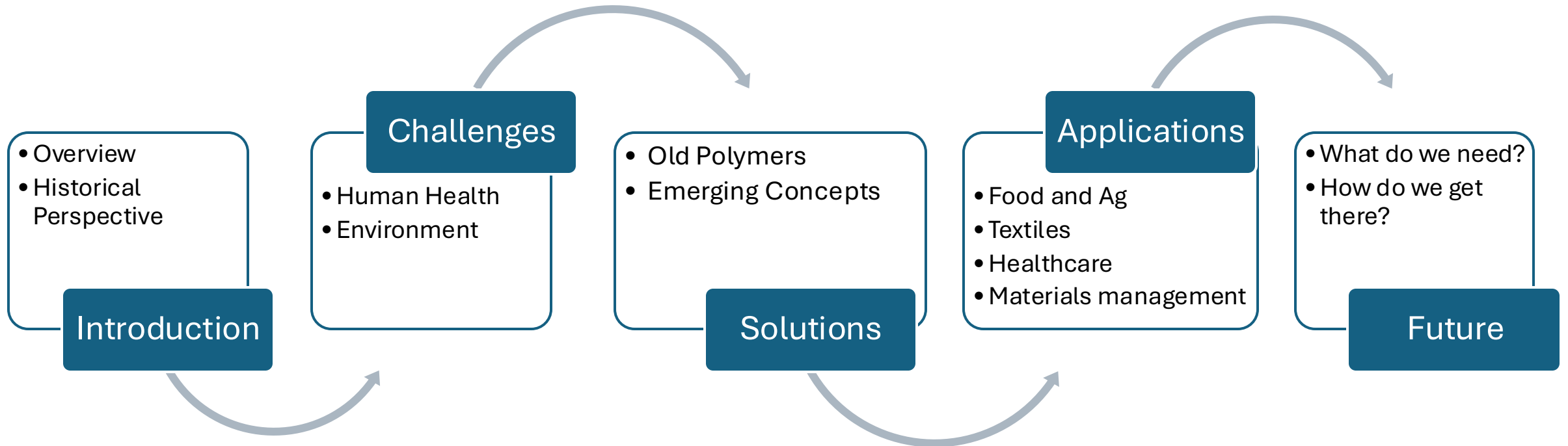
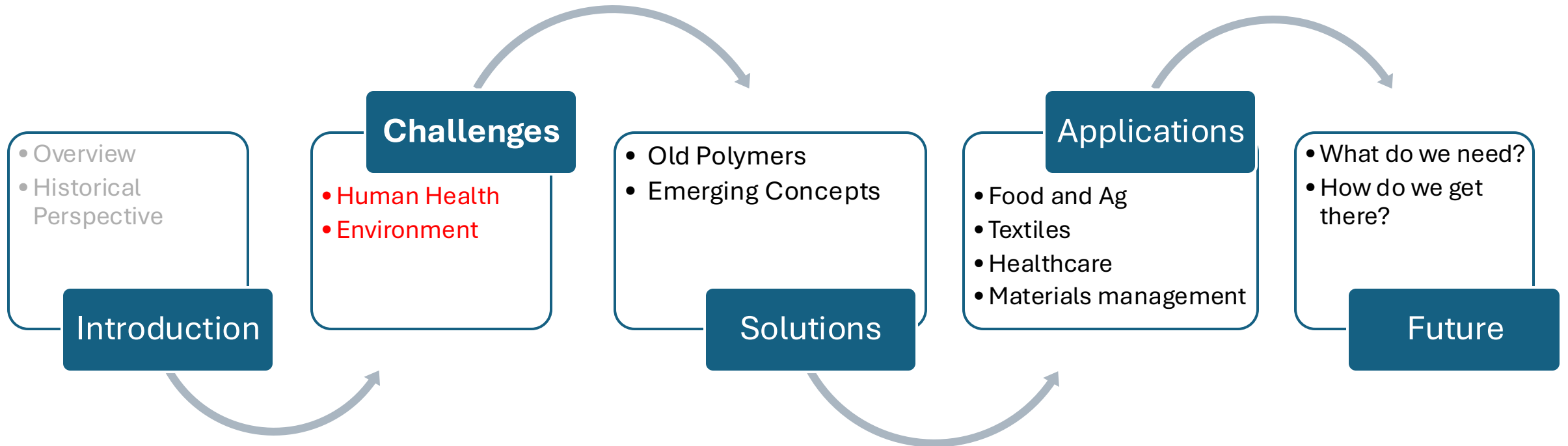


Course Overview



Course Overview



Learning Objectives

1. Be able to identify key challenges in developing sustainable materials
2. Be conscious of potential pitfalls in designing sustainability focused inventions
3. Begin thinking about materials design in a more faceted and real-world way
4. Consider how to avoid challenges when pitching your own project idea

Clean, healthy, and sustainable environments are a human right

- It's not me saying that—**It's the united nations:**

“Sponsored by Costa Rica, Maldives, Morocco, Slovenia and Switzerland, the universal recognition of the right to a healthy environment was unanimously approved July 2022, by a vote of 161-0.”

“A healthy environment – recognized as a right by more than 150 States around the world – is a prerequisite for the realization of other human rights. Its recognition as a universal human right can lead to more effective laws and policies, and can help to empower local communities in the protection of their territory.”



**United
Nations**

**Peace, dignity and equality
on a healthy planet**

OK—but what makes a healthy environment?

- Any thoughts?

Clean air, water,
and land

Sustainable stable
shelter

A stable climate

Safe food and
agriculture

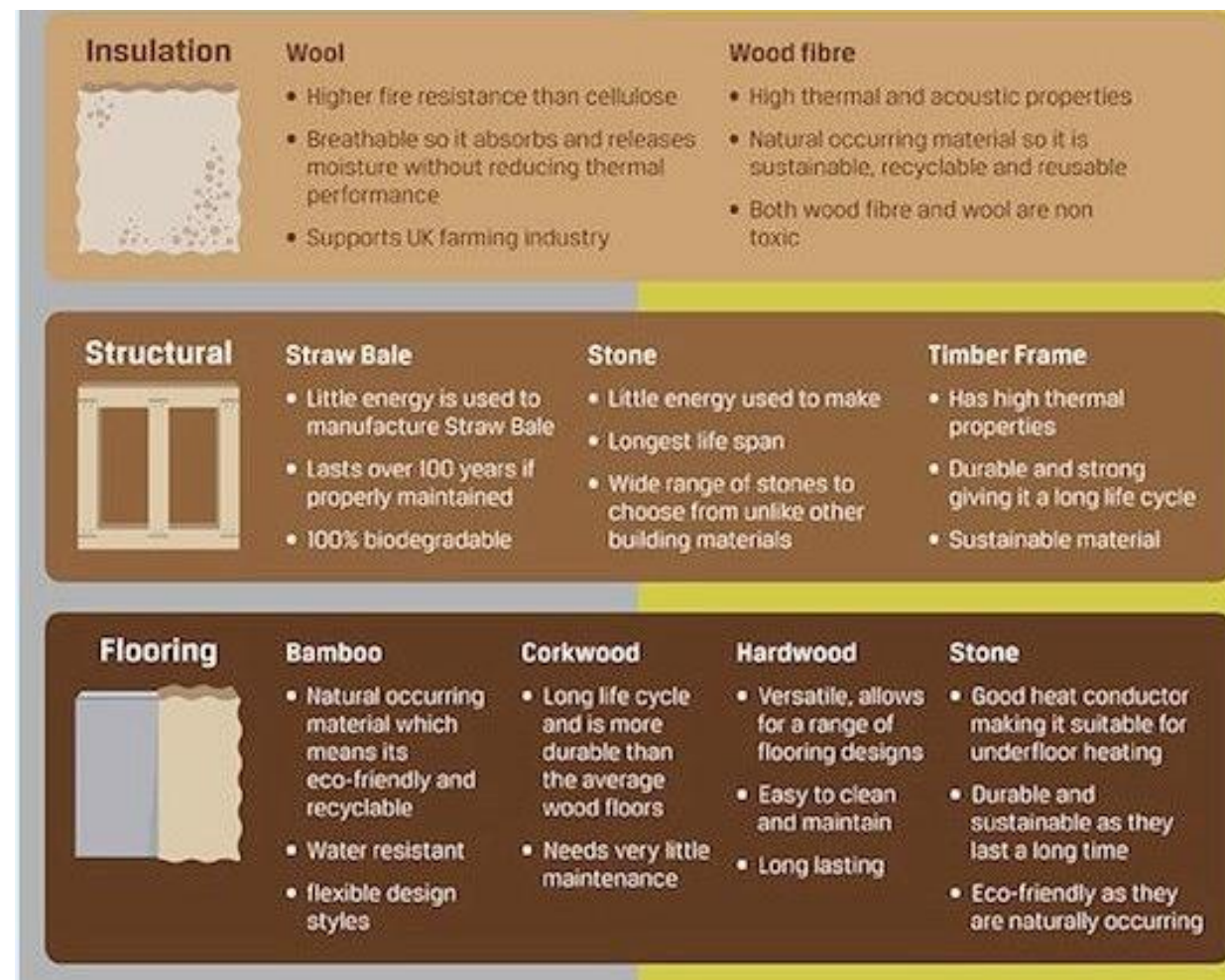
Products free of
harmful chemicals

Healthy living and
working conditions

Rights and self-
determination

Which uses sustainable materials?

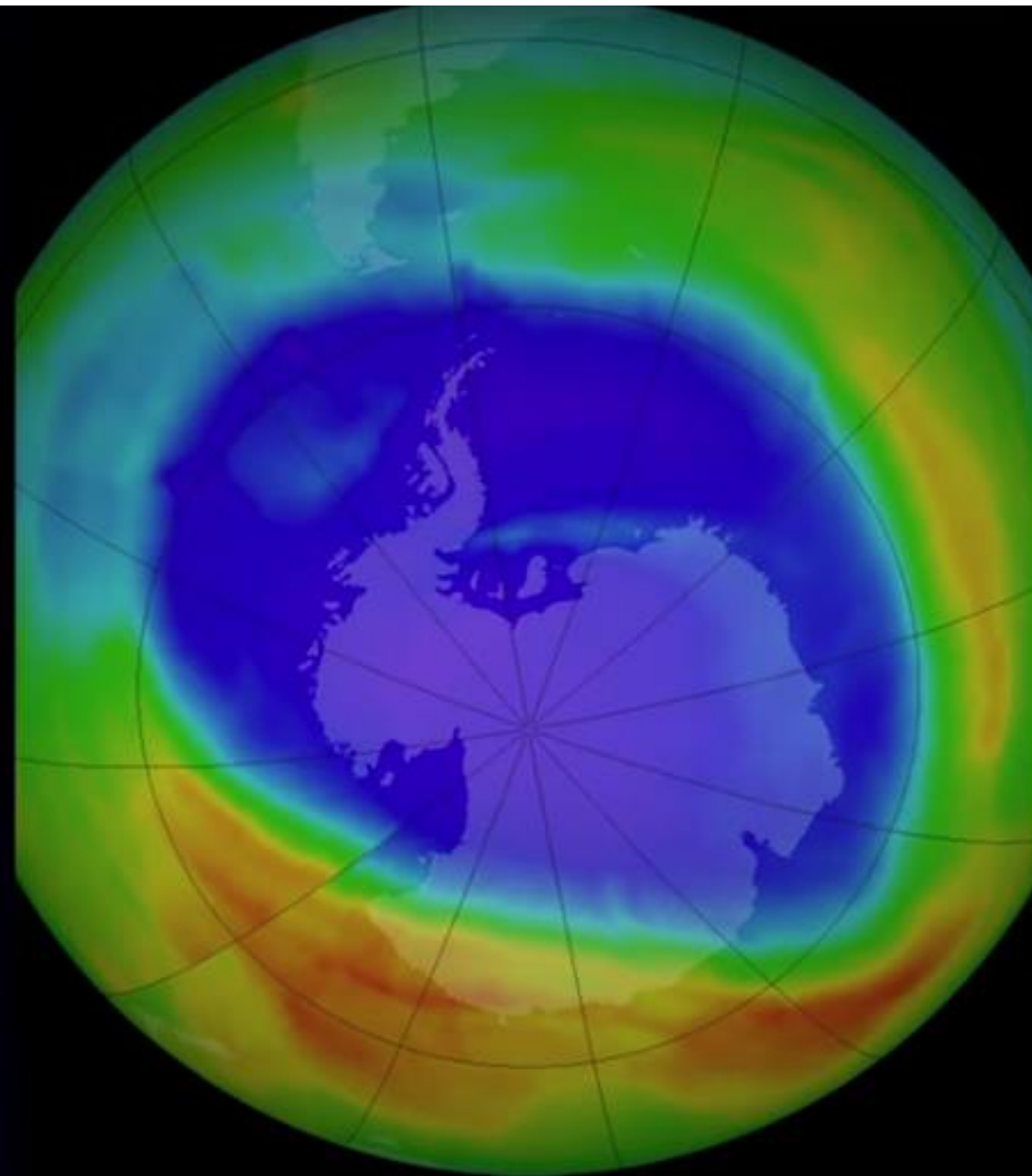




So why are so many houses built with the materials on the left?

Ozone: Action works

- Evolved from Carbon tetrachloride, used in fire control
- In the 1920s, evolved into CFCs widely used for refrigeration and aerosol cans
- Quickly determined the impact on the Earth's ozone layer
- 1985 – Vienna Convention for the Protection of the Ozone Layer
- 1987 – Montreal Protocol
- 2019 – Smallest amount of ozone depletion detected





SUSTAINABLE DEVELOPMENT GOALS

Department of Economic and Social Affairs
Sustainable Development

1 NO POVERTY

2 ZERO HUNGER

3 GOOD HEALTH AND WELL-BEING

4 QUALITY EDUCATION

5 GENDER EQUALITY

6 CLEAN WATER AND SANITATION

7 AFFORDABLE AND CLEAN ENERGY

8 DECENT WORK AND ECONOMIC GROWTH

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

10 REDUCED INEQUALITIES

11 SUSTAINABLE CITIES AND COMMUNITIES

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

Which of these does your project address?

13 CLIMATE ACTION

14 LIFE BELOW WATER

15 LIFE ON LAND

16 PEACE, JUSTICE AND STRONG INSTITUTIONS

17 PARTNERSHIPS FOR THE GOALS

Challenges: discussion

Turn to your neighbors. Let's discuss.

1. What are current challenges with sustainable materials? (list 5+)
2. What are some solutions we could think of for getting around them? Are there any obvious solutions?
3. What can we do as advocates and activists to promote sustainable materials?
4. Do we have any examples of implementing sustainable solutions?

