Google

A Circular Google

A circular Google in a sustainable world

At Google, we believe that the path to a cleaner, healthier future begins with the small decisions we make each day. That's why we're committed to building sustainability into everything we do, making smart use of the earth's resources, and creating products with people and the planet in mind. We constantly look for ways to have a positive environmental impact and be even more responsible in our use of energy, water, and other natural resources—and we want to empower others to do the same. Operating our business in an environmentally sustainable way has always been a core value. We think there's a lot to be proud of—but there's also a lot more important work to do. We remain more committed than ever to the environment and will continue working hard for a cleaner, and a better future for the generations to come.

We also recognize that realizing a sustainable world means that we must accelerate the transition to a circular economy. We must become a circular Google. Our circular Google strategy is part of our wider effort to build sustainability into everything we do. The work behind our circularity strategy largely sits within our vision for a carbon-free and circular world, but by its very nature, draws from and contributes to other aspects of our sustainability strategy. Through our products and services, we can increase access to information and empower Google users with technology that can help reduce their environmental impact. There is also a clear link between transitioning to a circular Google and how it can benefit people and places where we operate by regenerating the natural systems we rely upon.

We need to disrupt the waste economy

People love stuff. This truism was proven during the 20th Century, as global raw material use rose at twice the rate of our population growth.[1] By 2018, humanity's consumption of resources such as metals, timber and even land would require 1.7 planet Earths to sustain.[2]

Is our demand for 'stuff' inherently unsustainable, or is the real problem with how we take, make, and waste it? To answer the question, we need to understand how we got here.

Since the Industrial Revolution, the preeminent economic model has been based upon taking a natural resource, making a product from it or burning it for fuel, and then sending what remains to landfill (or discarding it into nature) as waste.

The value generated by this system contributed to social development and helped raise livelihoods and quality of life for billions, reducing the percentage of people living in extreme poverty (defined by the World Bank as earning less than US$1.9 a day) from around 40% to just 10% of the world's population today. [3] For many people, the linear system has delivered progress.

But, for generations, the damaging environmental consequences of that model were relatively invisible, perhaps because the sheer scale of our resource economy is almost unimaginable; billions of tons of material, from plastic straws to blocks of concrete, bales of wheat to sheets of metal, all constantly being taken, made, moved around, built with, used up, and disposed of, all across the world. This great procession of material passes through our lives at an astonishing rate and we now know it's polluting our oceans, creating mountains of trash pushing against city boundaries, and fueling the climate crisis because of the energy demand to produce and move all that stuff. The unsustainable impacts have now become all too evident.

The circular economy concept provides a model of change and renewal that intends to improve this relationship between consumption of materials and the impacts on human and environmental systems. Circularity offers both a set of scientific principles and a mindset to problem-solving. Achieving circularity challenges how we design products, buildings, and infrastructure. When we consider that it has been estimated that transitioning to a circular economy could generate US$4.5 trillion in new economic output by 2030,[4] we're inspired to imagine the abundance and progress that can be achieved while significantly improving human and environmental systems for all.

But the challenges to making that vision a reality are as daunting as they are exciting. The human behavior change, infrastructure transformation, and technological invention required are far from simple. Reaching true circularity demands that we redefine value, processes, choices, assumptions, and industrial protocols that have been standard practice across our economy for decades. At Google, we have a role to play in all these crucial transitions, and this

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1 Elmau Schloss, Annex to the G-7 Leaders' Declaration National Archives and Records Administration, June 8, 2015, Accessed June 12, 2019, https://obamawhitehouse.archives.gov/the-press-office/2015/06/08/annex-g-7-leaders-declaration

2 Press Release July 2018 English, Earth Overshoot Day, July 23, 2018. Accessed June 12, 2019, https://www.overshootday.org/newsroom/press-release-july-2018-english/

3 Horra, Luis Pablo De La, Everything You Need to Know about Global Poverty, FEE Freeman Article, April 04, 2017, Accessed June 12, 2019, https://fee.org/articles/everything-you-need-to-know-about-global-poverty/

4 Waste to Wealth: Creating Advantage in a Circular Economy, Accenture, Accessed June 12, 2019, https://www.accenture.com/t00010101T000000Z__w__/ao-pt/_acnmedia/PDF-19/Accenture-Waste-Wealth-Transcript.pdf

strategy has been produced to guide our actions and decisions going forward.

