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Sustainability Practice

Retailers' climate road map: Charting paths to decarbonized value chains

Most emissions captured in the average retailer's Scope 3 metric are generated via product value chains. These value chains can be decarbonized—but only with targeted multistakeholder actions.

July 2024

Contents

Acknowledgments

The research for this report was led by Peter Spiller, a partner in McKinsey's Frankfurt office, and Steve Hoffman, a partner in the Los Angeles office, with Caroline Ling, a consultant in the New York City office; Philippe Diez, a senior client development adviser in the Paris office; and Varun Mathur, an associate partner in the Austin office. They were supported in this by Karl Murray, Mekala Krishnan, Miquel Ferrer, Neha Chatterjee, Olorunyomi Joel, and Per-Anders Enkvist—without whom this report would not have been possible.

This report is independent, reflects the views of the authors, and has not been commissioned or influenced by any business, government, or other institution.

We gratefully acknowledge the expertise, insights, and feedback provided by the following individuals:

Name	Organization
Angélique Diarra	*Carrefour*
Carine Kraus	*Carrefour*
Kathleen McLaughlin	*Walmart*
Aman Singh	*Walmart*
Bertrand Swiderski	*Carrefour*
Ronald Voglewede	*Walmart*

We also gratefully acknowledge the following individuals and organizations for their invaluable contributions:

Name	Organization
Christopher Adamo	*Danone*
Jim Andrews	*PepsiCo*
Pankaj Bhatia	*World Resources Institute*
Kate Brandt	*Google*
Chris Cassell	*Lowe's*
Stephanie Couch	*Tyson Foods*
Juan Facundo Etchebehere	*Danone*
Simon Fischweicher	*CDP Worldwide*
Jonathan Foley	*Project Drawdown*
Alexander Frantzen	*World Resources Institute*
Thomas Lingard	*Unilever*
María Mendiluce	*We Mean Business Coalition*
Katherine Pickus	*Tyson Foods*
Elizabeth Sturcken	*Environmental Defense Fund*
n/a	*World Wildlife Fund*

Executive summary

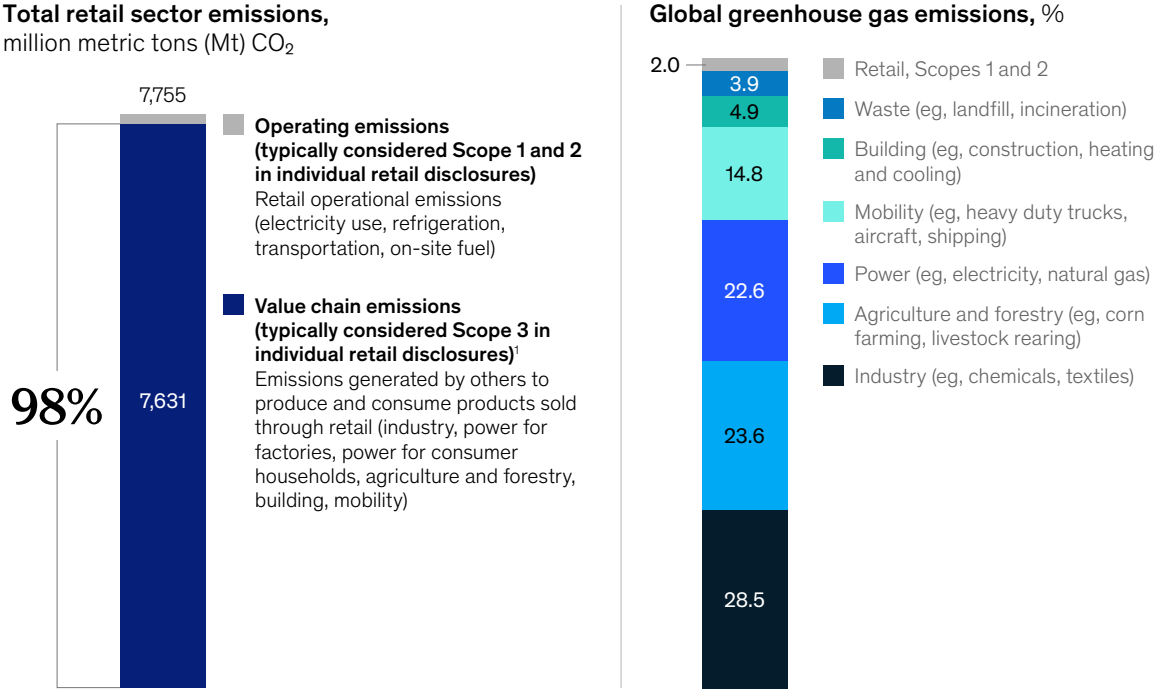
As companies in all sectors work to shrink their carbon footprints and hit their decarbonization targets, the path to reducing Scope 3 emissions is often anything but straightforward. For some, decarbonizing Scope 3 emissions can be more like navigating a particularly byzantine maze. Such is the case for retailers.