5-minute private discussion, 10-minute class discussion

Challenges to utilizing sustainable materials

- Limited availability
- Cost considerations
- Certification and standards
- Quality and performance
- Education and awareness
- Regulatory compliance
- Supply chain transparency
- Waste management
- Local sourcing



Challenges to utilizing sustainable materials

- **Limited availability**
- Cost considerations
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Limited Availability

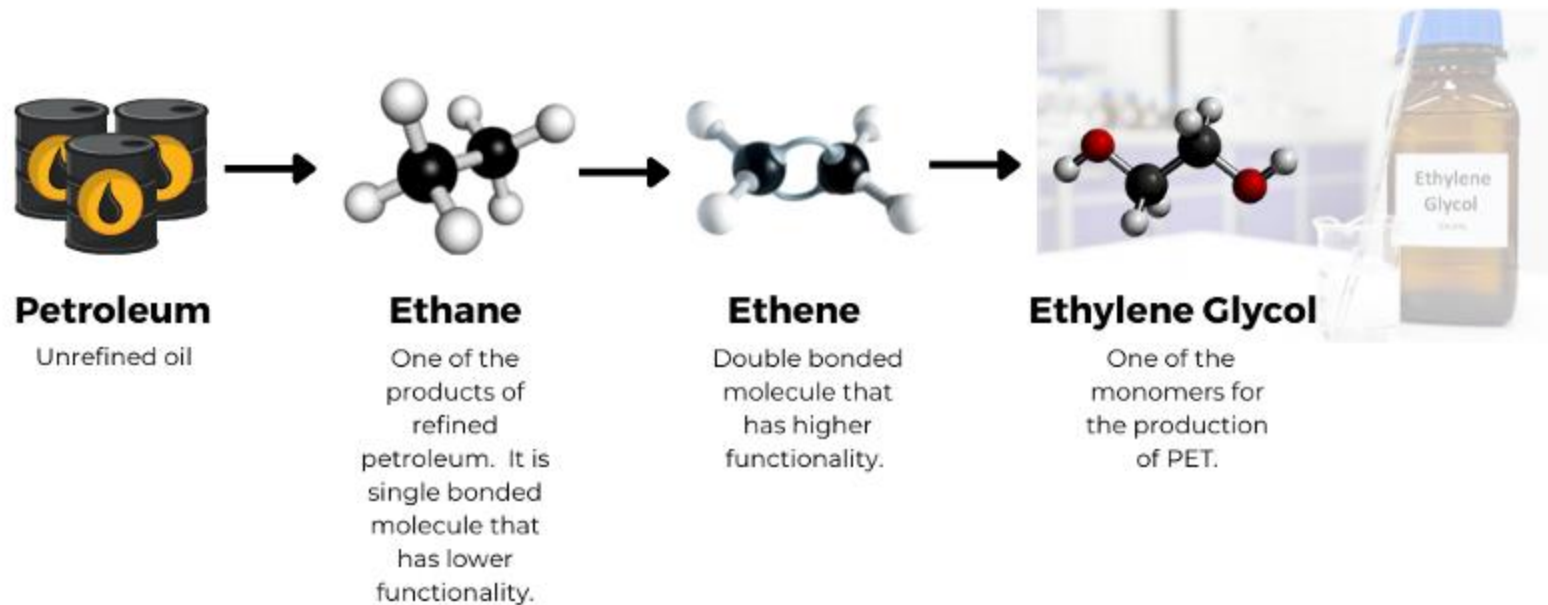
- In many cases, sustainable materials are not widely available
- Many materials are produced in small quantities, lacking the potential cost-savings at scale
- Due to a variety of factors:
 - limited production capacity
 - lack of demand
 - insufficient infrastructure for processing/transporting the materials

Why are clothes made of oil?



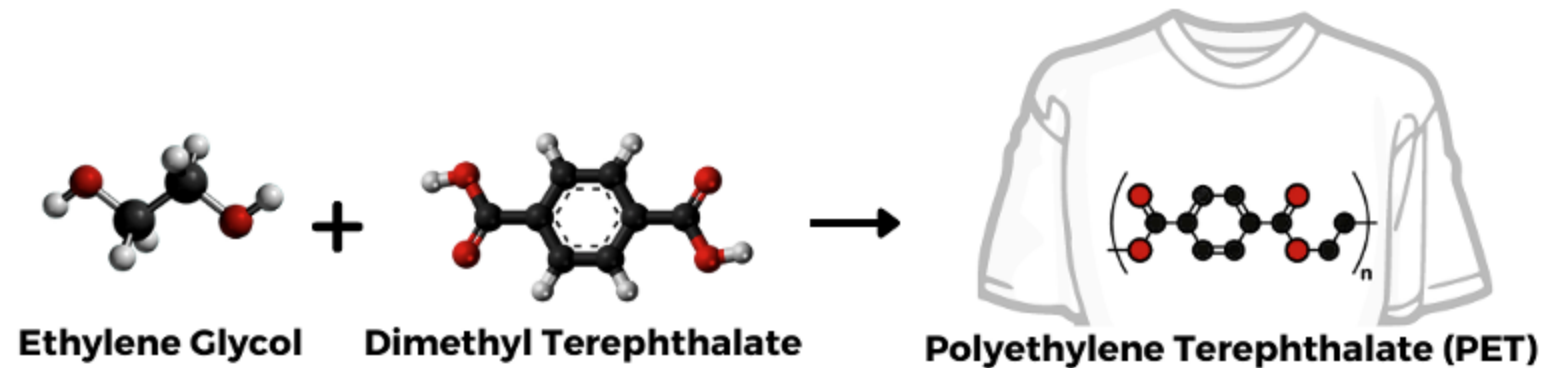
Why are clothes made of oil?

Making a Monomer



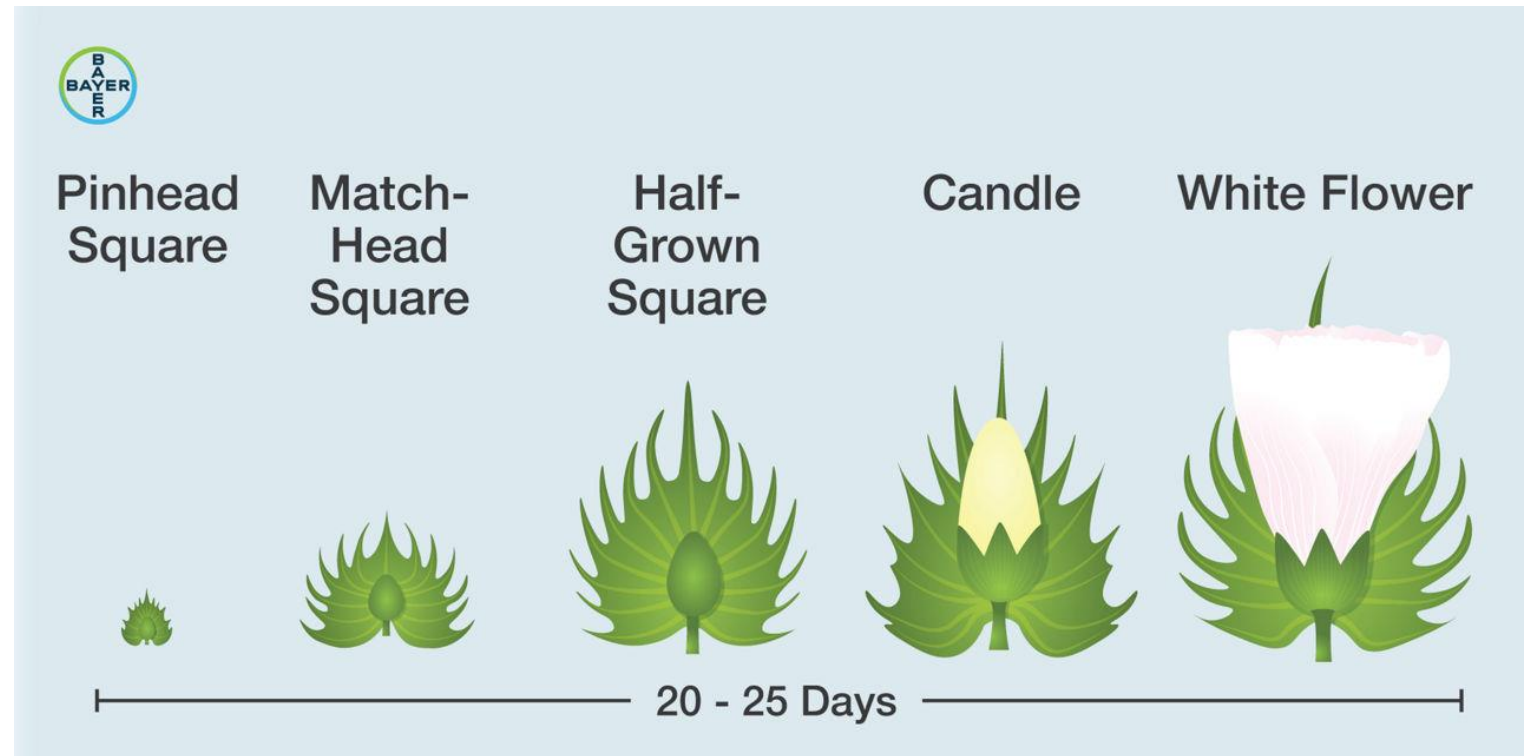
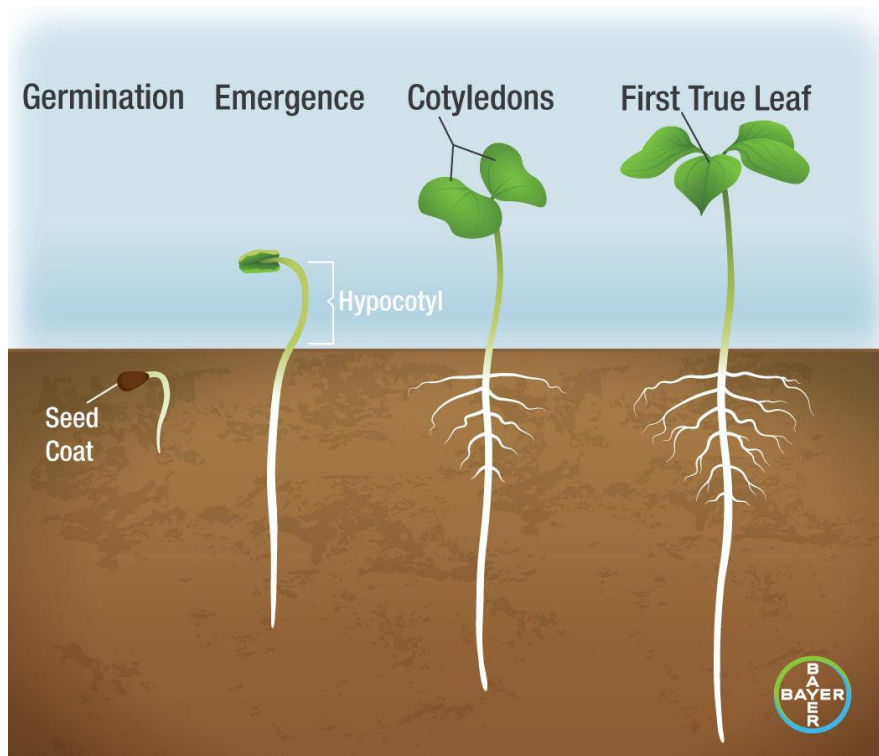
Why are clothes made of oil?

Producing a Polymer



This image shows a repeating unit of the PET polymer. The unit can be repeated n number of times. n=the desired amount.

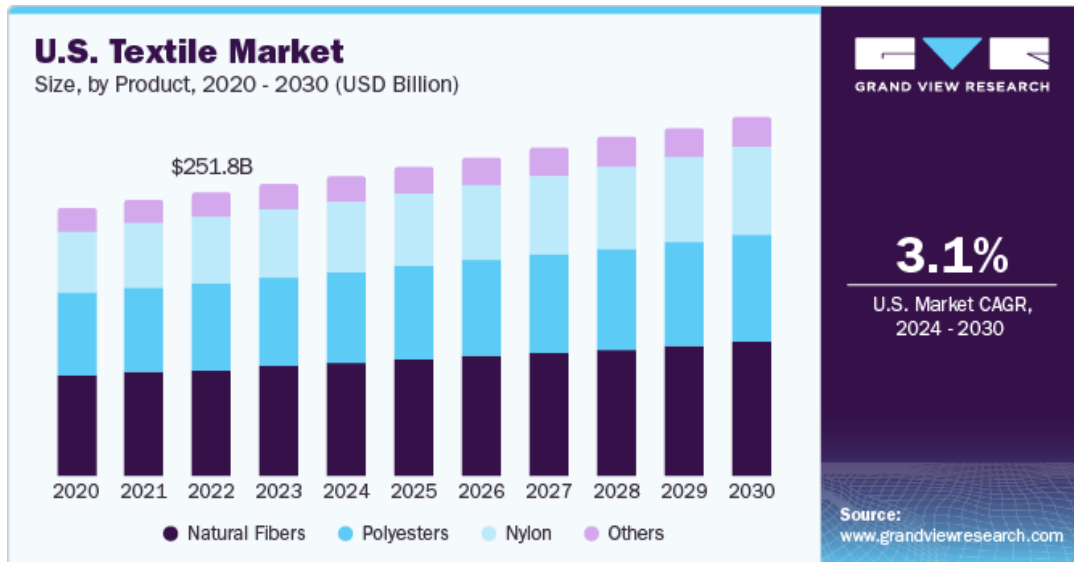
Why are clothes made of oil?



Why are clothes made of oil?



Why are clothes made of oil?



Property	Polyester	Cotton
Fiber type	Synthetic	Natural
Absorbency	Low	High
Breathability	Good	Excellent
Wrinkle resistance	Excellent	Poor
Durability	Very good	Good
Sustainability	Low	High
Cost	Relatively low	Relatively high

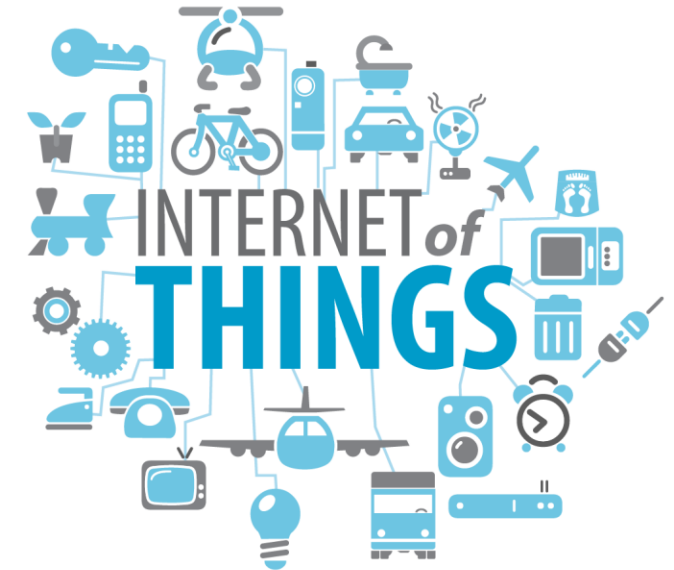
The sad truth is the only reason cotton is close to the same cost is due to forced labor for farming and picking cotton.

