury Cup in the UK, and RECUP in cities all over Germany. Two German cities started reusable cups programs on their own – the Hannoccino in Hannover and the Freiburg Cup in Freiburg. A Subscription Service.

Some systems offer a subscription service wherein customers pay by the month or the year for the service. USEFULL in Boston and Muuse in Singapore, San Francisco, and Hong Kong follow this model.

Discounts

Still other businesses offer a discount to customers who use a reusable. For many years, Starbucks, Seattle's Best, and Pete's have all offered a 10 cent discount to their customers who bring their own reusable cups, but most customers remain unaware of the incentive. Without promotion and customer education, these companies have never achieved much engagement. Only about two percent of Starbucks' beverages are sold to customers in reusables.[159]

For customers who forget to bring their own, they can still use a cafe-provided reusable and receive a discount at the British Costa coffee chain. All 3,800 locations offer a 25p discount to customers who take-out using the Costa "Clever Cup."

Cafes that won't serve customers in disposables (even for take-out)

Perhaps the most exciting stories are coming from chains that decided they will no longer provide disposables to their customers.

The Boston Tea Party coffee chain in London no longer offers a disposable cup in their 22 cafes. Customers must borrow one from the cafe or bring their own reusable. In December 2019, Blue Bottle coffee company announced it was going to test this model at two of its San Francisco cafes. The Waitrose grocery store chain in London stopped providing disposable cups to customers for coffee service at all 180 of their in-store cafes. Instead, customers have to bring their own, borrow one, or sit down and drink from a real cup. Perch Cafe in Berkeley, CA and follows this model as well.

Reusable take-out container services

New companies are also tackling the take-out food dilemma. Most are providing a similar polypropylene clamshell, like Durham Green-to-Go, Sparkle SF, and GoBox, which all rely on customer subscriptions in the U.S.

EcoBox in Luxembourg Germany uses a plastic container with stainless steel cutlery to go. The service is free to the customer, while the business provides the box. Dishcraft – a robotic dishwashing service – is currently expanding to provide a similar service with pilots in the San Francisco Bay Area. Similarly, Tiffin and Dispatch Goods use stainless steel containers, and their services are offered by the business free to the customer. Just Salad offers a reusable bowl for $1 and incentive of a free topping every time a customer reuses the bowl.

Reuse at events

It's getting easier to hold true zero waste events with all the companies that provide reusable cups and wash them. One popular model involves the customer paying a deposit on a venue cup, with the option to keep the cup as a souvenir or return it on-site. This service is provided by Enviro-cups and Green Goblet in the UK; Globelet in New Zealand, Australia, and the U.S.; and r.Cup in the UK and the U.S.

Meal and grocery delivery

A number of meal delivery services have moved to providing meals in tiffins. Dabba Drop in the UK, Dabbawala in Mumbai, and Planted Table and Green Tiffin in San Francisco are examples of this service. The meal delivery app Doordash is teaming up with Dispatch Goods to offer the first ever restaurant food delivery option in the U.S. in reusable containers. Meanwhile, Loop in parts of the U.S., U.K., and coming to Canada, Germany and Japan, delivers groceries in reusable containers.

Vending and bulk systems

My Fresh Bowl offers the world's first throw-away free vending machine. Fresh bowls are served in reusable glass jars at WeWorks in NYC with a $2 deposit.

There are also reverse vending machines for the distribution and return of reusable containers. These include the Tomra system for bottles and the OZZI system, popular on college campuses, for collecting cups and containers.

In the category of bulk dispensing, BeUnpackaged offers refill systems to retail stores. This system covers all the steps in the process – tare, fill, weigh, label, and pay steps. Goods Holding Company offers a simple reusable glass and metal jar system for bulk bin shopping. With the tare weight printed right on the jar, customers can take their filled jar up to the cashier without pre-weighing. Miwa offers a smart system for bulk shopping – a circular system of reusable capsules that fit the logistics and hygienic standards of supermarket chains.

For beverage dispensing, Econysia is a system offering water filters and reusable bottles for hotels and businesses. Bevi is a customized beverage dispenser system for offices that offers sparkling, pure, and flavored water. ♦

For a complete list of reusable service innovators, check out the UPSTREAM library of reuse systems.

