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McKinsey Technology Trends Outlook 2022

Future of sustainable consumption

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What is the tech trend about?

Sustainable consumption centers on the use of goods and services that are produced with minimal environmental impact, using low-carbon and sustainable materials. Enabling technologies transform industrial and individual consumption to address environmental risks, including climate change

6 main patterns reflect enhancements in conscious consumption

Low carbon

Minimizing greenhouse-gas (GHG) emissions over life cycle of production, use, and disposal



Reduce, reuse, and recycle

Reusing materials previously used in a product or created as a manufacturing by-product



Biodegradable

Using materials that can be broken down into chemical constituents in ambient conditions (ie, landfill)



Waste conscious

Minimizing waste through optimized consumption (eg, of water, plastic)



Biobased

Prioritizing materials intentionally made from substances derived from living (or once-living) organisms



Nontoxic

Following processes that emit fewer chemicals and environmental pollutants during production and use



Consumption types

Industrial

- Industry (eg, mining, chemicals)
- Sustainable agriculture
- Public and industrial transport
- Commercial buildings

Individual

- Residential buildings
- Passenger transportation (eg, personal vehicles)
- Household consumption (eg, food)

Energy end use contributes to ~50% of GHG emissions, vs ~20% from energy supply and ~30% from non-energy-related emissions

Why should leaders pay attention?

At a macro level, **sustainability is no longer optional**: 90% emission reduction paired with emission removal is needed to avoid an environmental crisis, creating a \$4 trillion–\$6 trillion addressable market focused on industrial and individual end use by 2030

For companies, production of sustainable goods and services can support compliance with emerging regulations, create growth opportunities, and help attract talent

Macro level

90%

GHG emission reduction required to comply with 1.5°C pathway¹

\$4T–\$6T

global sustainability addressable market by 2030 focused on industrial and individual end use

Global sustainability-addressable market

Carbon management Ag and land management Water
Waste Consumer Buildings



Micro level



Applying bolder sustainable-consumption regulation

30%–50%

corporate profits at stake (eg, from carbon pricing, sustainable-packaging and waste regulations)



Shifting customer expectations

≤50%

'green premium' customers are willing to pay for sustainably produced products and services across B2C and B2B sectors



Talent moving to sustainable companies

80%

millennials want to work for a company strong on sustainability and other ESG² dimensions



First movers capturing value

50%

faster growth in sustainable brands vs others (eg, Unilever's Sustainable Living Brands vs the rest of the portfolio)

¹The 1.5°C pathway refers to goal of holding global warming to 1.5°C above preindustrial levels through achieving net zero by 2050 and halving carbon emissions by 2030.

²Environmental, social, and governance.

What are the most noteworthy technologies?

Many sustainable end-use solutions are past the initial proof of concept phase and innovating to become cost effective; the next economic battleground is to scale them over the next decades

Land consumption



Sustainable agriculture; alternative proteins

Micro-irrigation; vertical farming; hydroponics; plant-based and cultured meats; methane inhibitors; green fertilizers



Natural capital and nature

Technologies for restoration of forests and natural ecosystems; coastal vegetation; biodiversity; freshwater basins; etc

Raw-material consumption



Circular technologies

Design; production; recycling and reuse; waste management



Green construction

Energy and water efficiency; waste reduction; eco-friendly materials use (eg, green cement, green steel)

Sustainability enablers for hard-to-abate industries



Carbon capture use and storage (CCUS)

Capture of CO₂ directly from industrial-emission sources¹



Carbon removals

Nature-based solutions (eg, tree planting); engineered carbon removal (eg, direct air capture, biomass to capture CO₂ during energy generation)









Electrification technologies











Electric heat pumps; electric propulsions for terrestrial and aerial vehicles (eg, magnetic levitation trains); electric arc furnaces for steelmaking; electrification of farm equipment

¹Excluding bioenergy with carbon capture and storage (BECCS), covered under carbon removals.

What industries are most affected by the trend at present?