The power of Internet of Things (IoT) for scaling

**Harnessing the
power of IoT for
sustainability**



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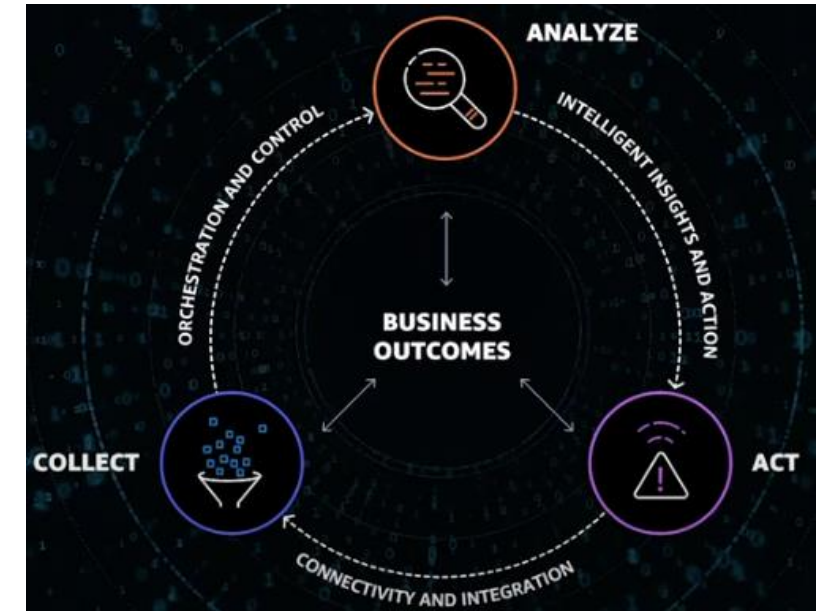
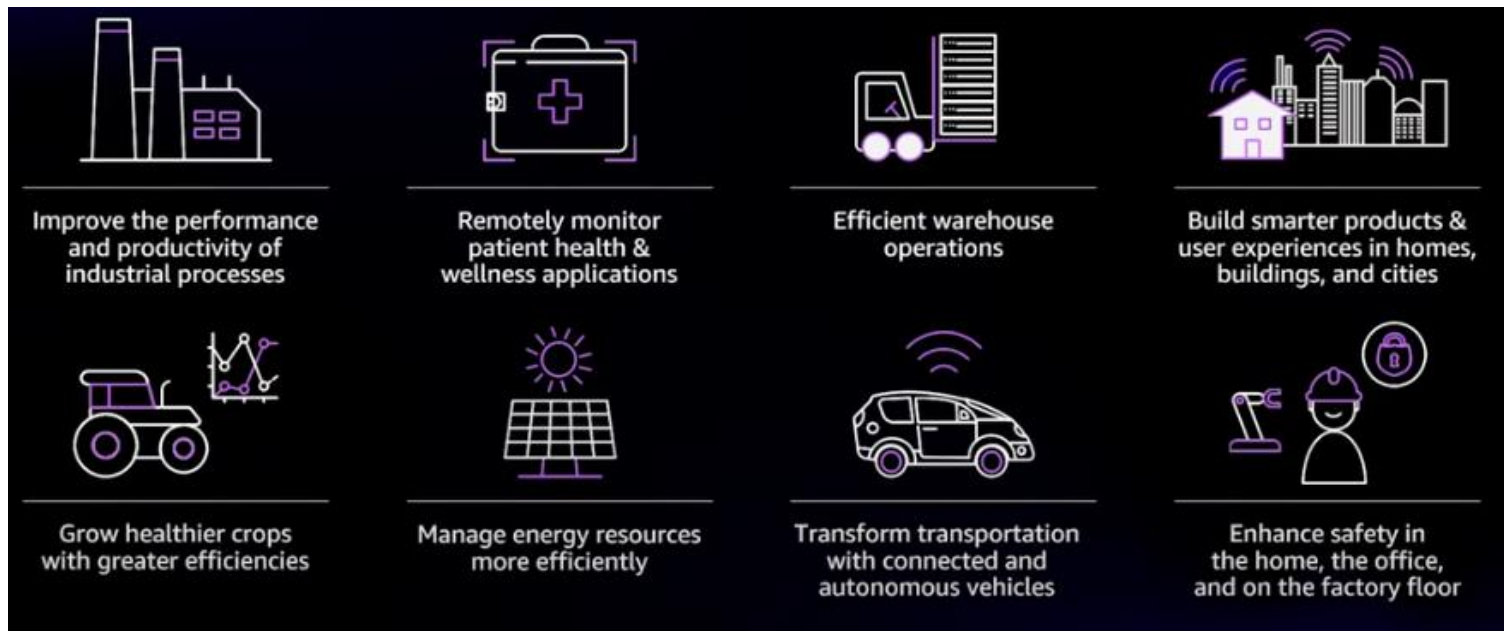


The power of Internet of Things (IoT) for scaling

IoT adoption is rapidly accelerating



The power of Internet of Things (IoT) for scaling



There's so much data being produced from all of our tech... We need to harness this to improve and optimize sustainable material production, implementation, and utilization.


The power of Internet of Things (IoT) for scaling

Smart agriculture: CropX 



Soil sensors enable sustainability

- Combines above-ground datasets with in-soil data measured by sensors that transmit the data to the AWS-based platform
- Integrated with imaging, weather, topography, and soil data and analyzed by AI-based algorithms to provide analytical insights via the CropX web or mobile app
- Demonstrated more than 40% water savings across different crop types, with a 10% yield increase

 **BEEWISE**

“They pollinate better and they produce more honey. And for us, there’s no greater satisfaction, because we’re doing well by doing good.”

Saar Safra
CEO and Founder of BeeWise

Beewise deployed a wide, interconnected network of distributed devices and sensors using AWS IoT Core and AWS IoT Device Management

Beewise was able to achieve a dramatic increase in plant pollination and honey production

Beewise **lowered the average bee mortality rate from ~40% (in today’s beehives) to less than 10% in Beewise’s robotic AI-controlled beehives**

 **solshare**


“With AWS investments, we have been able to shift our development resources to focus on building an innovative peer-to-peer microgrid that is bringing affordable solar electricity to communities in Bangladesh and beyond.”

Hannes Kirchhoff
SOLshare CTO

Securely and efficiently allow people to trade excess solar energy from in-home solar systems

SOLshare uses FreeRTOS on constrained MCU devices to **securely implement** microgrid logic connecting to AWS IoT Greengrass

Providing state-of-the-art technology from FreeRTOS on devices to services in the cloud

 **CCI**
Coca-Cola İçecek

CHALLENGE

Coca-Cola İçecek (CCI) is the sixth-largest bottler of Coca-Cola products by sales volume. CCI’s production facilities previously relied mainly on analog processes for asset measuring and monitoring. Routine process tracking and asset maintenance required operators to search for issues by hand and manually keep track of how much energy, water, and other materials production lines used.

SOLUTION

To improve its operations, CCI decided to digitize its shop floor and manufacturing processes to implement a complete digital twin solution that would scale to all 26 bottling plants.


In 2 months, CCI built a robust digital advanced analytics solution for its production line sanitation process using AWS IoT SiteWise and AWS IoT Greengrass.

IMPACT

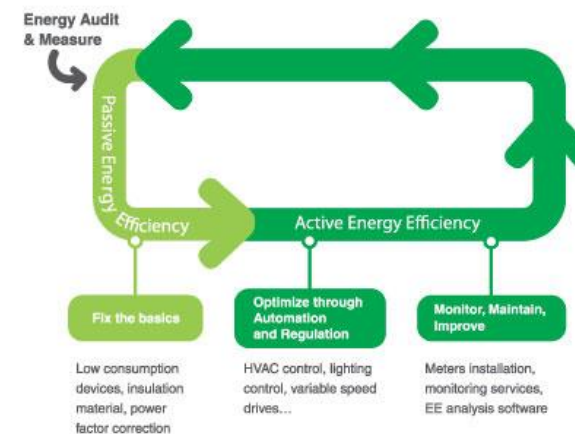
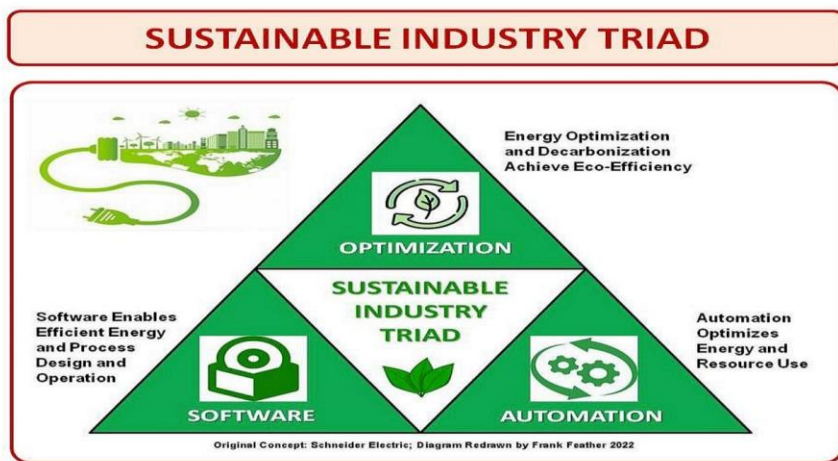
- Improved process efficiency and environmental sustainability
- Saved 20% on energy annually
- Saved 9% on water annually
- Optimized clean-in-place process time and cost performance

“If we can locate failures and other maintenance issues before they happen, we can keep the plant up and running at all times and improve our utilization.”

Suheyra Er Aksoy, Asset Optimization Digital Technology Leader, Coca-Cola İçecek



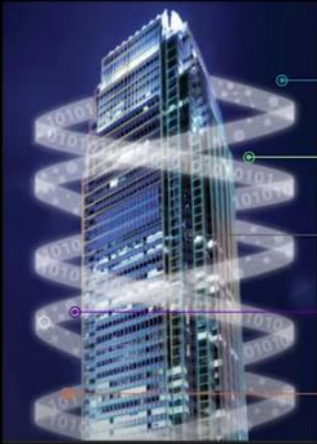
Optimization in sustainability



Optimization in sustainability

ENERGY AND USE EFFICIENCIES **SIEMENS**

Smart buildings: Key to sustainability objectives



Lighting control	Efficiency and safety
Temperature control	Democratization and choice
Utilization management	Regenerative spaces
Energy prosumer	Efficient local, on-site production
Intelligent platform	Amazon Web Services

Lighting control energy savings

Darkened by COVID-19, Salesforce and Enlighted light up the night with love and hope

TECHNOLOGY

- Sensor-based occupancy control
- Dimming
- Task tuning
- Utility-grade power meter provides real-time measurement & verification of energy savings

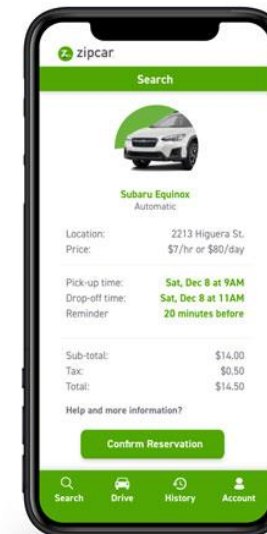
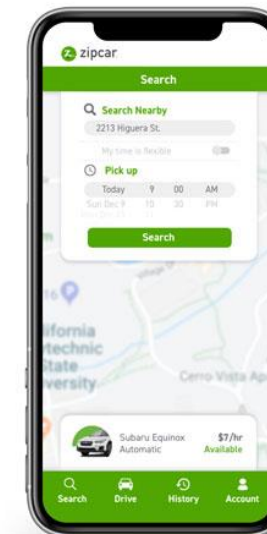
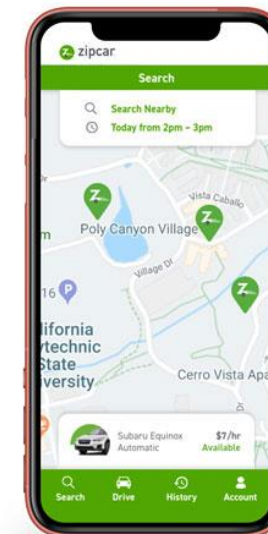
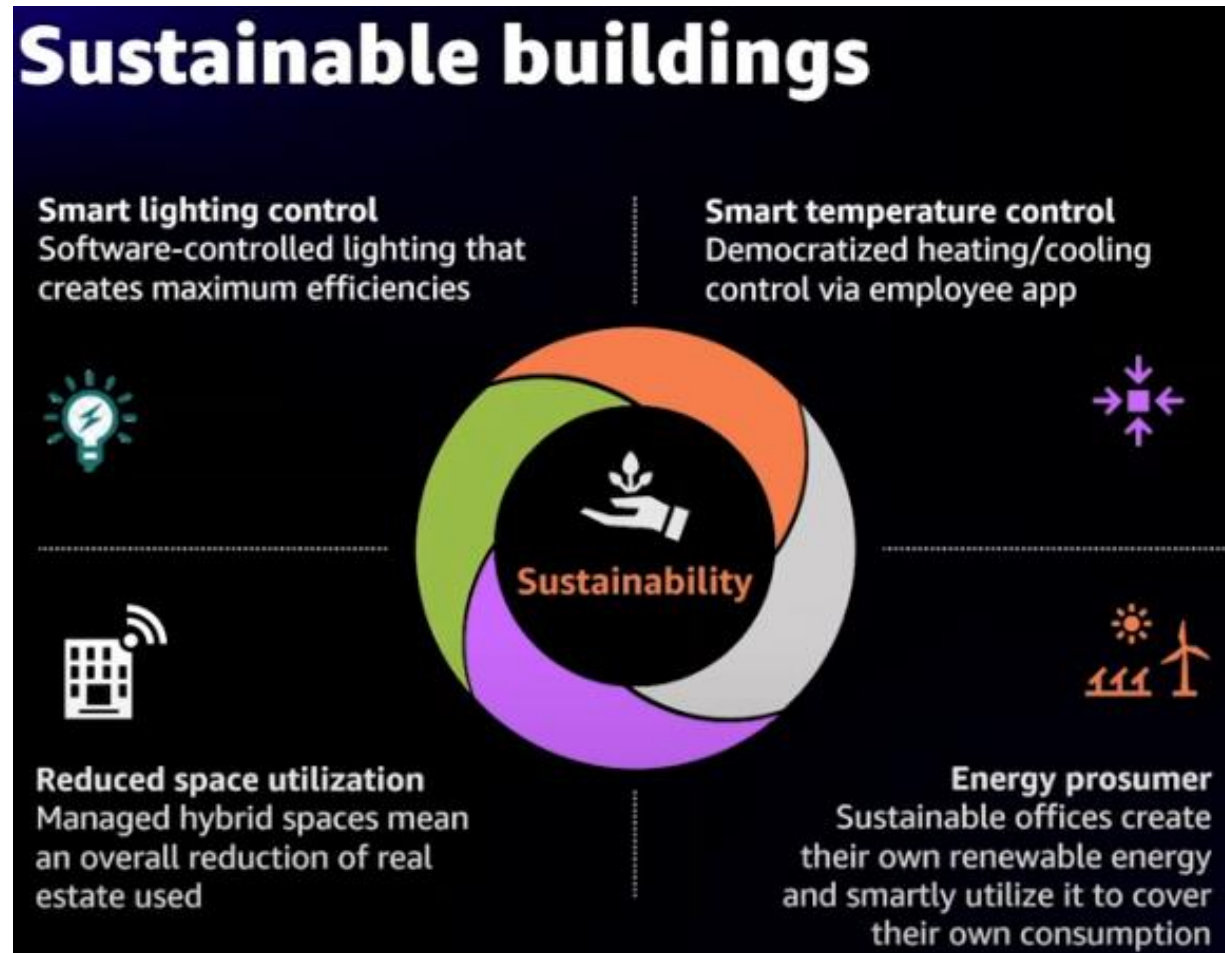
60–90+%
Customer energy savings

Smart lighting control results in savings and safe lighting systems



Your car spends >95% of its lifespan just waiting to be driven...meanwhile everyone else's does too. How inefficient!