As we considered the complexity of the challenge ahead, an intriguing insight emerged, one where we could play a pivotal role.

An element of reaching a fully circular economy requires identifying, tracking, and managing the overwhelming and globe-spanning swirl of materials. Thankfully, technological developments in the 21st Century suggest a way to do so: To see stuff as information. Rather than wheat bales and metal slabs, instead consider trillions of 'bits' of data racing across the planet, often inefficiently, often wasted, and with most of the opportunities to reduce, reuse, and share missed. If we regard our material economy in information terms–then we realize that our resource and waste challenge is, partly, a data problem. There are industries seeking the very resources that other industries treat as waste, and we could better connect them through data.

Considering the circular economy as an information challenge is inspiring for us at Google. It suggests that we can leverage our scale, resources, and technological expertise to help the world meet resource needs. Data-driven circularity could accelerate innovation and growth, while at the same time reducing greenhouse gas emissions (GHG), and the extraction of raw materials. All while generating environmental, economic, and community value. This insight that we can approach waste as data is one we intend to test.

However, we're starting with our own direct impact. So, across Google, we've begun applying circular economy thinking to design out waste, keep the products and materials in use, and utilize safe and healthy materials. We strive to embed these principles of circularity into the fabric of our infrastructure, operations, and products: From how we build and manage servers in our data centers, to how we design consumer electronics, and how we select the materials we use to build and furnish our offices. As we deploy artificial intelligence and machine learning, we can test our hypothesis that one of the key challenges with waste is poorly managed data and share our discoveries with others.

Google was built to solve information problems, and the circular economy may be one of our most exciting challenges yet.

Setting a new direction

Our vision is simple: We want a circular Google within a sustainable world.

Achieving that outcome will be far harder than saying it. This vision asks us to challenge learned behaviors and traditional processes. It will take time, planning, and specific definitions of what we intend to do.

So, our new approach for Google starts with a clear mission**: To accelerate the transition to a circular economy in which business creates environmental, economic, and community value through the maximum reuse of finite resources.**

Within this mission we define 'maximize reuse' as the implementation, to the fullest extent possible, of our circular principles. We do so for each finite resource and the systems those resources are connected to.

The inclusion of 'value' is also central to our approach. Because the paradigm shift from an extractive and linear economic model to one that is regenerative and circular, must deliver a net benefit for all.

How do we get there?

Our circular principles are the heart of our approach, inspired by the breakthrough work of our partners at the Ellen MacArthur Foundation, and adapted for Google's specific impact and opportunity. The principles are designed to drive consistency and replicability across our business:

1. **Design out waste and pollution**
   Circularity must be incorporated into design from inception, so things created today can become the resources of tomorrow. Design must also eliminate the negative impacts of economic activity that could cause damage to human health and natural systems. This includes factors such as the release of greenhouse gases, the use of toxic and hazardous substances, the pollution of air, land, and water, and landfilling and incineration of waste.

2. **Keep products and materials in use**
   Producing materials requires the use of resources, but how those materials are used can have dramatically different impacts. So, the effective use of each resource must be extended, for as long as practical, while balancing safety and quality. Maximizing product use and reuse helps to preserve embedded energy, labor, and materials, and reduces environmental impact. Examples include: designing for durability, repair, reuse, remanufacturing, and ultimately recycling. For biological materials, this could mean cascaded use of by-products, before nutrients are returned to the biosphere.

3. **Promote healthy materials and safe chemistry**
   A circular economy requires us to not only focus on the flows of materials through our business, but also to ensure safe and healthy use, reuse, and recycling of resources. To keep materials flowing in commerce longer, we must design them to be safe for human and environmental systems, because we can't change the chemistry of products once we put them out in the world.

Principles are important, as it's impossible to write a rule or target for every possible decision. For Google, these principles will guide our choices going forward and help resolve any competing requirements. They won't always be easy to follow, and education, debate, and iteration will be needed to fully embed them in how we do things.

Starting the journey to a circular Google

Throughout Google, we've begun applying our principles to our actions. This really is the start, but our efforts to date have set us on the right path. There are five key areas where we are already seeing early signs of what's possible:

1. **Data centers**

   Google's data centers are fundamental to our company, powering products like Search, Gmail, and YouTube for billions of people around the world, 24/7. We own and operate 14 data centers on four continents, and we continue to add new sites to serve our growing community of users.