Section 6:

Wrapping it up

Technicians evaluating LCAs to determine which single-use food serviceware products are best for the environment have concluded that there are no universal answers, except that reusable is better (if the product is reused enough times). Reducing the amount of single-use products consumed, whether they are made from fossil fuels or plants, always has greater environmental benefits.[160]

Moving forward, the priority must be to reduce single-use food serviceware to the greatest extent possible. Then, in choosing which disposables to use, the focus should be on the realities of the local waste management system.

It is therefore imperative to understand what actually gets composted or recycled (as opposed to what is collected) in the local waste management system. Simply specifying recyclable or compostable is unlikely to provide any environmental benefits. Recycled content can be a good specification, but for concerns about toxicity.

These understandings must be a part of the policies enacted in the U.S. and around the globe. Too many jurisdictions are banning single-use plastics without considering the consequences of the replacements. UPSTREAM has been a leader in designing policies that promote reduce and reuse specifically for food service in the U.S.

We are designing policy models in partnership with community partners across the country that address the plastic pollution problem by reducing all single-use food serviceware. To help get these policies enacted, we've helped to launch reuse coalitions[1] across the country – in San Francisco, Los Angeles, New York, Boston, greater New England – that engage activists and government staff in working to end our throw-away culture. And our national Reuse Networks for government and activists are creative laboratories for policy and business innovation in this space.

Reducing the amount of single-use products consumed, whether they are made from fossil fuels or plants, always has greater environmental benefits.

The bottom line is that reusable food serviceware helps reduce the plastic and climate impacts of serving prepared food to customers and saves businesses money. It's a win-win.

And it's not just a hypothetical vision for the future. All over the world, people are working to change the throw-away system by innovating new ways to bring durable, reusable, and refillable products into food service.

This is a growing industry that is building a new economy around reusables in food service. The number of jobs available as these businesses expand will grow. There is much to be learned from observing how these various models and systems perform. As they iterate, we will see which models are the most successful.

Key questions will be answered over time. Will the subscription services succeed? Will customers accept reusable cups and containers as a replacement for single-use plastics? Which reusable materials will last longest and provide the most customer satisfaction?

But one question is already answered. Does reuse make sense? The answer is absolutely YES. Reuse is better for the planet, better for the business bottom line, and a more enjoyable way to enjoy prepared meals and beverages. ♦

1 https://upstreamsolutions.org/community-coalitions

Photo courtesy of SF Cup

The bottom line is that reusable food serviceware helps reduce the plastic and climate impacts of serving prepared food to customers and saves businesses money. It's a win-win.

Appendix A:
Foodware product summary and abbreviations

Foodware Product Summary

Product	Paper & Paperboard	Fiber-based	Plastic	BioPlastic	Reusables
Source Materials	Trees, recycled paper	Molded pulp (trees bagasse, other plant waste)	PETE, PP, PS, EPS	PLA, PHA	Ceramic, stainless steel, shatterproof glass, plastic
Uses	Cups, plates, liners, boxes	To-go clamshell containers, plates, bowls, trays	All types of disposable foodware	Cups, lids, utensils, straws, to-go clamshell containers	Dining on-site, take-out cups & food containers
Challenges	Can contaminate compost – not accepted by all compost facilities.	Can contaminate compost – not accepted by many compost facilities.	Most too contaminated or not designed to be recycled; when littered, doesn't biodegrade.	Not accepted by most commercial composters. Degrades in lab setting but not in real world.	Upfront purchasing costs. Dishwashing (generally a perceived rather than true challenge).

Abbreviations

PE: Polyethylene

PET or PETE: Polyethylene Terephthalate

PS: Polystyrene

PC: Polycarbonate

PP: Polypropylene

PLA: Polylactic Acid

Appendix B: How to define reusable

Reusable is defined in the Merriam-Webster dictionary as "capable of being used again or repeatedly." Without a numeric standard, however, any manufacturer of a throw-away or disposable product could claim that their product is "capable of being used again or repeatedly." One *can* use a plastic cup, plastic water bottle, paper bag, or a paper cup or bag more than once.

California's plastic bag recycling law – AB 2449 – created criteria for reusable bags providing a numeric standard which has been adopted by many plastic bag laws in the U.S., including California's plastic bag ban, SB 270. These policies state that reusable plastic bags must be capable of carrying 22 pounds over a distance of 175 feet for a minimum of 125 uses. It must also be at least 2.25 mils thick. Fabric bags must meet similar numeric standards. Subsequently, communities that have adopted plastic bag bans now see plastic film bags labeled "reusable" littering their streets – even bags that people paid 10 cents for. Whereas, fabric and woven polypropylene bags are not commonly littered.