Optimization in sustainability



Soon cars might not be a thing you “own”
they might be a thing you “use”

**Could other sustainable materials be
seen this way?**

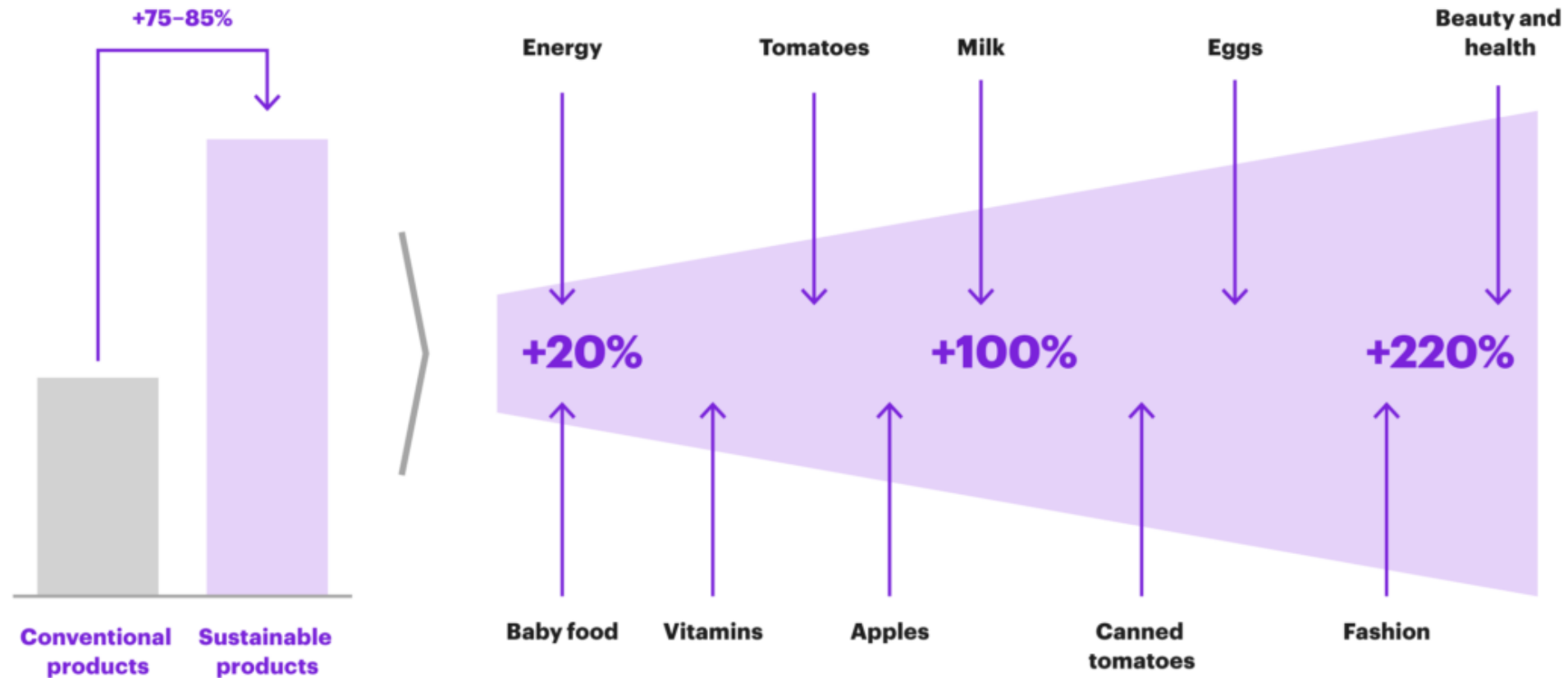
Challenges to utilizing sustainable materials

- Limited availability
- **Cost considerations**
- Certification and standards
- Quality and performance
- Education and awareness
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- Supply chain transparency
- Waste management
- Local sourcing



Think about it from a consumer standpoint...

Price markups for sustainable products



Think about it from a consumer standpoint...

Sustainability: a Splurge for the Rich

US consumers surveyed who agreed with the following statements:

■ Income below \$100,000 ■ Income above \$100,000

"Companies should be able to charge at least 10% more for a sustainable product"



"I will personally pay at least 10% more for a sustainable product"



Source: "The Conscious Maximalist," Squared Circles, 2024 • N=3,000 US consumers



Think about it from a consumer standpoint...

Food	Conventional	Organic	Difference
Rice	\$1.40	\$4.00	185.71%
Pasta	\$1.00	\$1.65	65.00%
Canned tomatoes	\$0.80	\$1.20	50.00%
Ice cream (dairy-free)	\$6.60	\$22.00	233.33%
Tofu	\$3.65	\$4.80	31.51%
Celery	\$3.90	\$7.00	79.49%

Think about it from a consumer standpoint...

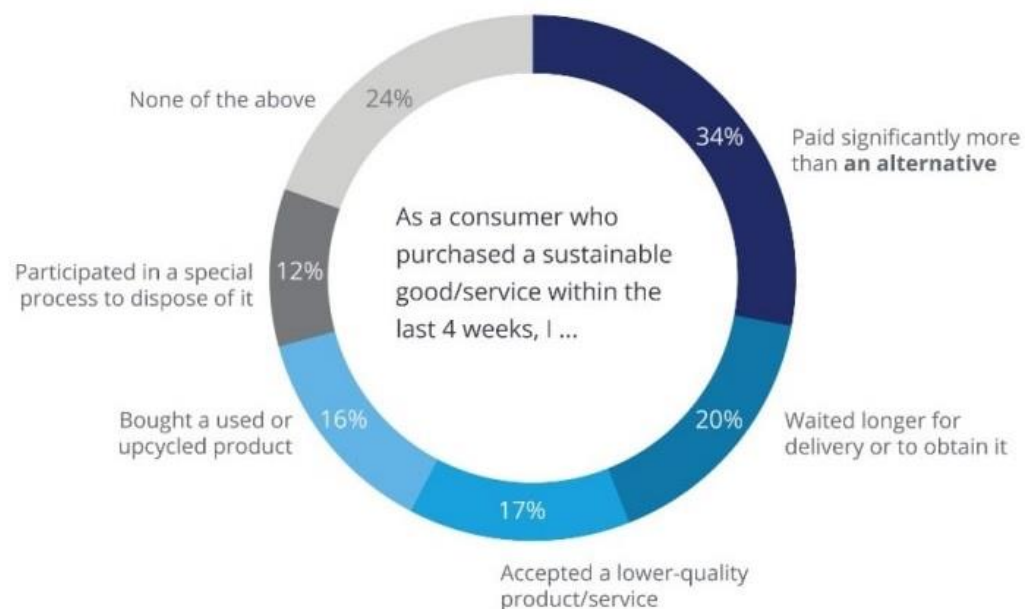
Personal care	Conventional	Natural	Difference
Deodorant	\$3.90	\$7.00	79.49%
Toothpaste	\$5.50	\$9.95	80.91%
Hand wash	\$2.79	\$8.00	186.74%
Body lotion	\$8.00	\$19.95	149.38%
Toilet paper	\$12.00	\$34.00	183.33%

Think about it from a consumer standpoint...

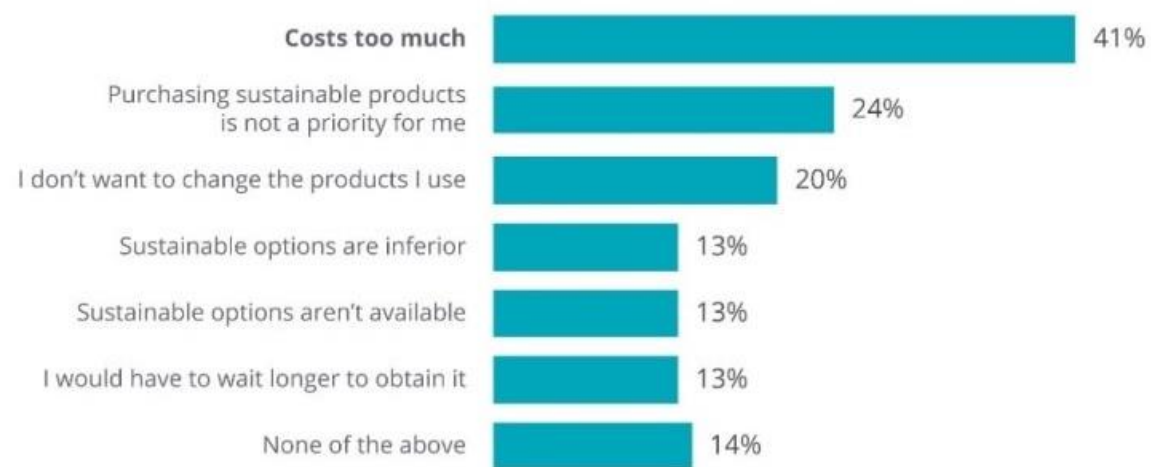
Fashion	Conventional	Eco	Difference
Sneakers	\$120.00	\$120.00	0.00%
T-shirt	\$2.00	\$31.90	1495.00%
Hoodie	\$16.00	\$90.00	462.50%
Socks	\$1.00	\$9.95	895.00%

Think about it from a consumer standpoint...

Consumers cite cost as a major concern while making decisions around sustainable purchases



Reasons why consumers did not purchase a sustainable good/service within the last 4 weeks



Note: N = 21,034 adults from Australia, Belgium, Canada, China, Denmark, France, Germany, Ireland, Italy, Japan, Mexico, Netherlands, Norway, Poland, South Korea, Spain, Sweden, Switzerland, United Kingdom, and United States.
Sources: Deloitte Global State of the Consumer Tracker; Organisation for Economic Cooperation and Development.

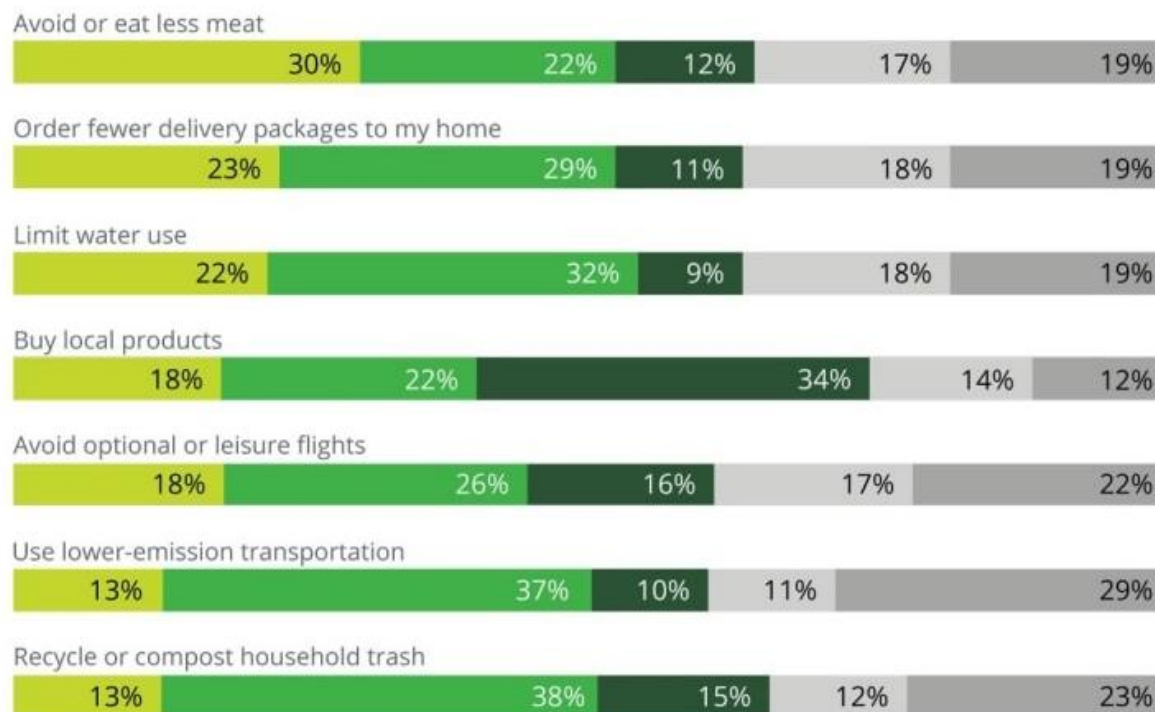
Is it worth the trade-off?

Perceived trade-offs vary across sustainable activities

Among consumers who never, rarely, or only sometimes do the following activities

■ Believe it won't make a difference ■ Convenience ■ Cost

■ Did not occur to me ■ Not an option given my circumstances

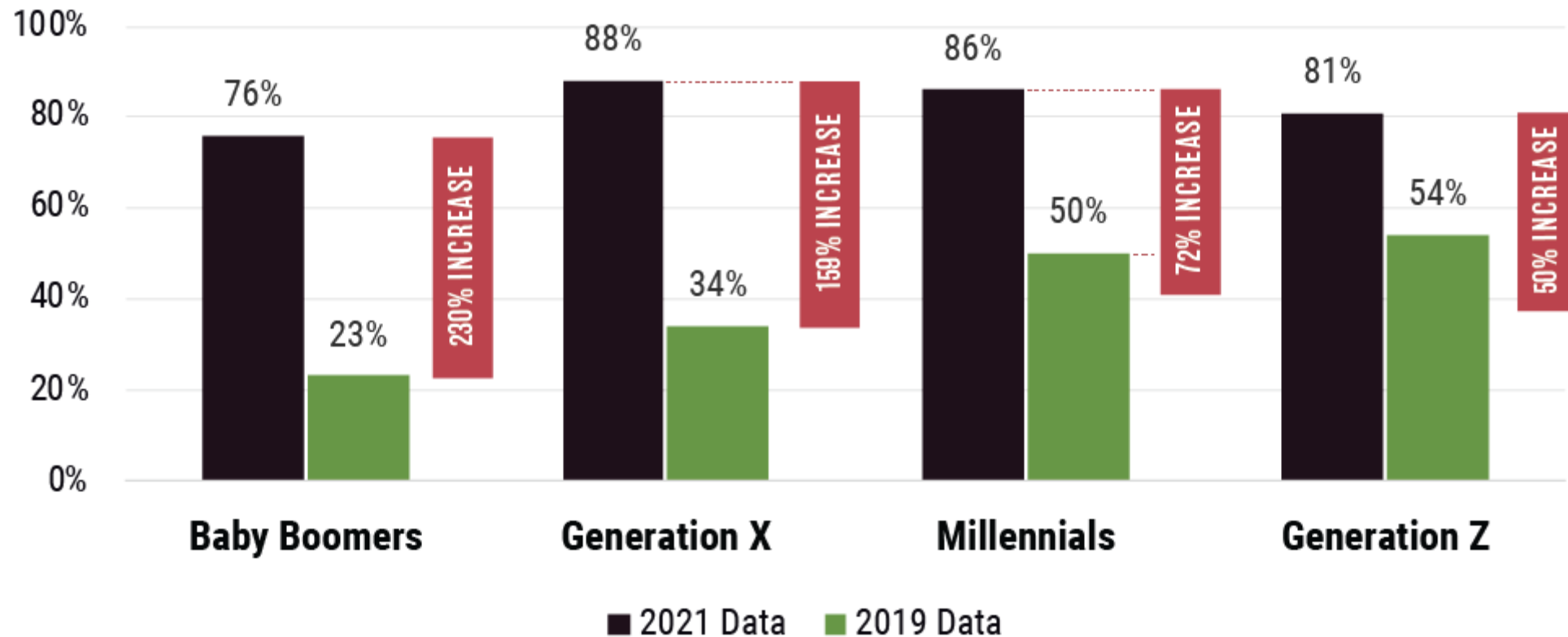


Note: N = 21,034 adults from Australia, Belgium, Canada, China, Denmark, France, Germany, Ireland, Italy, Japan, Mexico, Netherlands, Norway, Poland, South Korea, Spain, Sweden, Switzerland, United Kingdom, and United States.