For the average retailer, Scope 3 metrics capture emissions generated upstream and downstream within the value chains of every SKU it sells—numerous, disparate, and sometimes highly fragmented value chains with multiple tiers of suppliers and inputs. And the emissions generated within this labyrinth of value chains span six energy and land-use systems: agriculture and forestry, building, industry, mobility, power, and waste (Exhibit E1).

Scope 3 emissions are, by definition, indirect greenhouse gas (GHG) emissions that are generated within a company's value chain; unlike Scope 1 and

Exhibit E1

A retailer's Scope 3 metric encompasses emissions generated by many industries.



Note: Gasoline retail was not included in calculations. Figures may not sum to 100%, because of rounding.
[1]Aggregate and sector emissions were considered on a regional basis rather than on a company-by-company basis, and double counting was avoided.
Source: "Climate change," Walmart, updated December 15, 2023; "Global greenhouse gas overview," United States Environmental Protection Agency, updated April 11, 2024; "The net-zero transition: What it would cost, what it could bring," McKinsey Global Institute, January 2022; *Walmart climate transition analysis*, Planet Tracker, November 3, 2023; *Walmart, Inc. - Climate change 2021*, CDP Disclosure Insight Action, 2021

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2 emissions, companies do not directly control these emissions. Consequently, reducing Scope 3 emissions depends on the engagement and efforts of all value chain actors, including suppliers, distributors, and consumers, as well as other public and private sector actors—a retailer cannot realize these reductions in isolation.

The breadth and complexity of their Scope 3 emissions have far-reaching implications for retailers in areas including economic, strategic, brand and reputation, and regulatory compliance. This is why retailers worldwide have embraced the opportunities in these challenges, pursuing ambitious sustainability goals and wide-ranging initiatives that have led to meaningful reductions in product value chain emissions. Their efforts include engaging suppliers to improve energy efficiency in manufacturing and transportation, reduce waste, and transition to renewable energy sources.

Some decarbonization efforts, such as converting power grids to renewable or clean energy in geographies where suppliers are concentrated, are longer-term efforts that depend greatly on the actions and decisions of multiple public and private sector players. However, many decarbonization solutions are within reach of retail value chain stakeholders—and are either cost-neutral or cost-saving to implement.

Framed within seven strategic decarbonization action themes, this report illustrates how retailers and other value chain stakeholders could strategically deploy economic resources, natural and physical resources, human resources, low-carbon technology, and data transparency to realize emissions reductions. Because the scale, complexity, and key players for these efforts vary, so does the retailer's role in the efforts, ranging from leading and scaling, to convening value chain partners, to collaborating and catalyzing, to advocating and supporting actions for reducing emissions across retail value chains.

Reducing the average retailer's Scope 3 emissions by 15 percent at a system level is feasible by 2030 using existing technologies; however, innovations in technologies and practices could enable an additional 40 or 50 percent reduction.