- **Zero-waste data centers:** Designing out waste in our server management has long been a Google priority. By 2017, 18% of Google's newly deployed servers were remanufactured machines, and 11% of the components used for machine upgrades were refurbished inventory. When we can't find a new use for our equipment, we completely erase any components that store data and then resell them. In 2017, we resold over 2.1 million units into the secondary market for reuse by other organizations.

  We're committed to achieving zero waste to landfill for our global data center operations by reducing the amount of waste we generate and finding better disposal options. In 2017, we diverted 91% of waste from our global data center operations away from landfills. Our data center in Mayes County, Oklahoma has proven that zero waste to landfill is possible.

2. **Workplaces**

   At Google, just as we focus on people when it comes to designing our products, we also focus on people when creating healthy and sustainable workplaces—from our San Francisco Bay Area headquarters to our offices in more than 160 cities around the world. For example, we've implemented strategies to minimize contamination in our office waste streams and have identified diversion pathways that keep the waste we do generate out of landfills. In 2017, we reached 78% landfill diversion for our offices globally and reduced landfill waste per Googler by 4% at our Bay Area headquarters.

   Also, our Healthy Materials Program, launched in 2012, leverages Google's purchasing power in the market to create a demand signal for healthier building products. Healthy materials are products that eliminate harmful chemicals and are optimized for human and environmental health. In the context of materials staying in the value chain, material health and safe chemistry provide a foundation for the transition to safe and circular. To date the healthy materials program has been deployed on over 28 million square feet of office space.

- **Reducing building waste through constructions and deconstruction:** We're designing our ground-up campus projects with circularity principles in mind. Our Bay View project will have the largest geo-energy system in North America that allows us to recover waste heat from the building and store it in the ground below, to be used for space heating without fossil fuel use.

  Google has also been implementing interior 'salvage and reuse' at the interior building scale since 2012. We've saved valuable doors, cabinetry, carpet tile, ceiling tile, and plumbing fixtures and ensured that these materials had a second life with nonprofits. Continuous salvage and reuse keep products and materials in use and also meets the increased landfill diversion requirements from Leadership in Energy and Environmental Design (LEED), Living Building Challenge, and our local jurisdictions. It's also an opportunity to reduce the life-cycle and embodied carbon of new buildings and to provide a benefit to communities in need.

  In 2018, we started to explore structural deconstruction of our existing buildings and we're now partnering with the Ellen MacArthur Foundation to investigate the triple bottom line benefits of deconstruction.

- **Reducing food waste**: Our cafés and Food Spots also offer nutritious, responsibly sourced meals, snacks, and beverages without the waste. We compost or donate leftover food wherever we're legally able to do so, but we've learned that the best way to reduce food waste is to prevent it in the first place by tracking data, and using it to make adjustments. Using Leanpath technology in 197 kitchens in 22 countries, we've prevented over six million pounds of food from ending up in landfill since 2014.

- **Reducing inorganic waste:** Our food program is focused on reducing single-use beverages and we've relied on behavior science insights to raise the desirability of sustainable and healthy options, such as spa water and filtration stations with reusable glasses. Culture change also matters and we've encouraged employees to visibly keep their own reusable bottle (and coffee mug) at their desks.

3. **Consumer electronics**

   Google has made it a company-level goal to increase the sustainability and circularity of our consumer electronic products, operations, and communities. Our suite of Google-branded hardware includes a wide range of products like Google Pixel 3a, Nest Learning Thermostat, and Google Home. Google products can be found in millions of homes around the world, and therefore, is a priority area for our circularity efforts.

- **Consumer electronics and circular design:** We think it's critical to create demand for recycled materials in order to accelerate the transition to a circular economy.

  To date, we've shipped millions of consumer electronics made with post-consumer recycled plastic. Products like the Nest Thermostat E, Google Home, and Chromecast all contain parts with 20%–75% post-consumer recycled plastic content. We're fascinated by the potential of new sustainable materials and will continue to offer products that utilize them.