Source: Deloitte Global State of the Consumer Tracker.

Things are Changing...for the better!

WILLING TO SPEND AT LEAST 10% MORE FOR SUSTAINABLE PRODUCTS



Generational differences in eco-friendly consumerism

Millennials are most likely to be thinking about sustainability while shopping.

Q: Please indicate to what extent you agree or disagree with the following statements around shopping sustainably.
(Answers are a combination of “agree” and “strongly agree” responses)

Darker shades of green indicate greater proportions of agreement relative to other generational cohorts.

	Generation Z	Young millennials (age 23-26)	Core millennials (age 27-32)	Mature millennials (age 33-36)	Generation X	Baby boomers
I choose products with a traceable and transparent origin	47%	59%	60%	62%	56%	48%
I buy from companies that are conscious and supportive of protecting the environment	49%	60%	61%	58%	53%	47%
I intentionally buy items with eco-friendly packaging or less packaging	48%	55%	60%	55%	55%	51%
I am buying more biodegradable/eco-friendly products	48%	56%	59%	58%	52%	47%
When shopping for products, I check the labeling/packaging for sustainability certification(s)	47%	57%	58%	53%	51%	43%

Base: Generation Z (1,360); young millennials (933); core millennials (1,588); mature millennials (919); generation X (2,848); baby boomers (975).

Note: The greatest generation (the oldest group) is not shown, because the base is too low.

Source: June 2021 Global Consumer Insights Pulse Survey

Barriers to Purchasing Eco-Friendly Products According to UK and US Internet Users, Jan 2021

% of respondents

High cost of products

60%

Hard to find eco-friendly products/brands

24%

Not enough information as to what "eco-friendly" means

19%

Not familiar with eco-friendly brands/prefer brands they know

19%

Unclear about the benefits/value of eco-friendly products

14%

Don't think eco-friendly products/brands are as effective as traditionally made ones

11%

Don't think their individual impact makes a difference

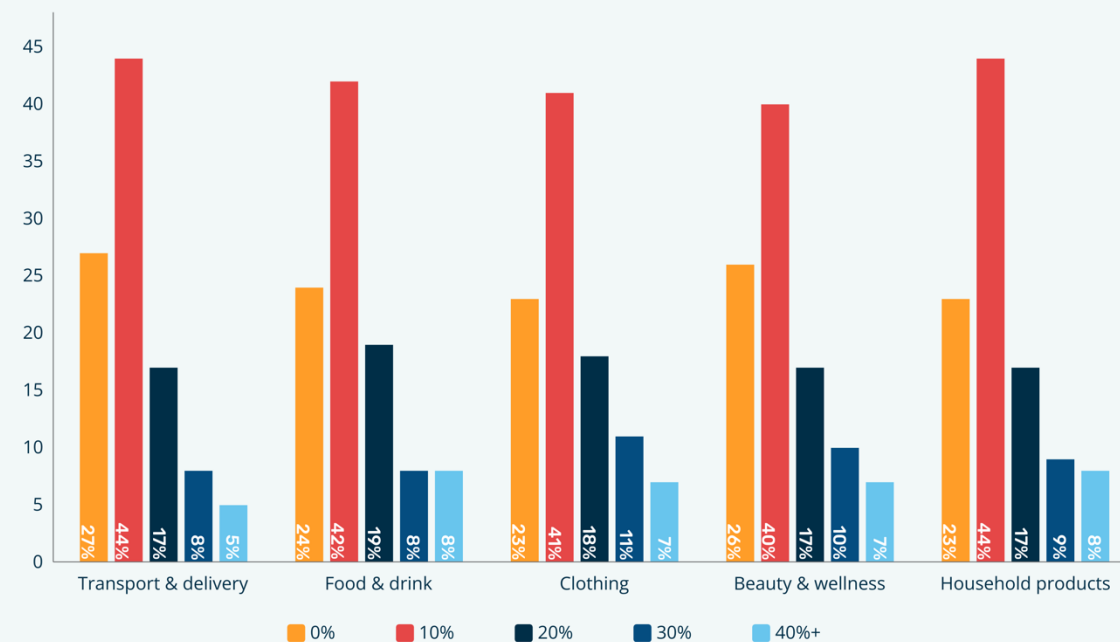
10%

Note: UK n=2,000 ages 16-64; US n=2,001 ages 16-64

Source: GlobalWebIndex as cited in company blog, Feb 23, 2021

Where can we, as scientists, engineers, and activists contribute?

How much more are you willing to pay for sustainable products by industry?



Source: Capterra Sustainability Survey 2021

Q: How much more are you willing to pay more for sustainable products in comparison with regular products?
n: 1019

Businesses make the same decisions!

Sustainable materials can often be more expensive than traditional materials:
higher production costs
limited availability
the cost of complying with environmental and social standards
This can make it difficult for builders and developers to justify the higher costs, especially in markets where there is intense competition and tight profit margins.

Anyone have an idea on how we might “bridge the gap” between sustainable and conventional materials in the industrial sector?

Many economists have recommended a carbon tax (or equivalent subsidization of sustainable materials to bring the costs in line).
Anyone know how many U.S. states have implemented a carbon tax?

There are currently **no** state or federal carbon taxes in the U.S.

Challenges to utilizing sustainable materials

- Limited availability
- Cost considerations
- **Certification and standards**
- Quality and performance
- Education and awareness
- Regulatory compliance
- Supply chain transparency
- Waste management
- Local sourcing



There's no centralized standard for what makes a material sustainable

- There are numerous standards and certifications for sustainable materials, but they can be confusing and sometimes contradictory.
- This can make it difficult for even the most sustainably minded to know which materials to choose and how to ensure that they are truly sustainable.



We can't even agree on what **IS** a sustainable material

Stay tuned for later discussions of **life cycle analyses** (LCAs):

“systematic analysis of environmental impact over the course of the entire life cycle of a product, material, process, or other measurable activity. LCA models the environmental implications of the many interacting systems that make up industrial production. When accurately performed, it can provide valuable data that decision-makers can use in support of sustainability initiatives.”

- LCAs can often give surprising results—a classic example is that using paperless billing is usually **WORSE** for the environment since e-billing uses grid energy (fossil fuels) to power servers and devices.

GREENWASHING, EXPLAINED

WSJ • Glossary



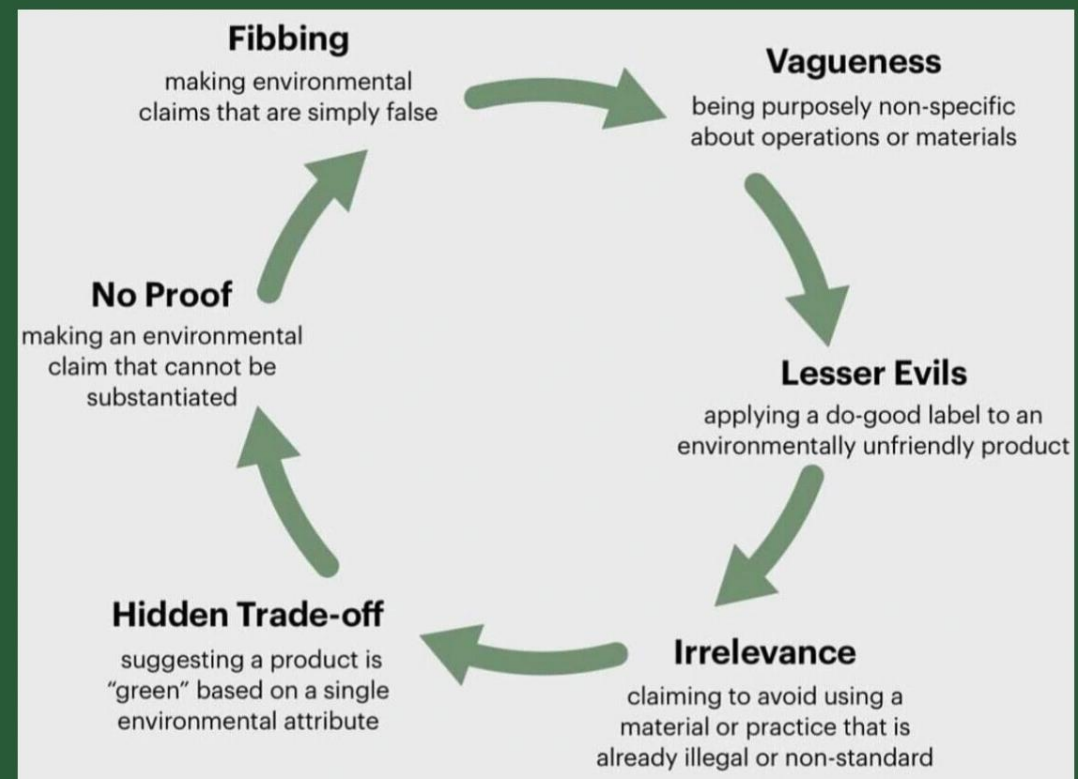
Look for these classic signs of greenwashing

GREENWASHING ADVERTISEMENT EXAMPLE

The advertisement features several greenwashing tactics highlighted by callouts:

- Green imagery:** The background is filled with fresh green leaves, creating a natural and eco-friendly aesthetic.
- Vague claims without further explanation or data:** The claim "Now using sustainably sourced ingredients" is made without providing any specific details or evidence.
- Bold and vague comparisons:** The claim "50% more sustainable than the leading competitor" is bold and lacks context, such as which specific attribute is being compared.
- Emphasis on one "green" aspect to compensate for less sustainable practices:** The focus is on "Eco-friendly packaging" and "sustainable ingredients" while ignoring other environmental impacts.

Six sins of greenwashing



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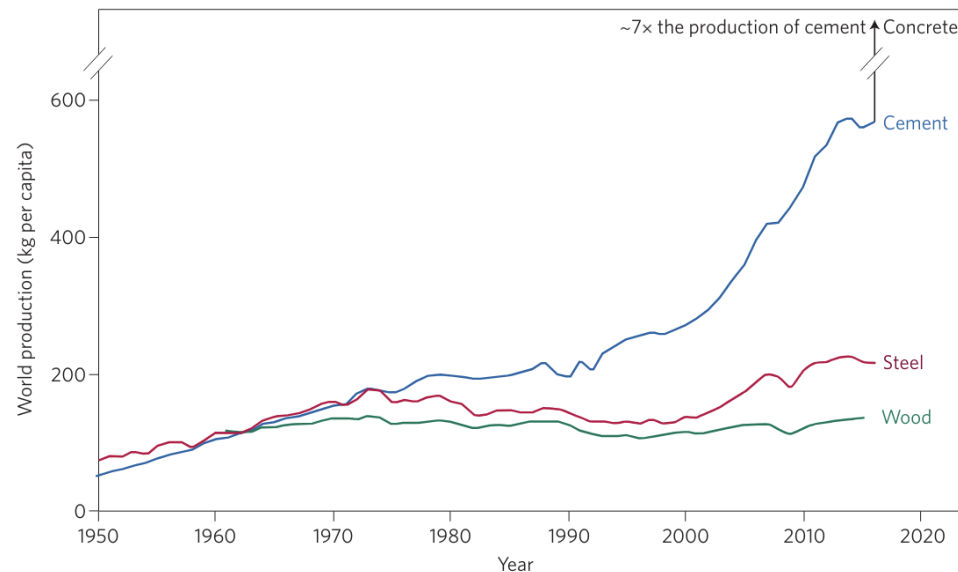


What is the most consumed material in the world by mass?

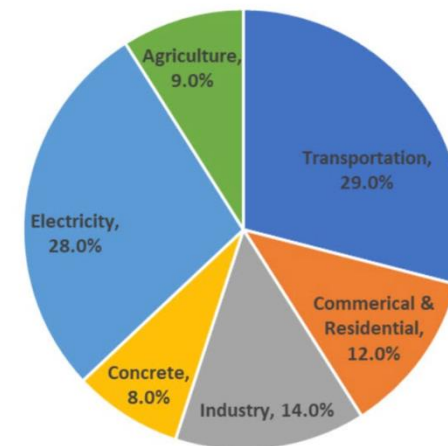
It's water...but what is number 2?

It's concrete! Over 30 billion tons!

Concrete outpaces per capita production of any other material

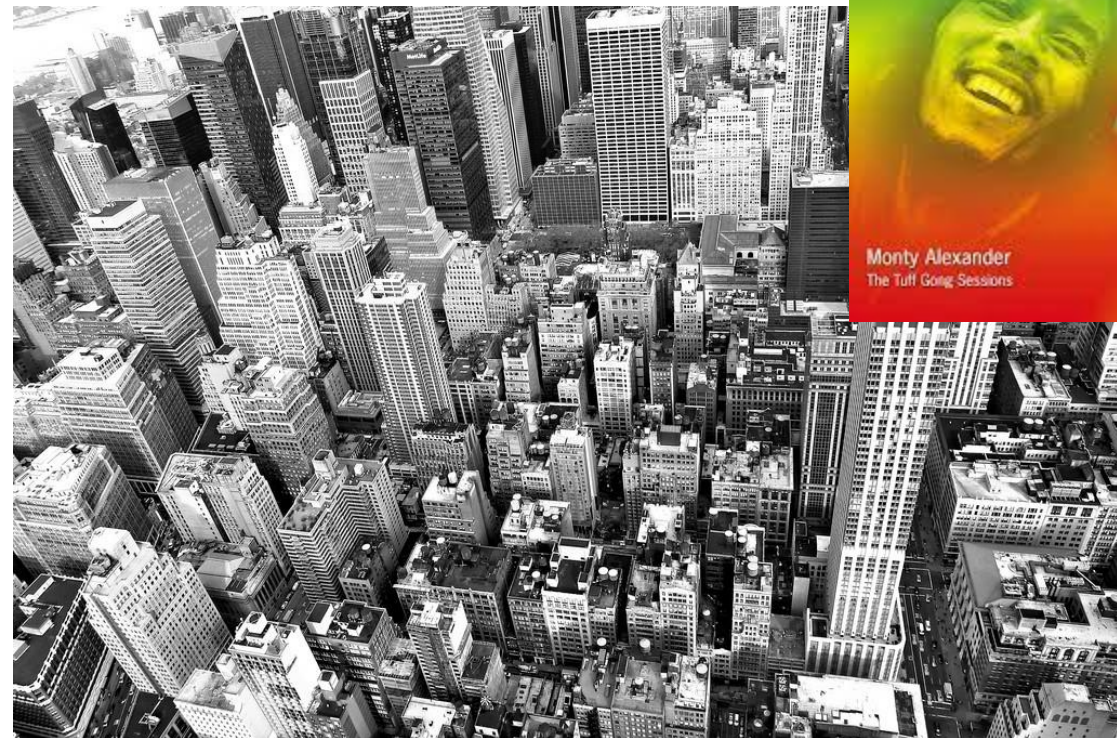


Total Global Carbon Emissions by Sector



We should stop using concrete!

- Easier said than done—there's a reason we use it.
- It's a fantastic material
 1. Strength
 2. Durability
 3. Reflectivity
 4. Versatility



We should stop using concrete!