So the real question is not the number of uses that a product is designed for, but rather how will consumers treat the product? Will consumers treat products as reusable when they are made from materials that people generally consider to be disposable, such as paper and film plastic? The question of consumer perception has yet to be studied.

In the absence of such studies, numeric specifications are helpful for creating a shared industry standard – one that regulators can enforce. For food serviceware (cups, utensils, clamshells), numerical standards for reuse do not exist. However, currently, the second draft of regulations under SB 1335, the Sustainable Packaging Act for the state of California, would create the first known standard as follows:

- maintains its shape, structure, and function after 750 cycles in a cleaning and sanitizing process...as demonstrated by a third party certification, or
- the manufacturer of the food service packaging item provides an express warranty that the food service packaging item can be reused for its intended purpose for a minimum of one year, or the manufacturer will take back and replace the item at the manufacturer's expense.[161]

Many plastic reusable cups will meet the 125 use standard. Typically, ceramic, glass, and stainless steel are designed for thousands of uses. While a ceramic cup is designed for 3,000 uses,[162] LCAs generally assume 1,000 uses for durable products like glass, ceramic, and stainless steel.[163] Stainless steel is assumed to be durable enough to last a lifetime[164] or at least 15 years in the case of household appliances and metal goods.[165] Glassware can also last a lifetime, although it is typically highly breakable. Shatterproof and break-resistant forms of glassware include tempered, annealed, and titanium-infused glass.[166] Woods and Bakshi (2013) and others have selected 500 uses as a description of "true usage" for a reusable cup, suggesting that loss, breakage, and products falling out of favor with a consumer serve to lower the actual usage.

Appendix C:
A review of LCAs that compare disposable to reusable food serviceware

This summary of LCAs focuses entirely on LCAs that compare disposable to reusable food serviceware products that UPSTREAM identified through an extensive literature search. LCAs conducted prior to 2000 have not been included due to the age of the data. Two studies that are highly cited, Hocking (1994) and TNO (2007) were not included because assumptions of cup (8 oz. or less) do not jibe with actual portion size in the U.S. (around 16 oz). Furthermore, these studies are outdated in terms of evaluation of assumptions of power generation sources, and suffer from other criticisms cited in Woods and Bakshi (2014).

ProMo: Dishes and Cups, 2015[167]

The study was carried out by ProMo, an industry trade group for the disposable plastic tableware production sector in Italy that represents about 80% of that sector. The study evaluated disposable dishes made from polypropylene (PP), polystyrene (PS), polylactic acid (PLA), cellulose pulp, and reusable porcelain dishes; and disposable drinking cups made of PP, PS, PLA, polyethylene (PE) laminated cardboard, and reusable glass cups. Overall it found that reusable glass and ceramic tableware has by far the lowest environmental impact by any environmental measure considered. Whereas, among disposable options, PP and PS options have lower impact than PLA and cellulose pulp.

The study evaluated impacts of 1,000 of each type of disposable product compared to a reusable product used 1,000 times. The study used two different LCA methodologies, each with differing types of environmental impact categories. The first, CML-IA baseline, is limited to 4 impact categories: Global Warming Potential (GWP), photochemical oxidation, acidification, and eutrophication. Each impact was considered using a different end of life scenario – recycle, incineration, or landfill. The results showed that for every environmental impact, under every end of life scenario, the reusable product had much lower impact, with the exception of water resource depletion, where the reusable had a marginally higher impact than cellulose, PS and PP, but much lower impact than PLA. The efficiency level of the dishwashing assumption was not reported, making it difficult to determine the accuracy of this impact level.

Alliance for Environmental Innovation, The Starbucks Study: Cups, 2000[168]

A life cycle analysis was performed for Starbucks focusing on ceramic, paper, glass, and polyethylene terephthalate (PET) plastic cups, from production, to use, to end of life. When looking at energy use, water pollution, air pollution, and waste, they concluded that using a ceramic cup as little as 70 times and a glass cup as little as 36 times lead to environmentally superior outcomes compared to disposable cups. As reusable cups are intended to last 3,000 uses, the environmental benefits increase with every use.