  For the circular economy to be trusted, it must be based on safer chemistry, so in 2018, we published our Restricted Substances Specification to ensure the use of safer materials across our product portfolio.

4. **Enabling others**

   While we work to build a circular Google, we're also working to provide tools to help the billions of people worldwide who use our products every day. Our new digital tool Your Plan, Your Planet walks users through interactive scenarios to showcase everyday examples of how small changes can make a big difference. The tool enables individuals to make their own pledges to support a circular economy. We will review the reach and impact of this work as we design new circularity solutions for our users.

   Google also works with over 1,000 trusted suppliers worldwide to manufacture hardware components for our data centers and consumer electronics, and to provide many other products and services. These partnerships matter and they're a priority for activating our circularity principles. This builds on our existing commitments to ethical and fair treatment for workers, safe and healthy workplaces, and a smaller environmental footprint. Across our supply chain we've been designing in circularity.

Our theory of change

As we've worked on embedding circularity into Google, we've recognized challenges within the wider systems of which we are a part. We've identified three systemic barriers to circularity and the role we can play to help overcome them. These represent our theory of change: **To develop and deploy Google's technological assets and know-how + cultural influence + purchasing power to accelerate the transition to a circular Google that contributes to a sustainable world.**

Our technological assets and know-how

Barrier 1:

Innovative circular models can be undermined by poor data and lack of information availability (for example, when materials cross borders, or the disconnect between where goods are manufactured versus where they are used).

Where Google can help:

By utilizing our technological assets and know-how, such as enabling technologies like Artificial Intelligence (AI) and cloud computing to address key data challenges to improve circularity outcomes.

Desired outcome:

Emergent circular solutions and technologies are taken to the next level with replicable and scalable data systems and metrics.

Our cultural influence

Barrier 2:

The vision of a circular economy is often seen as one of constraint and compromise, rather than abundance, innovation, and development.

Where Google can help:

We connect with billions of users every day through products like Search, Gmail, and YouTube, which gives us the cultural influence to inspire enthusiasm and action for circularity. We can also specifically share the lessons of our own experience in our operations and decision making.

Desired outcome:

Support a clear and compelling vision of a near-term circular future that is exciting and full of possibility. Share what we learn and create a sense of abundance that inspires action.

Our purchasing power

Barrier 3:

Circularity pilots rarely reach scale as it's costly to take solutions from infancy to maturity.

How can Google help:

We can leverage our purchasing power to help circular solutions replace linear options.

Desired outcome:

Scalable solutions and a demand in the market for secondary and upcycled materials.

How to make a circular system

Learning from our success to date, recognizing the barriers, and laddering up from our three circular principles, we've now set a new overarching circularity goal for Google:

Maximize the reuse of finite resources across our operations, products, and supply chains and enable others to do the same.

Designing a roadmap to achieve this goal was inspired by the steps we take to develop a basic algorithm:

1. **Define scope and boundaries**

   We identified three areas of our business where we can focus on maximizing the reuse of finite resources:

   - Google workplaces and supply chains
   - Google data centers and supply chains
   - Google consumer electronics and supply chains

2. **Understand flows**

   We mapped our resources and how they flow through each of the key areas of our business. We then added the possible outcomes for each resource as they near the end of their originally intended utility.