36% of global energy used by buildings and their construction

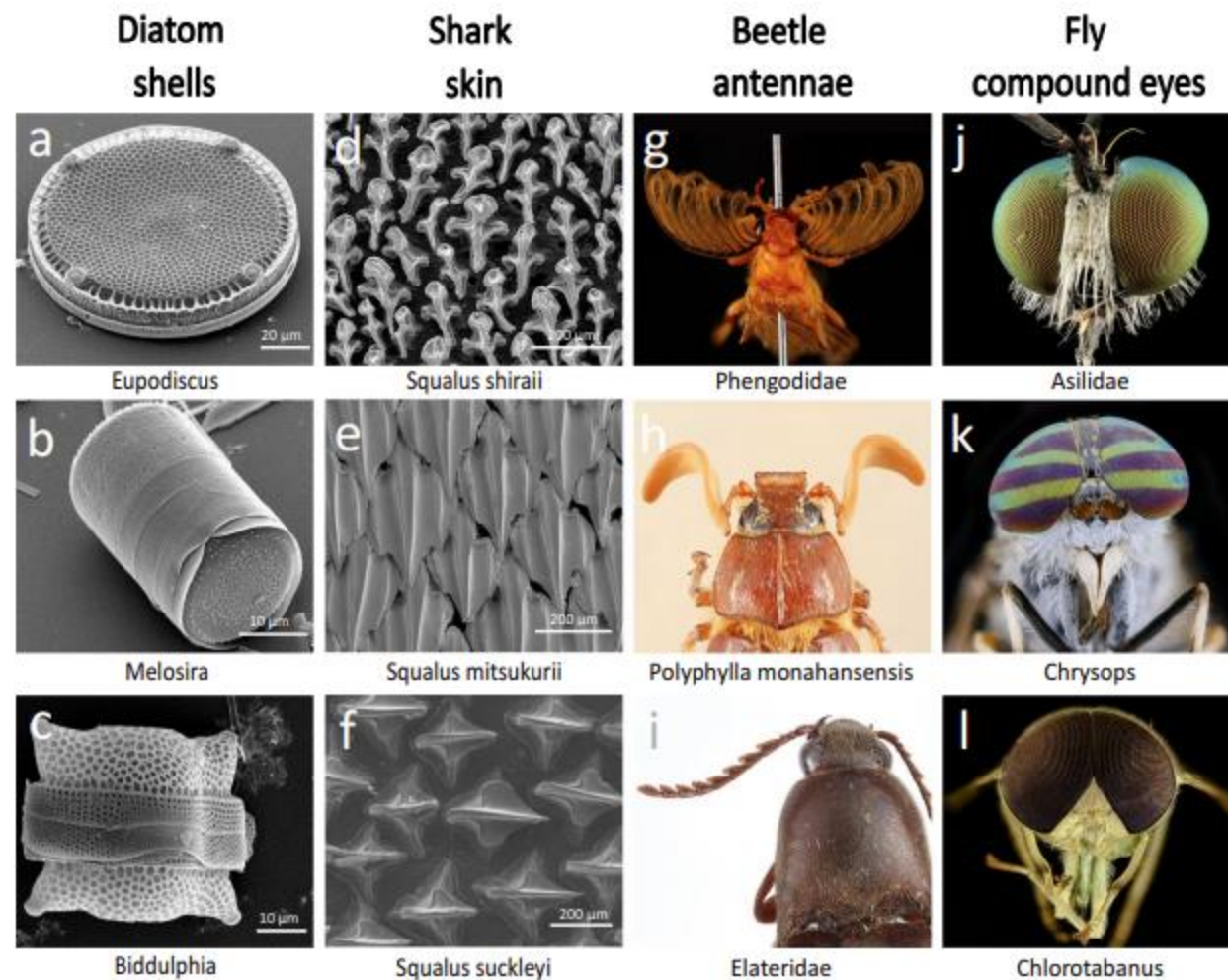
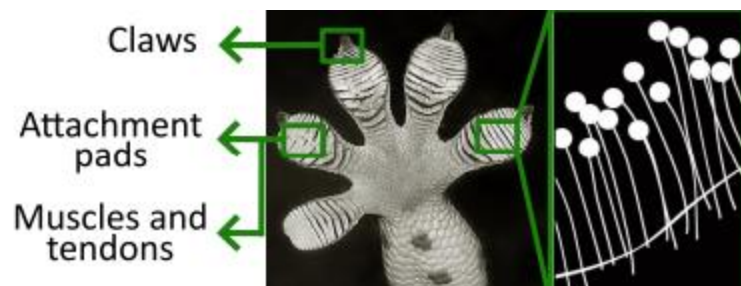


5% increase from 2020

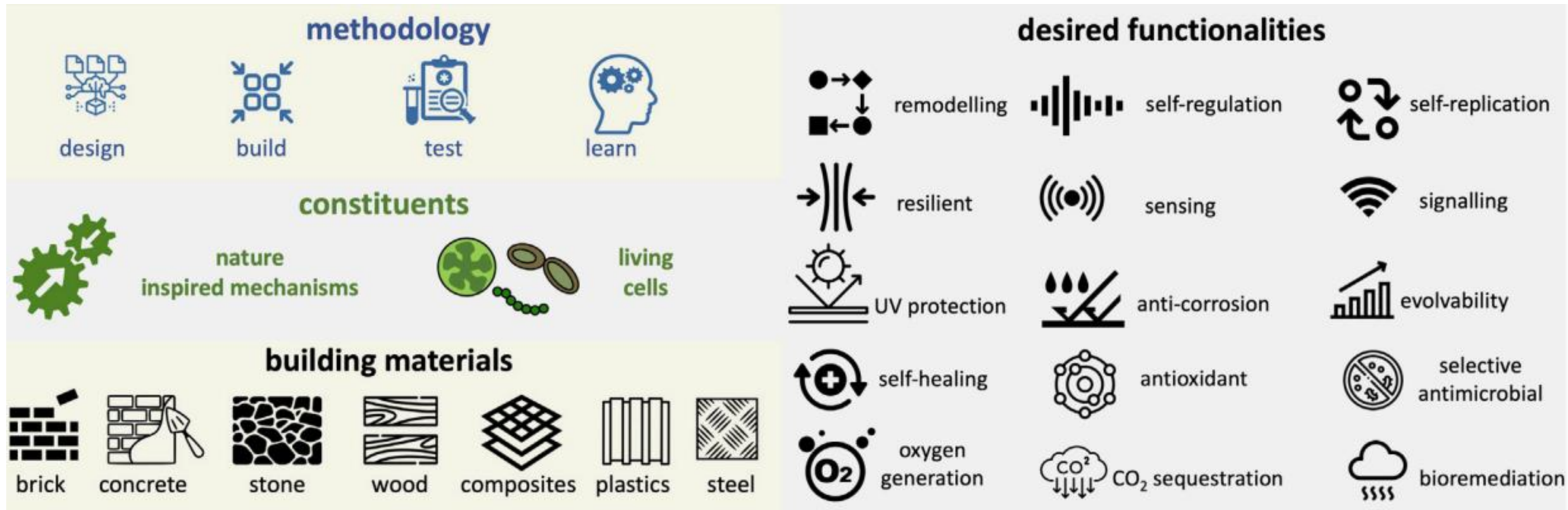
CO₂ emissions from building operations reached a record high



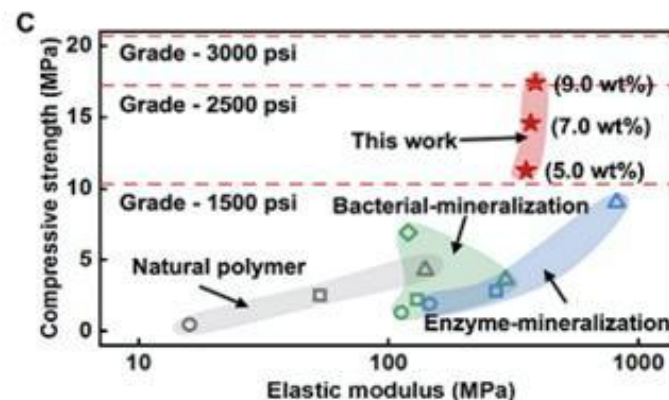
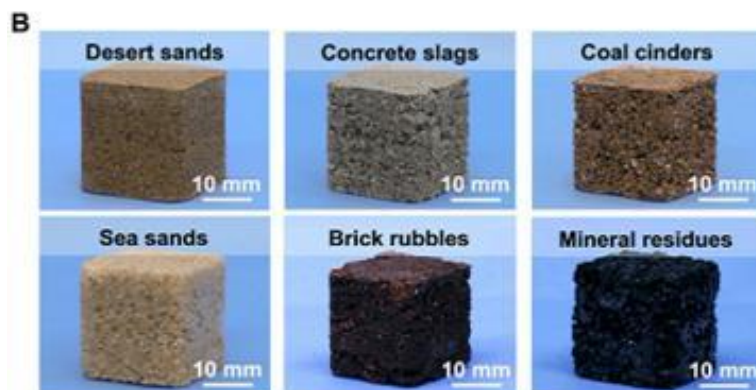
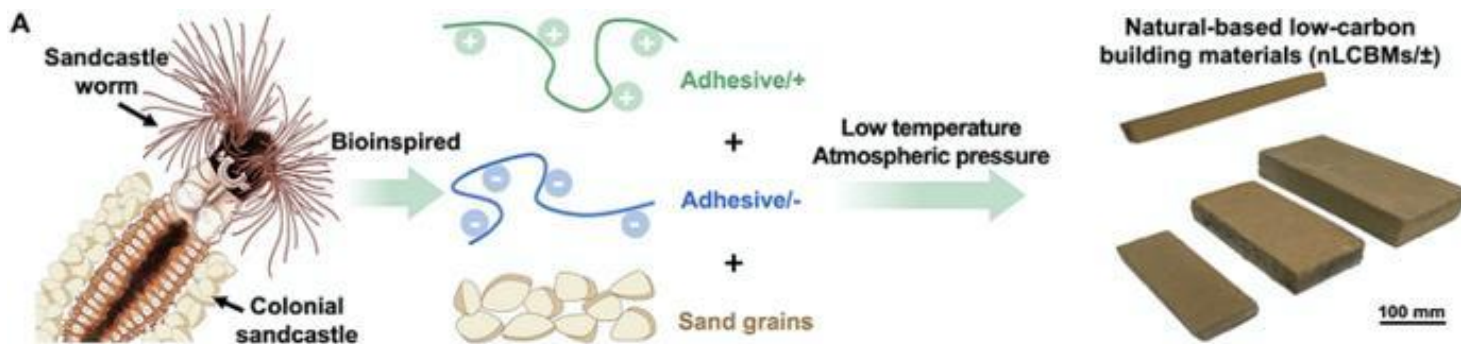
Can biology be our inspiration for new materials?



Can biology be our inspiration for new materials?



Can biology be our inspiration for new materials?



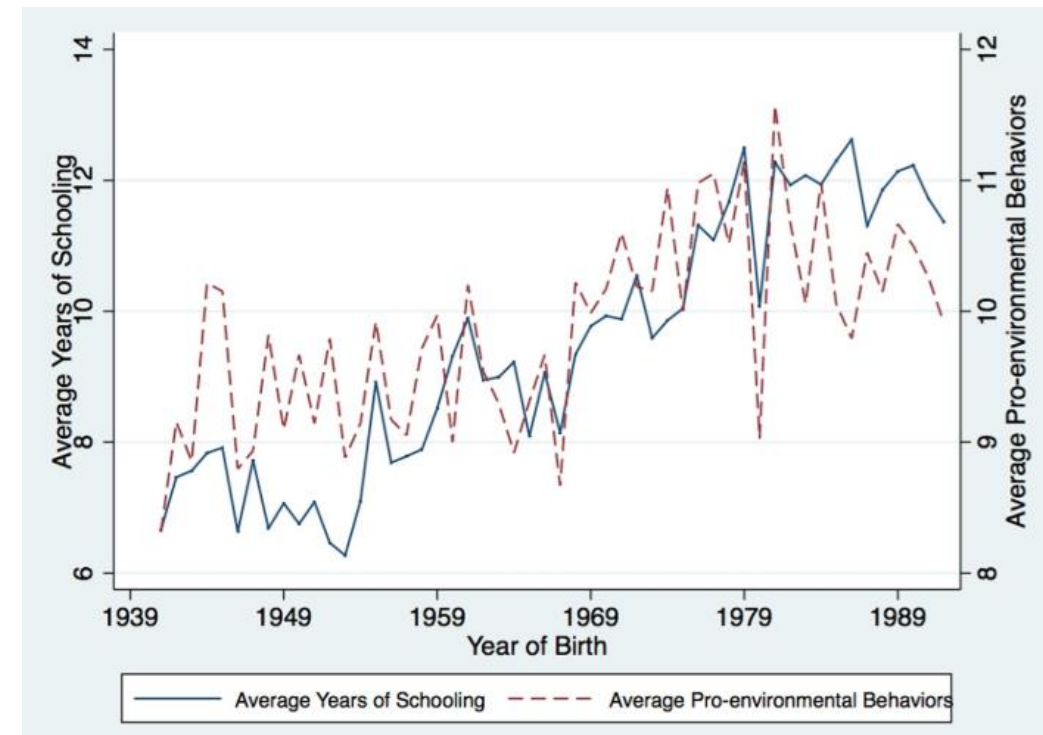
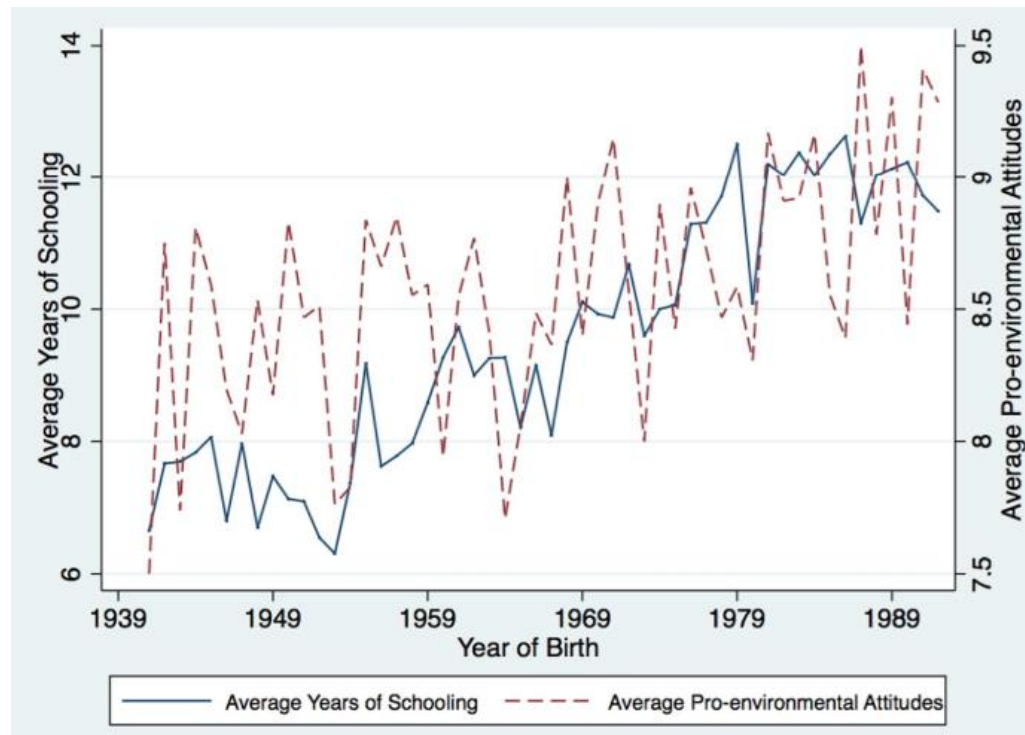
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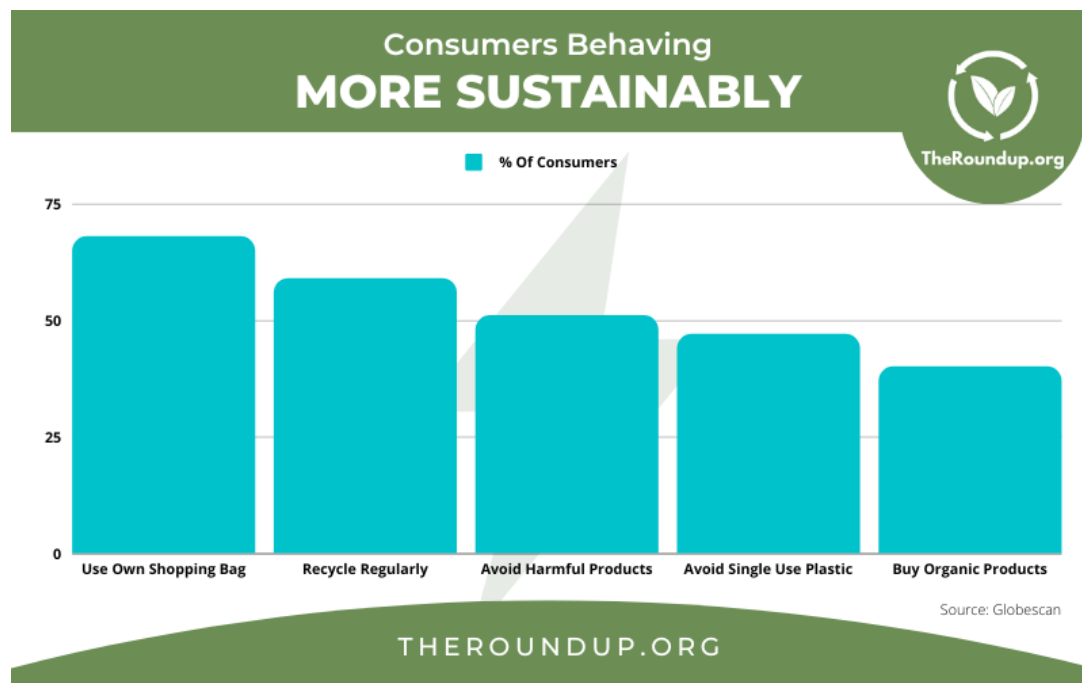