Industry affected	Implications from technology trend
 Automotive and assembly	<ul style="list-style-type: none"> • Electrification of global fleet, slowly replacing oil-powered internal-combustion-engine vehicles as costs, battery ranges, and charge times improve
 Agriculture	<ul style="list-style-type: none"> • Digitally enhanced agronomy services (up- and downstream) for precision agriculture • Innovative agriculture technologies (eg, indoor, vertical farming, drip irrigation, GHG-focused animal breeding, gene editing to improve carbon sequestration of plants) • Alternative proteins (eg, plant or microorganism based, cultured)
 Aviation, travel, and logistics	<ul style="list-style-type: none"> • Fleet modernization (eg, electrification, vehicles with higher fuel efficiency) • Decarbonized fuels (eg, sustainable aviation fuel) • Fleet dispatch and travel route optimization for sustainability (eg, shift toward more rail use) • Truck load optimization (eg, redesign of boxes, double stacking of pallets) • “Green corridors” (trade routes among major port hubs where zero-emission solutions are supported)
 Construction and building materials	<ul style="list-style-type: none"> • Novel building techniques (eg, insulation to lower space heating/cooling demand, electrification for small-carbon-footprint heating) • Increased use of sustainable materials (eg, green steel, recycled plastics) • Change in material usage patterns (eg, more scrap steel, less carbon-intensive materials)
 Pharmaceuticals and medical products	<ul style="list-style-type: none"> • Optimized manufacturing processes to improve energy efficiency and reduce water consumption • Substitute traditional single-use plastics for more sustainable, recycled materials for packaging
 Public and social sectors	<ul style="list-style-type: none"> • Organizations can incentivize the market for sustainable goods and services and mandate shifts, boost innovation by securing funding, and deliver important initiatives to other parts of the economy

What industries could be most affected in the long term?

Industry affected	Implications from technology trend
 Chemicals	Growing markets for recycled plastics and specialty plastics created from captured CO ₂ ; conversion of CO ₂ into polyurethane foam, displacing hydrocarbon that would otherwise come from fossil fuels
 Oil and gas	Increasing adoption of carbon sequestration to support enhanced oil recovery (EOR); CO ₂ EOR technology injects CO ₂ into partially depleted oil fields to force out additional volumes of oil, with CO ₂ being residually trapped and permanently stored
 Metals and mining	Decarbonization of operations and offset of production activity effects on natural capital, as well as increasing production of the minerals needed for clean energy and other sustainable tech
 Electric power, natural gas, and utilities	Variable demand for electric power based on sustainable consumption trends such as electrification
 Consumer packaged goods	Circular economy solutions and business models enabled by product optimization (eg, material selection, product/packaging design); improved product and material flows (eg, optimized reverse logistics); and enhancements in recycling (eg, new material recovery technologies); as well as rising demand for products with legitimate sustainability attributes
 Aerospace and defense	Designing and manufacturing aircrafts that rely more on sustainable fuels and increased energy efficiency
 Information technology and electronics	Optimizing electric power consumption in data centers; powering data centers by renewable energy; and reducing waste across the consumer electronics value chain
 Retail	Green product sourcing; in-house facility management (energy, water, and packaging waste minimization); appropriate management of customer returns/disposal of products
 Real estate	Market shifts in response to changes in consumer preferences; urban planning; and infrastructure development
 Telecommunications	Optimized energy consumption by upgrading to 5G, and networks operated with renewable energy

Who has created impact with technologies enabling sustainable consumption?

Relevant technologies are already enabling climate impact across a variety of industries; today's main challenge remains scale