Bramberg: Cups, 2011[169]

The goal of this study for the Royal Institute of Technology was to determine if a disposable paper cup or a ceramic cup is the most environmentally sound option for serving coffee. The functional unit was 2070 servings of coffee. The focus was on evaluating impacts through the complete life cycle of the cups, from material extraction to waste management. The study showed that a ceramic cup is the most environmentally sound option as long as it is used more than ten times. The ceramic cup has the largest impact in its use phase. For the paper cup, the production stage is most significant.

CIRAIG for Recy-Quebec: Cups, 2015[170]

This study compared the potential environmental impacts of a 16-ounce, single-use coffee cup made of a mix of cardboard and polyethylene (with a lid made of polystyrene) to those of a 16-ounce, reusable ceramic cup and to those of a variety of 16-ounce travelers' mugs made of stainless steel, polypropylene, and polycarbonate. Over a one-year span (using one cup a day), the reusable cups were associated with fewer greenhouse gas (GHG) emissions than the single-use cups and were better in the human-health category for toxic emissions, smog, and ozone depletion. But washing reusables by hand with hot water and soap dramatically increases the ecosystem impacts. CIRAIG advises limiting the

amount of hot water and soap and using durable cups for several years.

Garrido and Castillo: Cups, 2007[171]

This study compared single-use versus reusable PP cups for serving 1,000 liters of beer during a major event in Barcelona in 2004. The study concluded that the reusable cup needed to be used a minimum of ten times before its impact was smaller than the same number of disposable cups. As the number of uses of the reusable cup increases, the environmental benefits increase.

Martin, Bunse, Ciroth: Cups, 2018[172]

Comparing a ceramic mug and a ceramic cup with and without a lid, washed by hand and washed by dishwasher, to a paper cup with and without a polystyrene lid through production, use and disposal phases, based on 750 disposable cups and one reusable one – this study found that the ceramic mug and ceramic cup had the best outcomes in 14 impact categories (out of 15) when using a dishwasher. The hand-washed option is never the most environmentally friendly choice, and washing a lid by hand had the worst impacts in every category. Because the mug has no lid, and therefore reduced impacts from lid washing, it is a better choice than the reusable cup with lid. The paper cup was the best choice in one impact category (freshwater eutrophication). However, when the option of washing in cold water was added, the ceramic mug was the best in every impact category, because electricity associated with ware-washing is the biggest factor impacting the environmental impact.

Potting and van der Harst: Cups, 2015[173]

This study involved a comparison of PS cups disposed of via incineration and reusable ceramics also incinerated at end of life. The authors assumed that they should compare both cups based on the same number of uses – in this case, they evaluated the disposable versus reusable after one use and two uses each. They seem to think it a more justified comparison to compare washing and reusing a disposable cup as many times as the reusable cup is washed and reused, even though this does not mimic the realities of how people use disposable cups. Essentially, this assumption wiped out the typical environmental benefits of reusable cups, e.g., that they are usually used hundreds if not thousands of times in the real world. Even with this flawed assumption, the results indicated that reusable cups perform better than disposable PS in four out of seven impact categories when used only one time before washing (when machine-washed). When used twice, the reusable cups out-performed the disposable cups in all categories except ozone depletion for both types of washing.

Pladerer, C. et al: Cups, 2008[174]

This study evaluated PET, PS, PLA, and paperboard cups versus reusable PP cups at three-month long soccer tournaments and a nine-month long domestic league soccer season. Results favored the reusable cups even when soccer fans took the reusable cups home with them. The study assumed the end-of-life scenarios common in the countries where these soccer events took place: Switzerland, Austria and Germany.

The results indicated that all reusable cup scenarios had lower environmental impacts compared to all the disposable cups examined. The best scenario for reusable cups were the unbranded cups, which showed a higher number of reuses. The best disposable cup scenario has twice as many environmental burden points as the worst reusable cup scenario. The study found that compostable cups made of PLA did not result in any reduced environmental burden because composting this type of plastic does not render any tangible ecological benefit.

Vercalsteren, An. et al: Cups, 2006[175]

This study compared a reusable polycarbonate cup (PC), with three single use cups – PP, polyethylene-coated cardboard (LC) and PLA – used in small indoor and large outdoor events. The life cycle of the reusable cup was studied at 20 and 45 uses, disposable cups were studied at a single use. The study found that none of the cups had consistently the lowest or the highest environmental score. Various cups were distinguished for specifically high impacts in different categories. The study then used the Eco-indicator 99 method to create one indicator for all the environmental impacts. The study concludes that in the single indicator the reusable PC cup system has the most favourable score, even at the lower boundary of 20 uses.