You're already taking step 1!

- One of the most reliable ways to improve individual sustainable attitudes and behaviors is education



Awareness improves behavior



People's intention to adopt more sustainable behaviors has accelerated during the pandemic

1/3

are currently practicing green behaviors consistently

25%+

say they have been doing this more since the crisis started

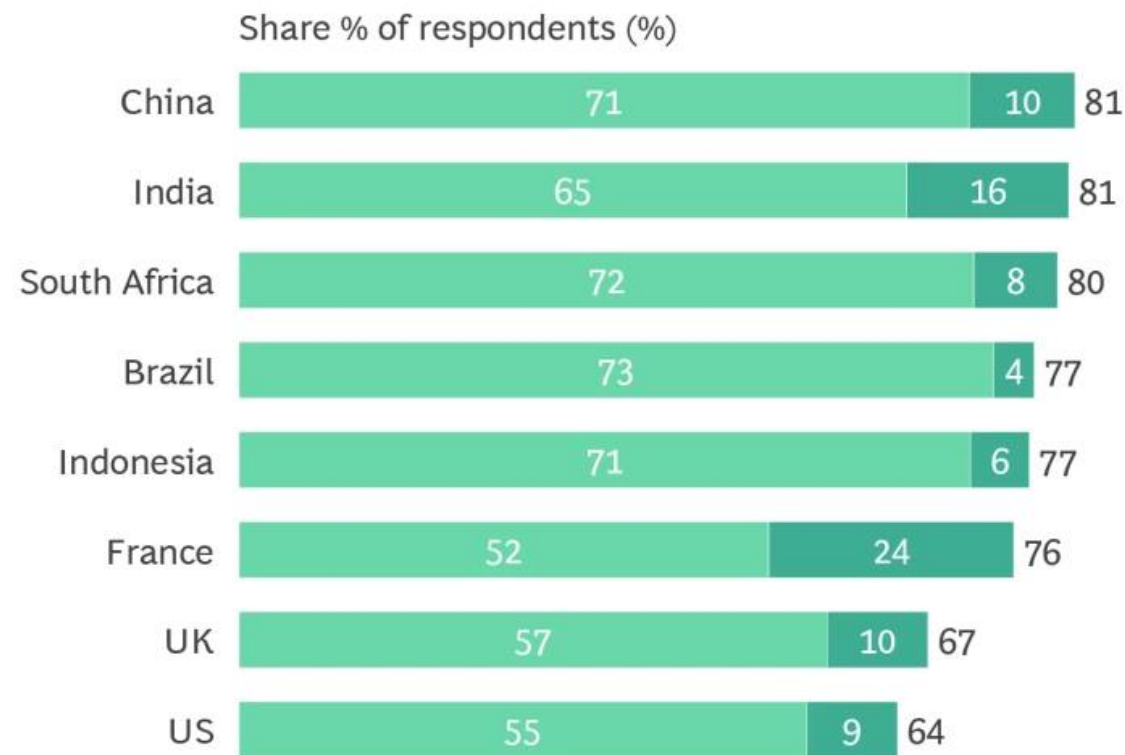
Nearly

40%

intend to integrate more sustainable behaviors in the future

Source: BCG Survey on COVID-19 and Environment, conducted May 20-29, 2020, in Brazil, China, France, India, Indonesia, South Africa, the UK, and the US. Number of respondents N = 3,249.
Note: Survey text: "In light of the COVID-19 outbreak, I am now more aware of the fact that humans can be threatened by the degradation of the environment" and "In light of the COVID-19 outbreak, I am now more aware of how the climate is threatened by human activity." Overall, 72% and 70% of respondents, respectively, agreed with these two statements.

About three-fourths of respondents consider environmental issues at least as concerning as health issues



= Both issues as equally concerning for the world

+ Environment is more concerning than health for the world

76%

think environmental issues are as concerning as or more concerning than health issues

= The proportion is the same regardless of whether people have been impacted financially or suffered illness, and does not vary by age or gender

People expect companies to do more to protect the environment—and they believe that governments should embed that priority in their recovery plans

“ To what extent do you think private companies should integrate environmental considerations into their products or services and the way they operate?

87%

Average percentage of respondents answering "A lot more" or "Somewhat more" across countries (%)

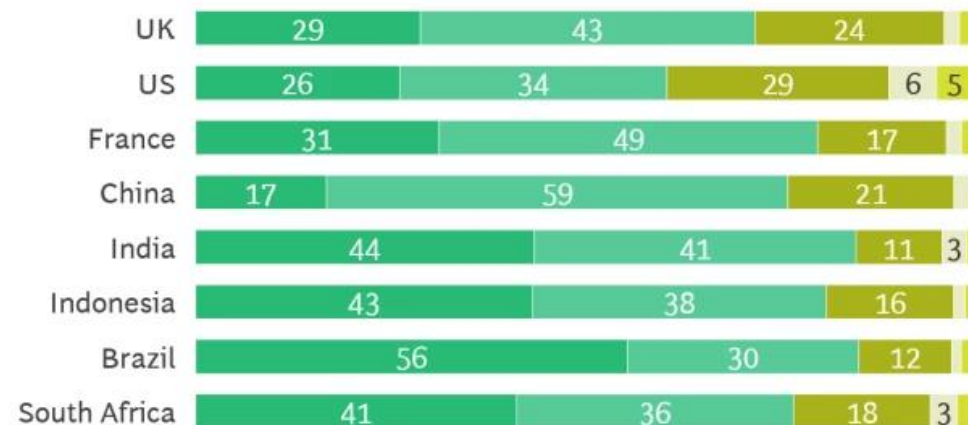


■ A lot more ■ No change required ■ A lot less
■ Somewhat more ■ Somewhat less

“ Companies that are likely to benefit from public aid or grants should take on extra environmental responsibilities and commitments

77%

Average percentage of respondents answering "Strongly agree" or "Somewhat agree" across countries (%)



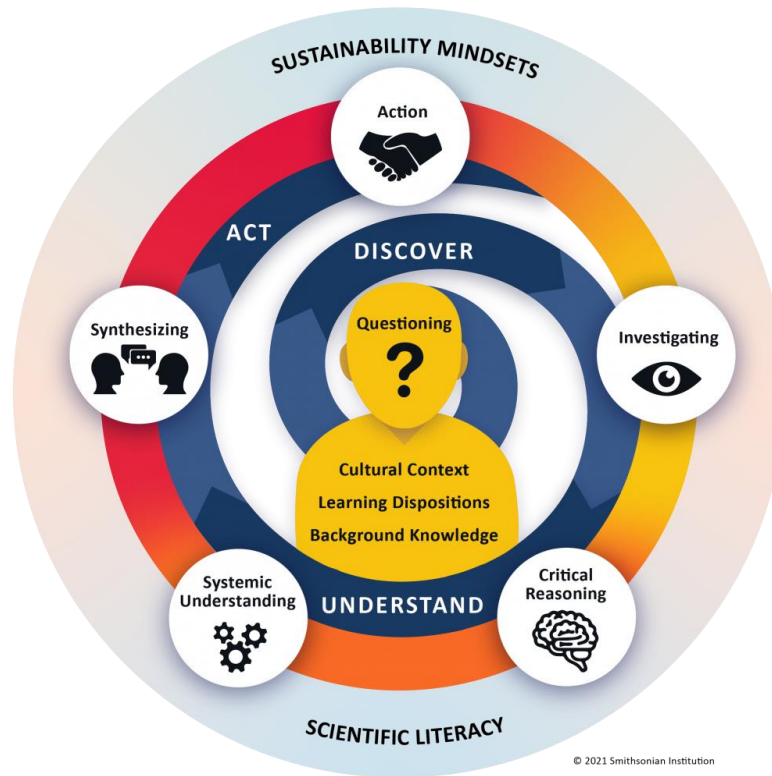
■ Strongly agree ■ Neither agree or disagree ■ Strongly disagree
■ Somewhat agree ■ Somewhat disagree

Source: BCG Survey on COVID-19 and Environment, conducted May 20–29, 2020, in Brazil, China, France, India, Indonesia, South Africa, the UK, and the US. Number of respondents N = 3,249.

Note: In this slide, bar segments representing percentages of 2% or less are not labeled. For this reason and because of rounding, the sums of the percentages identified in most of the bar charts do not equal 100%.

Be informed. It is up to you!

GLOBAL GOALS ACTION PROGRESSION



SUSTAINABILITY MINDSETS



Challenges to utilizing sustainable materials

- Limited availability
- Cost considerations
- Certification and standards
- Quality and performance
- Education and awareness
- **Regulatory compliance**
- Supply chain transparency
- Waste management
- Local sourcing



Regulation is one of the most efficient ways to enact change

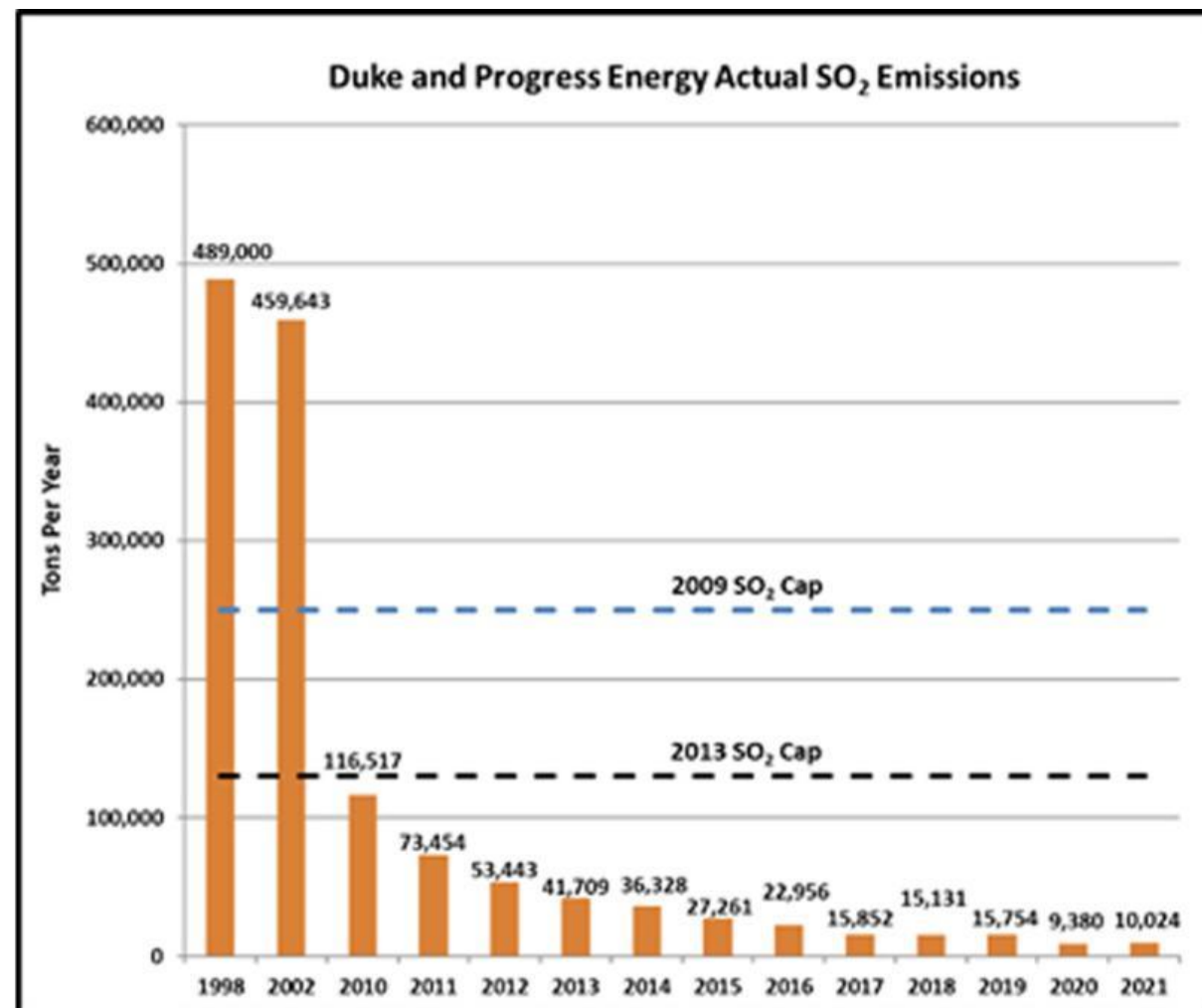
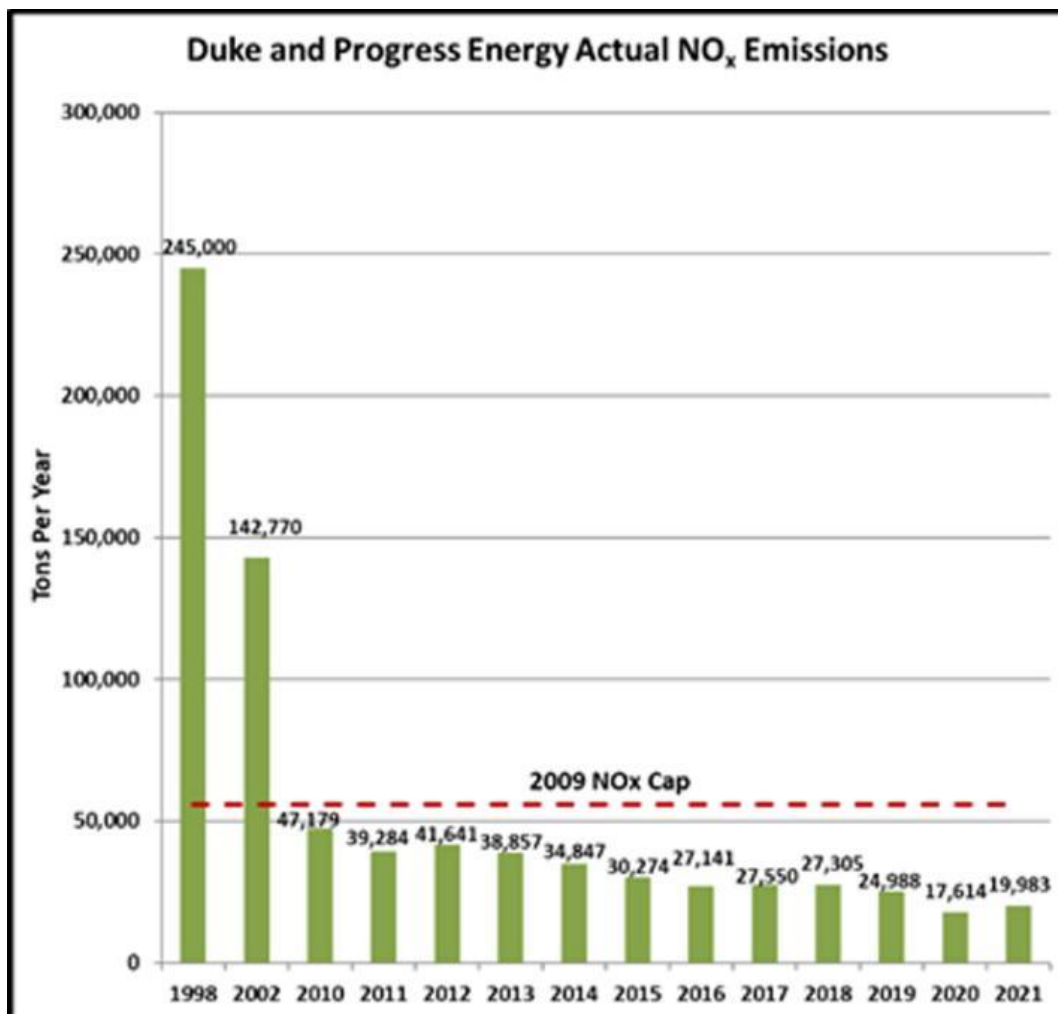