	CCUS	Occidental Petroleum and Cemvita Factory launched a pilot project for conversion of captured CO₂ to bioethylene ; OxyChem can then use the bioethylene as feedstock, and resulting chlorovinyls are used in manufacturing of plastics, including foams and PVC pipes
	Carbon removal	Several start-ups, such as Running Tide and Kelp Blue , have introduced technologies that grow significant amounts of seaweed, seagrasses, and algae through artificial farming and pregrown seeds, using CO ₂ to accelerate their growth; the plants are then used to absorb CO₂ or converted into food sources for fish and marine animals Frontier is an advance market commitment by Stripe, Alphabet, Shopify, Meta, and McKinsey, to incentivize accelerated development of permanent carbon removal by guaranteeing future demand
	Green construction	ArcelorMittal is developing a series of industrial-scale hydrogen projects for use in steelmaking that will start to deliver substantial CO ₂ emission savings within the next 5 years
	Natural capital and nature	IKEA Systems includes biodiversity and deforestation considerations in its value chain partnerships (eg, supplier code of conduct), restricting business activities in areas of high conservation value and encouraging suppliers to follow the lead
	Alternative proteins and sustainable agriculture	Nutrien drastically reduced upstream emissions in fertilizer production , became a leader in blue ammonia/blue nitrogen production, and created one of the industry's first and broadest carbon marketplaces for farmers
	Circular technologies	The Hong Kong Research Institute of Textiles and Apparel (HKRITA) has partnered with Gap to develop eco-friendly production processes and technology solutions , with an initial focus on separation of spandex from used garments and denim decolorization for recycling

What should leaders when engaging with this trend?



Benefits

Operating savings in the long run: Cost-effective investments for rapidly scaling end-use-focused clean technologies (eg, green construction)

Early-mover advantage: Network benefits for companies that join climate tech ecosystems early

Incentives: Support or guarantees for new technology takeoff and increase in adoption (eg, green bonds, loan guarantees, decarbonization subsidies)

Transparent industry standards: Mature clean-energy standards in developed countries and global decarbonization commitments

Vibrant carbon markets: Rapidly growing global markets for CO₂ permits traded among clean-energy-ecosystem players

Risks and uncertainties



Commercialization pathways for climate tech mean they aren't yet cost competitive with conventional tech

Availability of critical input materials might be insufficient

Upfront and ongoing costs to decarbonize production facilities and value chains are of concern (eg, green-steel production >40% more expensive than conventional)

Regulatory action and alignment of standards across borders and regions will be important

Changes in consumer behavior, compared with stated commitments, can affect sustainable consumption initiatives (eg, willingness to pay "green premiums")

What are some topics of debate related to the trend?

Overall
 Land consumption
 Material consumption
 Sustainability enablers for hard-to-abate industries

1 Capital reallocation to accelerate decarbonization

How will companies and governments mobilize capital flows in support of sustainable consumption?

Estimated capital spending of ~\$9.2 trillion per year (an annual increase of as much as \$3.5 trillion from 2022) is required for a global transition to a net-zero economy; ~85% of technologies needed to meet this target already exist, highlighting the importance of closing the capital funding gap to deploy these technologies across sectors and geographies

2 Consumer behavior shift

How will consumer mindsets and behaviors change? Where and how will they diverge or converge? What new behaviors and habits will become mainstream?

More than one-third of global consumers are ready to pay a green premium as demand grows for environmentally friendly alternatives; however, attitudes vary across generations, countries, and industries; relative importance of sustainability during the purchasing process will continue to increase

3 Feasibility of sustainable agriculture

Is global adoption of sustainable agriculture practices feasible?

Sustainable agriculture benefits the environment through helping maintain soil quality, reducing erosion, and preserving water; however, such practices are often hard to abide by for mass agriculture farmers, given implications for crop yields, particularly challenging in regions with food security concerns

4 Future of circular economy

To what extent will circular-economy practices (those favoring the comprehensive recovery and reuse of materials with minimal losses of quality) replace conventional practices?

Current momentum in circular technologies is generating a seismic shift across manufacturing industries globally; however, an attempt to reach a 100% recyclability rate might prove counterproductive if the price of recovery remains higher than the value of the materials recovered; furthermore, the existing regulatory landscape does not incentivize all ecosystem players to pursue a circular economy

5 Balance of decarbonization levers

What is an appropriate balance between carbon removal and other decarbonization levers?

CCUS is necessary in industries without other decarbonization alternatives and is already cost effective for some industrial processes; however, investments in carbon removals may divert funds and attention away from the critical business of reducing emissions, further propping up the fossil fuel industry

Additional resources

Knowledge center

[McKinsey Platform for Climate Technologies](#)

Related reading

[The net-zero transition: What it would cost, what it could bring](#)

[Delivering the climate technologies needed for net zero](#)

[Decarbonizing the world's industries: A net-zero guide for nine key sectors](#)