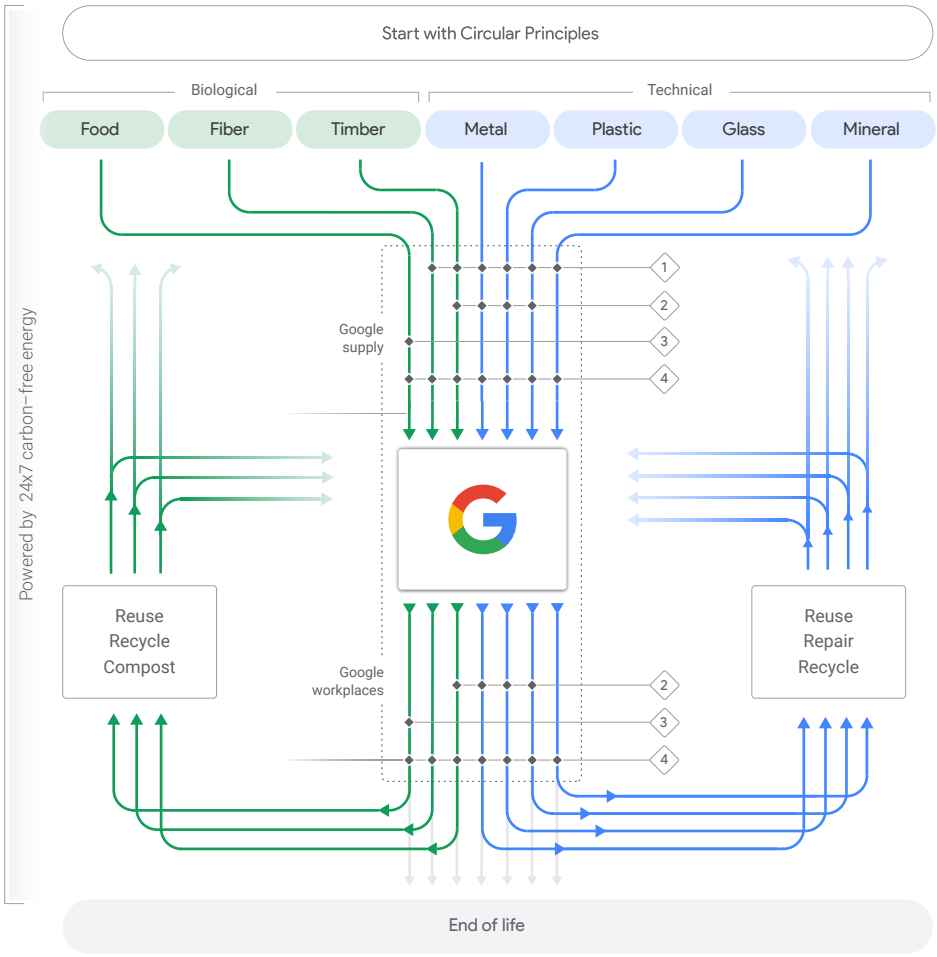
3. **Set sub-goals**

   After mapping our resources and understanding the flows, we introduced a set of applicable sub-goals in each area of the business with the objective to intercept each resource flow at its optimal time to promote the most favorable circular outcome.

   The resulting circular model for Google distinguishes between technical and biological cycles in resources flows. In biological cycles, food and biological materials (e.g., cotton or wood) return into the system through processes such as composting and anaerobic digestion. These cycles regenerate living systems such as soil, which provide renewable resources for the economy. Technical cycles recover and restore products, components, and materials through strategies including reuse, repair, remanufacturing, or recycling.

   Although we often encounter composite materials, we've distilled down to the basic biological (food, plant fiber, timber) and technical (plastic, metal, glass, minerals) resource groups in order to visualize the flow of these resources through our business in a clear way.

Flow of resources through Google workplaces and supply chain



Goal

Maximize the reuse of finite resources across our operations, products, and supply chains, and enable others to do the same

Circular Principles

- (D) Design out waste and pollution
- (K) Keep products and materials in use
- (P) Promote healthy materials and safe chemistry to enable perpetual recycling of resources