Woods and Bakshi: Cups, 2014[176]

Intended to provide a comprehensive and current study for U.S. consumers as to whether disposable or reusable cups are the most environmentally conscious choice, this study concluded that the results almost entirely favor reusable cups. This study compared 16 oz. PE lined paper cups and EPS cups with glass, ceramic, and varying plastic blends for reusable cups. The study assumed reusable cups would be used 500 times; that waste disposal would be 11.7% via incineration and the rest landfill for disposables; and that all reusables would be landfilled at end of life (these figures are based on EPA 2009 Municipal Solid Waste information).

Key findings of the study point to the superiority of reusable cups in regard to climate change impact in most regions of the U.S. The authors point out that earlier studies, such as Hocking, relied on an 8 oz. cup size, which is no longer the U.S. norm, and fail to account for increases in dishwasher energy and water efficiency. They found that most U.S. consumers live in areas where electricity sources result in lower GHG emissions for ceramic cups compared with single-use cups.

Broca: Plates, 2008[177]

This investigation compared the use of ceramic versus Polylactic Acid (PLA) plates – i.e. plates made from corn – for Yale University campus dining. It found that ceramic plates became environmentally preferable after 50 uses, when compared to an equal number of disposable plates. Study assumed ceramic plates get landfilled and PLA goes to incineration because no composting facility was available.

Copeland: Clamshells, 2013[178]

This study compared disposable foam clamshells with reusable polypropylene plastic clamshells and found that just 30 reuses lead to environmental benefits in terms of energy consumption for the reusable option. When looking at GHG emissions, the quantity is half that: only 15 uses render reusable environmentally superior.

Harnoto: Clamshells, 2013[179]

Harnoto compared bagasse-based[180] compostable clamshells to reusable PP clamshells used for take-out. The study evaluated the number of reuses of PP before deterioration (43 as determined by testing at a pilot site) versus the manufacturer claim of 350 uses. The PP clamshells performed better for global warming potential, energy consumption and material waste, while the compostable versions performed better for water consumption. The study found that after 14 uses, the reusable clamshell would have lower GHG emissions, energy, and material waste othan the compostable takeout clamshells.

Gallego-Schmid et al: Containers, 2019[181]

This study compared the life cycle impacts of aluminum, PP, and EPS single-use containers compared to reusable polypropylene containers. It concludes that single-use PP containers are the worst option for seven out of 12 impacts considered. They are followed by aluminum, the alternative with five of the highest impacts, including depletion of the ozone layer and human toxicity. Overall, EPS had the lowest impacts due to lower materials and electricity requirements. They are also the best option when compared to reused PP containers unless the reuse PP are reused 3-39 times. These reusable “Tupperware®” containers are generally reused between 16-208 times. The authors acknowledge that EPS and the other disposables aren’t usually recycled, and that EPS containers cause other environmental impacts that are not assessed through LCA, such as litter and marine ecosystem impacts.

Franklin Associates for School Nutrition Foundation: Trays, 2009[182]

The goal of the study was to develop environmental and cost profiles for the production, use and end-of-life management of disposable and reusable ware used in school cafeterias in order to inform school nutrition programs about the best options. Key findings from the study showed that reusable compartment trays had a lower environmental impact and were less expensive when compared to disposable serviceware options (i.e., a disposable compartmentalized plate carried on a reusable tray and disposable bowls/plate carried on a reusable tray). Reusable compartment trays had the lowest impacts in terms of energy, solid waste and greenhouse gases, and they were the least expensive. The type of dishwasher used had a significant impact. Newer high-efficiency dishwashers reduced water and energy consumption by nearly half, resulting in substantial reductions of environmental impacts.♦

Appendix D:
LCA summary of cups and climate impact details

The 2000 Starbucks study assumed that each paper cup lined with PE plus the paper sleeve is responsible for 0.11 kgs or 0.24 lbs. of CO_2 emissions. They showed that replacing a 16 oz paper cup lined with PET plus paper sleeve with a 16 oz. ceramic cup results in noticeable GHG emissions reductions: 226 lbs. annually at a usage rate of 2 cups per hour and up to 1,130 lbs annually at a rate of 10 cups per hour of operation.

According to Hakkinen, for a paper cup lined with PLA, the GWP is 4830 kg CO_2e per 100,000 cups, or .048 kg per cup. A PET cup is nearly equivalent in GWP to a paper cup with PLA liner at 0.047 kg CO_2e, when landfilled (they assume methane collection occurs at landfill). The Starbucks study cup was associated with nearly twice as much CO_2 emissions, but that included the paper sleeve.