Congress passed the Clean Air Act in 1963. A little over a decade later, national laws requiring catalytic converters for new automobiles were introduced.

Would this improvement had occurred without regulation?
Probably not!



Regulation is one of the most efficient ways to enact change



Catalyzing Clean Energy Industries and Jobs Through Federal Sustainability

Executive Order 14057

- Achieve 100 percent carbon pollution-free electricity by 2030, including 50 percent on a 24/7 basis.
- Reach 100 percent zero-emission vehicle acquisition by 2035, including 100 percent light-duty acquisitions by 2027.
- Achieve net-zero building emissions by 2045, including a 50 percent reduction by 2032.
- Reduce Scope 1 and 2 greenhouse gas emissions by 65 percent from 2008 levels by 2030.
- Establish targets to reduce energy and potable water use intensity by 2030.
- Reduce procurement emissions to net-zero by 2050.
- Have climate resilient infrastructure and operations.
- Develop a climate- and sustainability-focused workforce.
- Advance environmental justice and equity-focused operations.
- Accelerate progress through domestic and international partnerships.

Environmental, social, and governance (ESG)

↳ The three central factors used to measure the sustainability and ethical impact of an investment in a company or business.

Environmental: This criterion examines how a company performs as a steward of nature.

1. Carbon emissions
2. Carbon footprint
3. Energy efficiency
4. Waste management
5. Natural resource conservation
6. Environmental risks

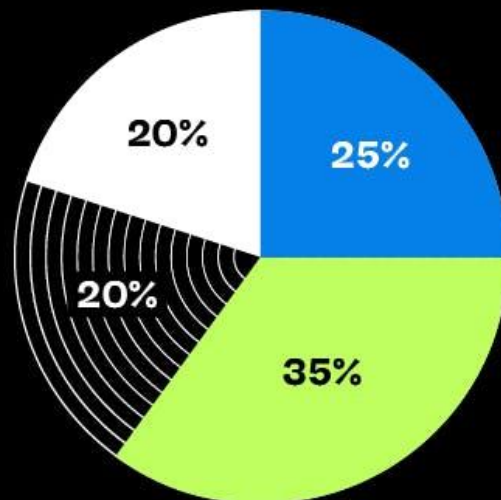


Put your money where your mouth is! Many investment firms integrate ESG criteria into their investment strategies.

BlackRock: One of the world's largest investment management firms, BlackRock has made significant commitments to ESG investing. They offer a range of ESG-focused funds and have been vocal about the importance of sustainable investing.

The biggest problem with regulations is compliance

Number of Hours Organizations Spend on Compliance in a Year



Source: Drata

“Significant violations occur at 25 percent or more of facilities in nearly all programs for which there is compliance data.”

Sector and regulation	Number of random inspections required	Noncompliance rate ^a
Organic Chemical Manufacturing small quantity generator hazardous waste requirements under RCRA ^b	112	34.3% (+/- 8.1%)
Ethylene Oxide Manufacturers Clean Air Act toxic air pollution requirements ^c	67	49.2% (+/- 5%)
Municipal Combined Sewer requirements under Clean Water Act ^d	214	61.4% (+/- 5%)

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To understand a sustainable material's impact, you need to know its journey



On average, organizations have to deal with

10,000

third-party relationships.

62%

of the organizations that participated in a recent Refinitiv survey did not know how many of their third-party vendors are outsourcing to other third parties.

43%

of third-party relationships are not subject to any form of due diligence checks, as companies struggle to monitor third-party risks in the post- COVID-19 environment.

To understand a sustainable material's impact, you need to know its journey



“

A landmark legal case has been launched against the world's largest tech companies by Congolese families who say their children were killed or maimed while mining for cobalt used to power smartphones, laptops and electric cars.

The Guardian, 2019



“

The resilience of a supply chain is dependent on the reliable performance of the suppliers who make it up, but the fiscal health of many of lower-tier firms is often not visible to executives at companies several tiers up.

Harvard Business Review, 2022

To understand a sustainable material's impact, you need to know its journey



Life and death in Apple's forbidden city



The New York Times

Foxconn Is Under Scrutiny for Worker Conditions. It's Not the First Time.

'Re-education', forced labour and surveillance beyond Xinjiang

ASPI
AUSTRALIAN STRATEGIC POLICY INSTITUTE

INTERNATIONAL CYBER POLICY CENTRE



Bangladesh collapse search over; death toll 1,127



To understand a sustainable material's impact, you need to know its journey



Raw materials: probably the most obvious example. If it is made from non-renewable materials, it is probably not sustainable.

To understand a sustainable material's impact, you need to know its journey



Manufacturing: if your new degradable plastic requires more energy than a town to produce, or uses solvents that are polluting the water supply, it is not sustainable.

To understand a sustainable material's impact, you need to know its journey



Packaging: I once heard a story of someone buying some degradable straws, and they were shipped in a plastic bag and individually wrapped in plastic...not sustainable!

To understand a sustainable material's impact, you need to know its journey



Distribution: transportation is the largest emitter of carbon dioxide. If you are shipping the material from China with jet fuel-it's not very sustainable.

To understand a sustainable material's impact, you need to know its journey



Use: if you only reuse your “reusable” plastic bag twice you should have just used the disposable bags.

To understand a sustainable material's impact, you need to know its journey

81% of 1,700 companies surveyed lack full visibility into the social responsibility practices of their suppliers; *over 50% of companies had no visibility at all.* (The Sustainability Consortium, 2016)

Improving visibility is costly and resource-intensive: *\$709M and 6 million staff hours were spent* in 2014 to try to comply with conflict minerals' regulations. (WSJ, 2015)

Marks & Spencer is working with "customers and stakeholders to identify *what information they consider to be important* about where and how M&S products are produced ..." (M&S Plan A Report, 2015)

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End-of-life material management is critical in sustainable materials design

What is the most preferred treatment after using a material?



1. Use it again! The more times something gets used the fewer we have to produce.

2. Recycle/compost (if possible for a given material)

3. Energy recovery-depending on the material (think wood) we could burn it to use its energy for another downstream process

4. Landfill-obviously not an ideal long-term solution

How can we make our materials more reusable?

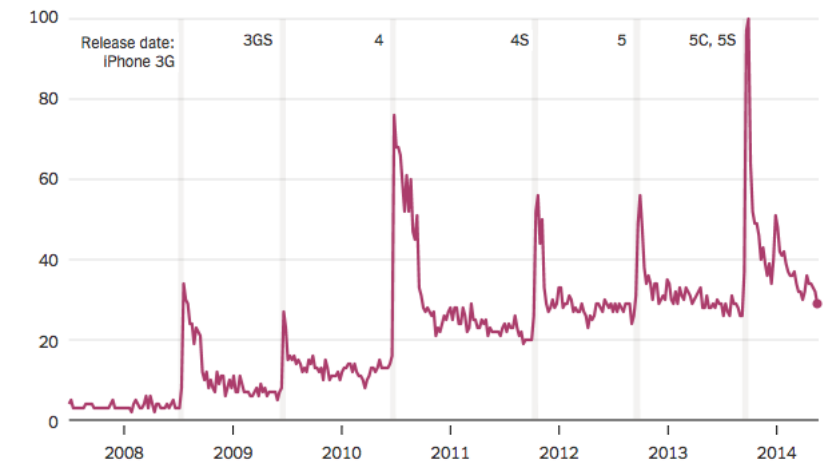
It needs to be:

1. Reliable
2. Durable
3. Lightweight (preferably)
4. Able to preserve quality over time

- Modular design offers additional advantages by making repair, refurbishment, and recycling easier.
- Another key issue-if you can reuse a product indefinitely you are not buying another one.
 - it is in the best interests of the business for you to buy a new one every day/week/year



Searches for "iPhone slow"



Sources: Google Trends, Laura Trucco

OPINION



OPINION

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Local sourcing materials has a variety of benefits and downsides

- Environmental benefits
- Stronger supply chain
- Order flexibility
- Quality control
- Community engagement
- Strengthens the local economy
- Predictable delivery times
- Transparency
- Lower spoiler risks
- Lower shipping costs

- Scarcity
- Higher price points
- Dependence
- Backlash
- Reduced innovation
- Scalability
- Lower objectivity
- Limited options
- Lower risk diversification

3D printing allows for on-site production of materials

7 Ways 3D Printing Helps You Go Green

Make Parts Locally

3D printers can fit in your office so you can make parts, prototypes, and products locally, as opposed to shipping them from a far away. The result is less environmental impact from planes, ships, and trucks.



Smaller, Quieter Factories

One 3D printer can replace several pieces of traditional manufacturing equipment because it can print a wide variety of parts in a wide variety of materials. Less equipment makes for smaller, quieter factories and fewer emissions.



Repairability & Spare Parts

3D printers can quickly and cheaply make repair parts for unique or out-of-production equipment, keeping old machines and vehicles off the scrap heap and eliminating the need for more raw materials and energy to manufacture new machines.



More Efficient Design

3D printers can make parts with shapes and features unachievable with other manufacturing methods. You can redesign your part to make it more efficient and use less material. Products that were once made of multiple parts can now be printed as one thus reducing material, time, and labor.

Streamline Manufacturing

3D printers require fewer tools and processes than traditional manufacturing thus eliminating a lot of labor, equipment, and energy. 3D printing is often faster.



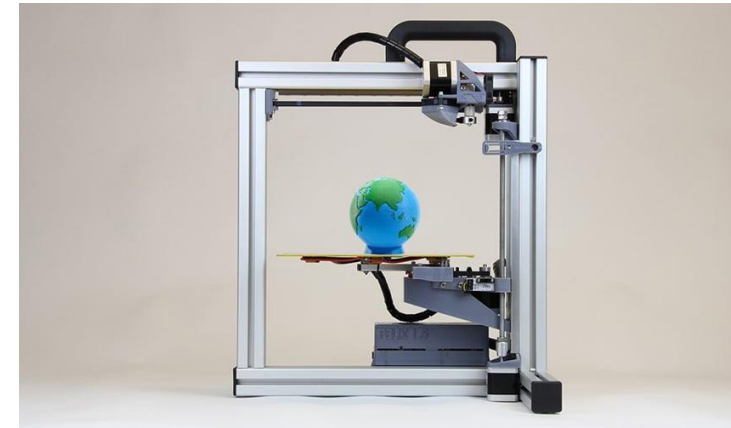
Less Raw Material

3D printers make parts with only the material needed and minimal support material instead of carving a part from a block of metal, wood, or plastic, which produces waste.



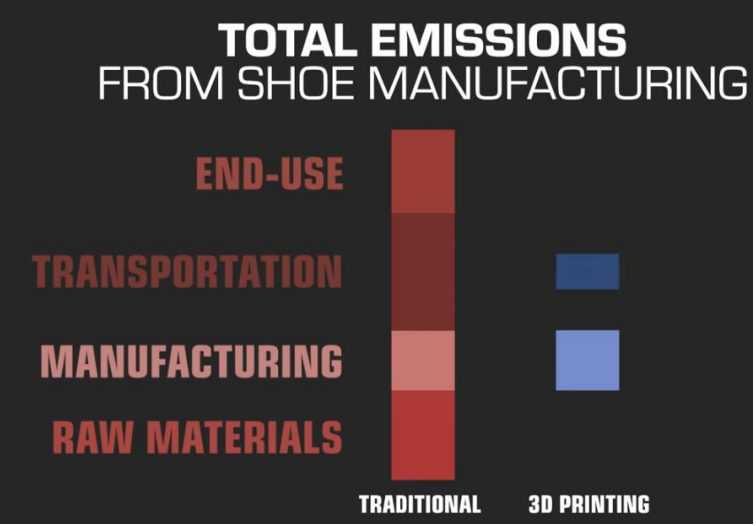
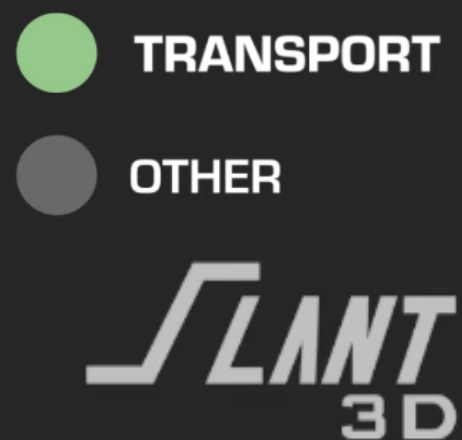
Eliminate Inventory

With 3D printers, you can print on demand or print small batches instead of having a warehouse of spare and overstock parts, many of which may never be needed.



Manufacturing optimization

TRADITIONAL MANUFACTURING



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That's a lot of challenges...

See you next time for some solutions with Dr. Lauren Blake!