Sub-Goals

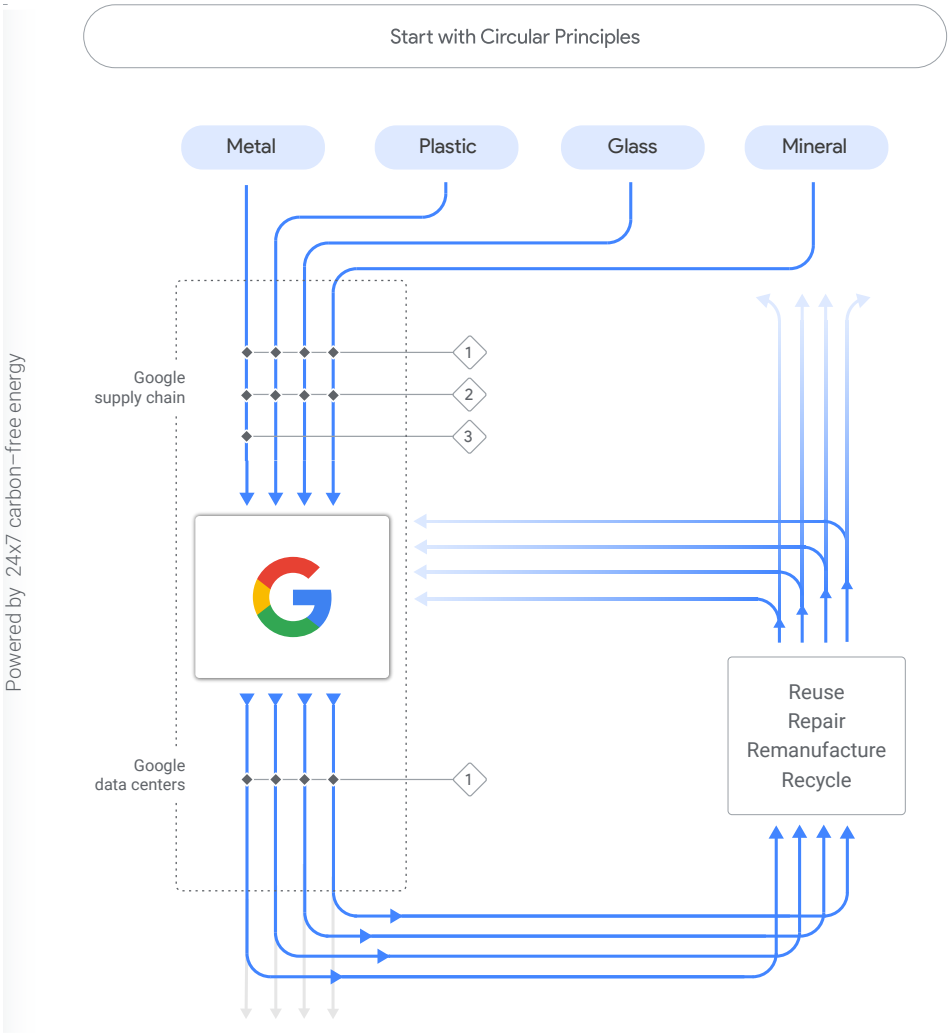
1. Pursue Living Building Challenge Materials Petal (which includes red list-free materials and net zero waste) at Charleston East, Google's first major campus being built from the ground up in Mountain View, California (certification targeted for 2021)
   (D) (P)

2. Meet a 35% reduction in single-use beverages per seated head count (SHC) at our top 25 office sites by 2019; and 50% reduction in single-use beverages per SHC at top 25 sites by 2020
   (D)

3. All Google cafes tracking pre-consumer food waste have a Food Efficiency Ratio of at least 2%-4%
   (D)

4. Evaluate regenerative strategies for 100% of Bay Area district infrastructure (including energy, water, and waste)
   (D)

Flow of resources through Google data centers and supply chain



Goal

Maximize the reuse of finite resources across our operations, products, and supply chains, and enable others to do the same