CIRAIG Quebec (2014) compared the potential environmental impacts of a 16 oz. single-use paper hot cup made with PE liner, a paper cup lined with PLA, and an EPS cup, which were landfilled, to a 16 oz. reusable ceramic cup and a variety of 16-oz. travelers' mugs made of stainless steel with PP lid, and PC. Over a one-year span (using one cup a day), the reusable cups were associated with fewer greenhouse gas (GHG) emissions than their single-use counterparts. They also scored better in the human-health category for things such as toxic emissions, smog, and ozone depletion. They also tended to use fewer minerals and fossil fuels than disposable cups did.

The 500 paper cups accounted for 26kgs of CO_2e, or 0.052kg/cup. A ceramic cup (used 500 times and washed in a commercial dishwasher after each use) has a 5 kg CO_2e footprint (or 0.01 kg. of CO_2e per use), and a stainless steel travel mug with polypropylene lid (used 500 times and washed by hand using 3 litres of cold water with 2 grams of soap per cup) is associated with 6 kg of CO_2e (0.01 kg. of CO_2e per use). Whereas 365 compostable cups have nearly 20 kg CO_2e (0.05 kg of CO_2e) and 365 expanded polystyrene cups represent 18 kg CO_2e (0.05 kg of CO_2e).

Pro.mo found the GWP of reusable glass cups is significantly lower than any of the disposable alternatives. Comparing the kg CO_2e impact of 1,000 disposable cups to a reusable glass cup used 1,000 times, PLA is the worst of the disposable options and laminated cardboard is best. The GWP of each is:

- PP: 0.025
- PS: 0.033
- PLA: 0.037
- Laminated cardboard: 0.017
- Glass: 0.008

Martin et al (2018) evaluated the impacts of 750 uses of a 10 oz ceramic mug, a ceramic cup with plastic lid, and a paper cup with PE lining and PS lid. The climate impacts were as follows:

- mug washed by hand = 3.66 kg CO_2e (0.005 per use)
- mug washed by dishwasher = 1.10 kg CO_2e (0.001 per use)
- lid washed by hand = 5.31 kg CO_2e (0.007 per use)
- lid washed by dishwasher = 1.32 kg CO_2e (0.002 per use)
- Paper cup = 3.97 kg CO_2e (0.005 per use)

This study found that the ceramic mug washed by hand, when the lid is added, is the worst choice. Whereas, when washed in the dishwasher, it's a better choice than the paper alternative.

Summarizing the findings for the GWP impacts of single-use vs. reusable cups, the compostable formats, or paper with added bioplastic, are worse than PP, PET, and PS plastics. All of the reusables are better in terms of GWP than the single-use options, except that laminated paper comes close to reusable. Glass appears to be the clear winner, followed by ceramic and stainless steel.

CO_2 Emissions Per Cup When Landfilled

	Type of Cup	Kg CO_2e	Size of Cup	Study
Disposable	Paper with PE liner & paper sleeve	0.11	16 oz	Starbucks
	Paper lined with PLA	0.048	16 oz	Hakkinen
	PET	0.047	16 oz	Hakkinen
	Paper with PE liner & PS lid	0.052	16 oz	CIRAIG
	Compostable	0.05	16 oz	CIRAIG
	EPS	0.05	16 oz	CIRAIG
	PP	0.025	N/A	Pro.mo
	PS	0.033	N/A	Pro.mo
	PLA	0.037	N/A	Pro.mo
	Laminated Cardboard	0.017	N/A	Pro.mo
Reusable	Ceramic	0.01	16 oz	CIRAIG
	Stainless steel with PP lid	0.01	16 oz	CIRAIG
	Glass	0.008	N/A	Pro.mo

Endnotes

1 Rich Grousset, Senior Vice President, Re:Dish- based on calculations using data from "Overbrook Foundation: The Dirty Truth About Disposable Foodware" and The Freedonia Group (https://www.freedoniagroup.com/Food-Service-Single-Use.html)

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3 Rich Grousset, Senior Vice President, Re:Dish – updated calculations used in "Overbrook Foundation: The Dirty Truth About Disposable Foodware," but updated to reflect increased product pricing (based on growth rates provided by the Freedonia Group report) and and the $24 billion in sales projected by Freedonia Group.

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