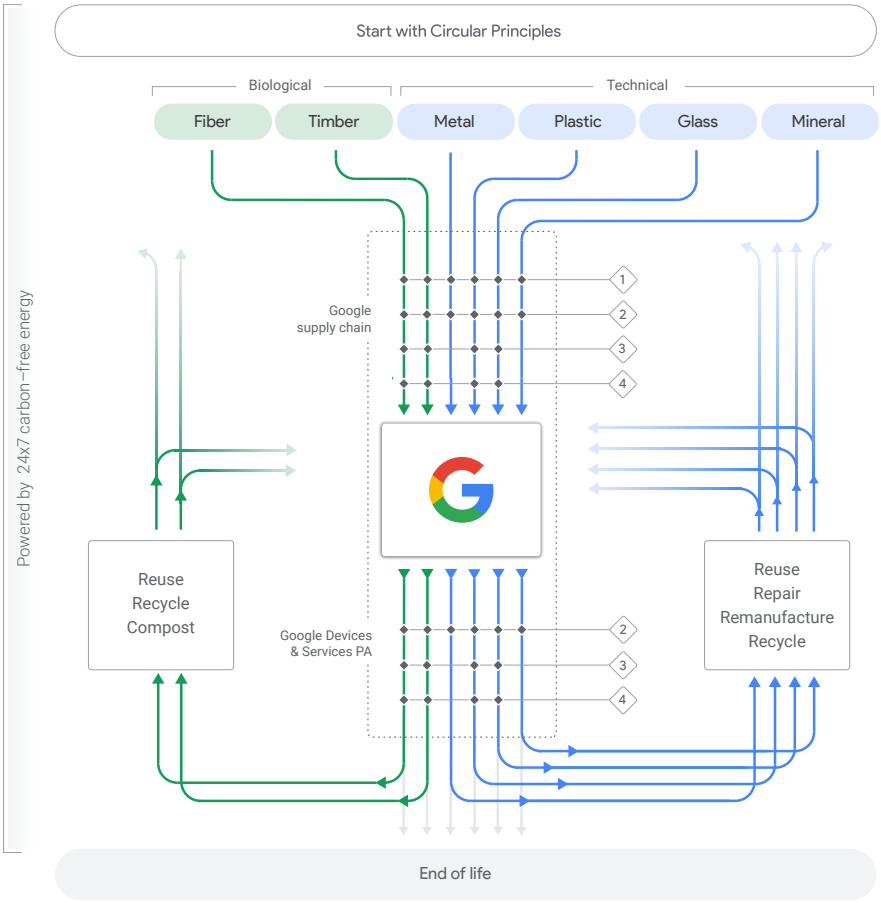
Circular Principles

- (D) Design out waste and pollution
- (K) Keep products and materials in use
- (P) Promote healthy materials and safe chemistry to enable perpetual recycling of resources

Sub-Goals

1. Maintain zero waste to landfill in our data center operations, construction, and procurement (D) (K)
2. Develop supply chain contracts to prioritize and accept secondary use materials by 2020 (D) (K)
3. Develop a scalable model for new hard drives using rare earth magnets from recovered end of life drives in 2019 (D) (K)

Flow of resources through Google consumer electronics and supply chain



Goal

Maximize the reuse of finite resources across our operations, products, and supply chains, and enable others to do the same

Circular Principles

- (D) Design out waste and pollution
- (K) Keep products and materials in use
- (P) Promote healthy materials and safe chemistry to enable perpetual recycling of resources

Sub-Goals

1. Develop supply chain contracts to prioritize and accept secondary use materials by 2020 (D) (K)
2. Build 100% of consumer electronic products launching in 2022, and every year after with the inclusion of recycled materials, with a drive to maximize recycled content wherever possible (D) (K)
3. Use safer flame retardants and solvents across our consumer electronics product portfolio by 2023 (P)
4. Eliminate antimicrobials across our consumer electronics product portfolio by 2023 (P)

Goals to change the flows

Within the material algorithms above, the decision moment between flows is dictated by sub-goals.

These are specific, time-bound, and measurable targets that will keep us on track to our long-term goal of maximizing the reuse of finite resources across our operations, products, and supply chains, and enabling others to do the same.

GOALS TO CHANGE THE FLOWS

Design out waste and pollution

Maintain zero waste to landfill in our data center operations, construction, and procurement

Pursue the Living Building Challenge Materials Petal, (which includes a requirement for net zero waste) at Charleston East, Google's first major campus being built from the ground up in Mountain View, California (certification targeted for 2021)

Meet a 35% reduction in single-use beverages per seated head count (SHC) at our top 25 office sites by 2019; and 50% reduction in single-use beverages per SHC at top 25 sites by 2020

All Google cafes tracking pre-consumer food waste have a Food Efficiency Ratio of at least 2%-4%

Evaluate regenerative strategies for 100% of Bay Area district infrastructure (including energy, water, and waste)

Incorporate circular economy data into Google products (e.g., recycling data in Google Assistant)

Keep products and materials in use

Develop a scalable model for new hard drives using rare earth magnets from recovered end of life drives in 2019

Deploy three community renewable energy projects in the Democratic Republic of Congo to diversify economic options for people in mining communities in 2019

Develop supply chain contracts to prioritize and accept secondary use materials by 2020

Build 100% of consumer electronic products launching in 2022 and every year after with the inclusion of recycled materials, with a drive to maximize recycled content wherever possible

Promote healthy materials and safe chemistry to enable perpetual cycling of products

Pursue the Living Building Challenge Materials Petal for red list-free materials at Charleston East, Google's first major campus being built from the ground up in Mountain View, California (certification targeted for 2021)

Use safer flame retardants and solvents across our consumer electronics product portfolio by 2023

Eliminate antimicrobials across our consumer electronics product portfolio by 2023

Can we do this?

We are at the beginning of our circular economy journey. Some of our circularity goals can be achieved in the near-term, while others will require a much longer time horizon.

We're encouraged by what we've achieved with renewable energy. In 2012, Google made a commitment to purchase enough renewable energy to match 100% of our global operations. In 2017, we met this goal.

When we publicly committed to 100% renewable energy purchasing, we knew it was an ambitious target and the path wasn't yet clear. We experimented with and even invented new purchasing tactics and pioneered new contracting models. Yet, we still see this achievement as just the beginning. As we continue to move forward with renewable energy technologies like wind and solar, we will work towards the more challenging long-term goal of powering our operations with carbon-free energy on a region-specific, 24x7 basis.

This success has taught us what we're capable of when we set ambitious goals. It's also proven to us that change at scale demands collaboration, imagination, and adaptability to new realities as they emerge.

Going beyond today

This new roadmap sets us on the path to circularity, but it's far from the destination. Circularity is an urgent and fascinating challenge and we're inspired by what might be possible.

The idea that waste is an information problem especially inspires us because Googlers love to unpack information problems. We believe that a new set of tools are emerging, which could radically accelerate our ability to do so for the circular economy. In 2018, we co-authored a paper with the Ellen MacArthur Foundation and with research support from McKinsey investigating the role of AI in the circular economy.

We uncovered a host of applications for AI, from predictive maintenance that prolongs asset life, to building traceability and transparency in supply chains, and even repair being made easier by smart 3D printing of spare parts. AI can enhance and enable circular economy innovation in three main ways:

1. **Design circular products, components, and materials**
   AI can enhance and accelerate the development of new products, components, and materials fit for a circular economy through iterative machine-learning-assisted design processes that allow for rapid prototyping and testing.

2. **Operate circular business models**
   AI can magnify the competitive strength of circular economy business models, such as product-as-a-service and leasing. By combining real-time and historical data from products and users, AI can help increase product circulation and asset utilization through pricing and demand prediction, predictive maintenance, and smart inventory management.

3. **Optimize circular infrastructure**

AI can help build and improve the reverse logistics infrastructure required to 'close the loop' on products and materials by improving the processes to sort and disassemble products, re-manufacture components, and recycle materials.

We're already using AI at Google to design out energy waste from our data centers. Machine learning optimizes the controls of the cooling system and has delivered a 30% reduction in energy use. This significant saving was made possible by leveraging the historical data already collected by thousands of sensors within the data center-such as temperatures, power, pump speeds, and using it to train a neural network, creating an AI-powered efficiency recommendation system.

Creating a broader awareness and understanding of how AI can be used to support a circular economy will be essential to encourage applications for circular design, circular business models, and circular infrastructure. Ultimately, AI could be applied to the complex task of redesigning whole networks and systems in any sector, from rewiring supply chains to creating global reverse logistics infrastructure.

This is the new frontier of circularity and one which we intend to fully explore.

To change everything will take everyone

A truly systemic shift to a circular economy goes far beyond Google. New partnerships across industries and value chains will be needed to achieve economies of scale, reduce costs, and test and refine new circular business models.

The scale of the change required to reach circularity will touch every part of society and span the entire global economy. Business will lead the change, as the primary designers, builders, and users of materials. Governments can send the signals that circularity is needed and in the public benefit. And each of us, every day, can keep the circular economy turning by choosing circular products and services for our own lives.

The need is evident and the rewards are significant. At Google, we are focused on utilizing the solutions we know best. Even as we develop and support systematic applications of technology for circularity, we will need collaboration and a degree of oversight to ensure that data can be shared in an open and secure manner, and that AI is developed and deployed in ways that are inclusive and fair to all. Transparency, with open or easy access to data, is required but rarely found. Within the businesses who are part of the Ellen MacArthur Foundation, we've found a trusted cohort and we thank them for their leadership.

Our new goal also commits us to enable others to embrace circularity. That has started with our partners and in our supply chain. It also extends to the billions of Google users across the world. In the coming months and years, we will work to inform, inspire, and partner.

If you're a Google team member, partner, supplier or one of the billions of people who use Google products every day, we hope you will come on this exciting journey with us.