Retailers' Scope 3: A complex array of value-chain emissions

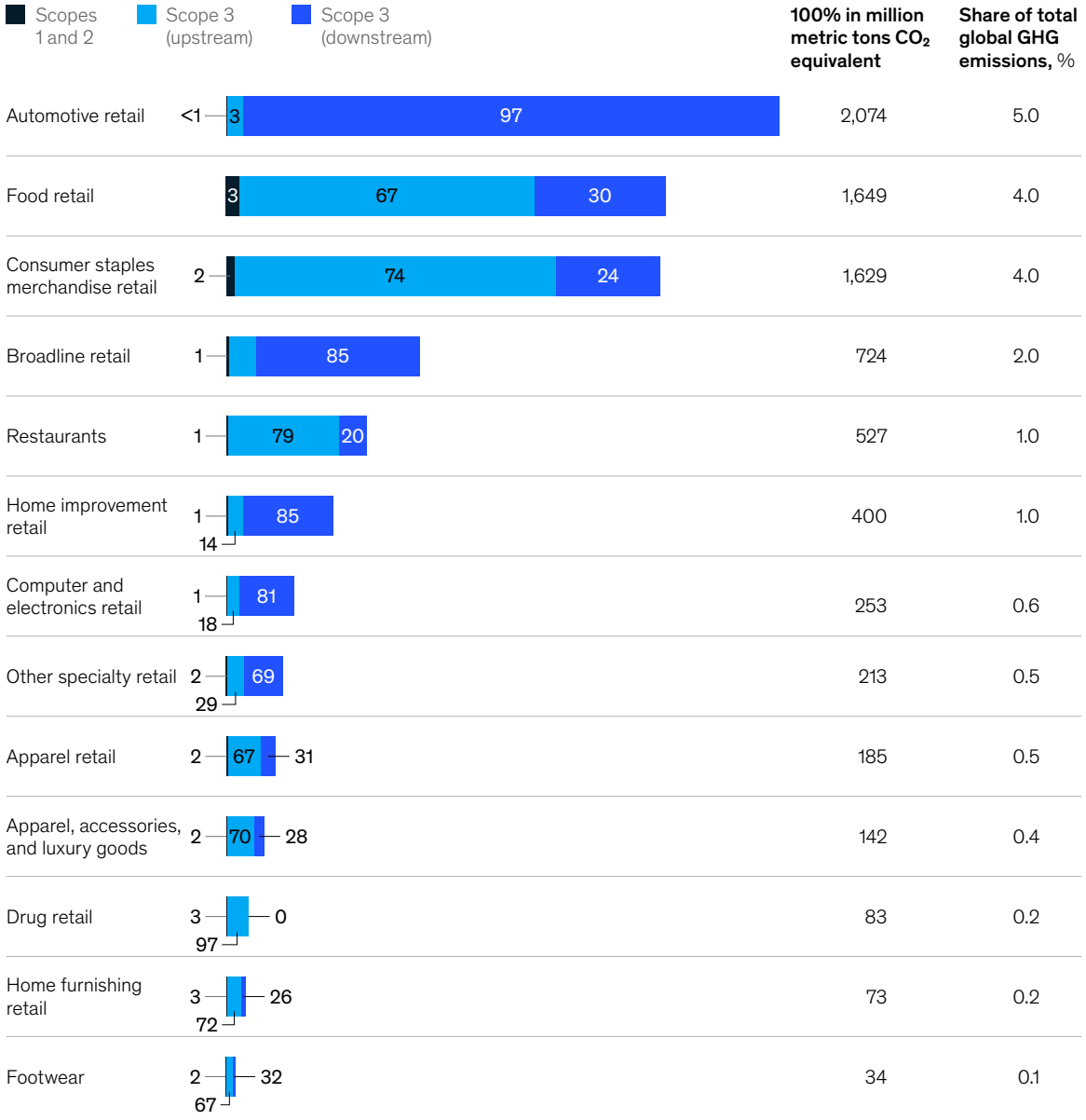
Retailers' reporting requirements are specified in the Greenhouse Gas Protocol's Corporate Value Chain (Scope 3) Accounting and Reporting Standard and ISO 14064, the international standard series for quantifying and reporting greenhouse gas emissions and removals. Under these standards, a retailer's Scope 3 emissions metric captures all GHG generated from sourcing, making, transporting, housing, selling, and using every product the retailer carries throughout its life cycle.

This means that for a multicategory retailer, reducing Scope 3 emissions—which include sources that make up around 98 percent of total emissions in retail—involves players from multiple sectors and industries and entails efforts to decarbonize six energy and land-use systems. And about 80 percent of a retailer's Scope 3 emissions are generated upstream in product value chains via feedstock production, materials and components, processing and manufacturing, and packaging (Exhibit E2).

Exhibit E2

Retailers' Scope 3 emissions reflect wide-ranging differences in production and consumption within product channels.

Total greenhouse gas (GHG) emissions, breakdown by 13 retail channels,[1] %



Note: Figures may not sum to 100%, because of rounding. Automotive reflects downstream fossil fuel use; food and staples reflect upstream manufacturing and farming.

[1]In the scope of this paper, the definition of "retail" based on the Global Industry Classification System includes automotive retail; consumer discretionary distribution and retail (including broadline retail, specialty retail, and home improvement retail); consumer durables, such as apparel and luxury goods (including accessories and footwear); consumer staples distribution and retail (including consumer staples merchandise retail, drug retail, and food retail); and restaurants.

Source: CDP Worldwide; McKinsey analysis

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Retailer challenges in focus: Delineating Scope 3 emissions in three value chains

Each of the millions of product value chains whose emissions are captured in a retailer's Scope 3 contains multiple tiers of suppliers and inputs from regions around the globe. The commodities involved are often mixed together in agricultural areas or at shipping ports, and each tier within a value chain can be highly fragmented. Additionally, suppliers can change their sources for inputs within the course of a single year. This complexity makes it challenging for retailers to influence how suppliers handle or report on emissions.

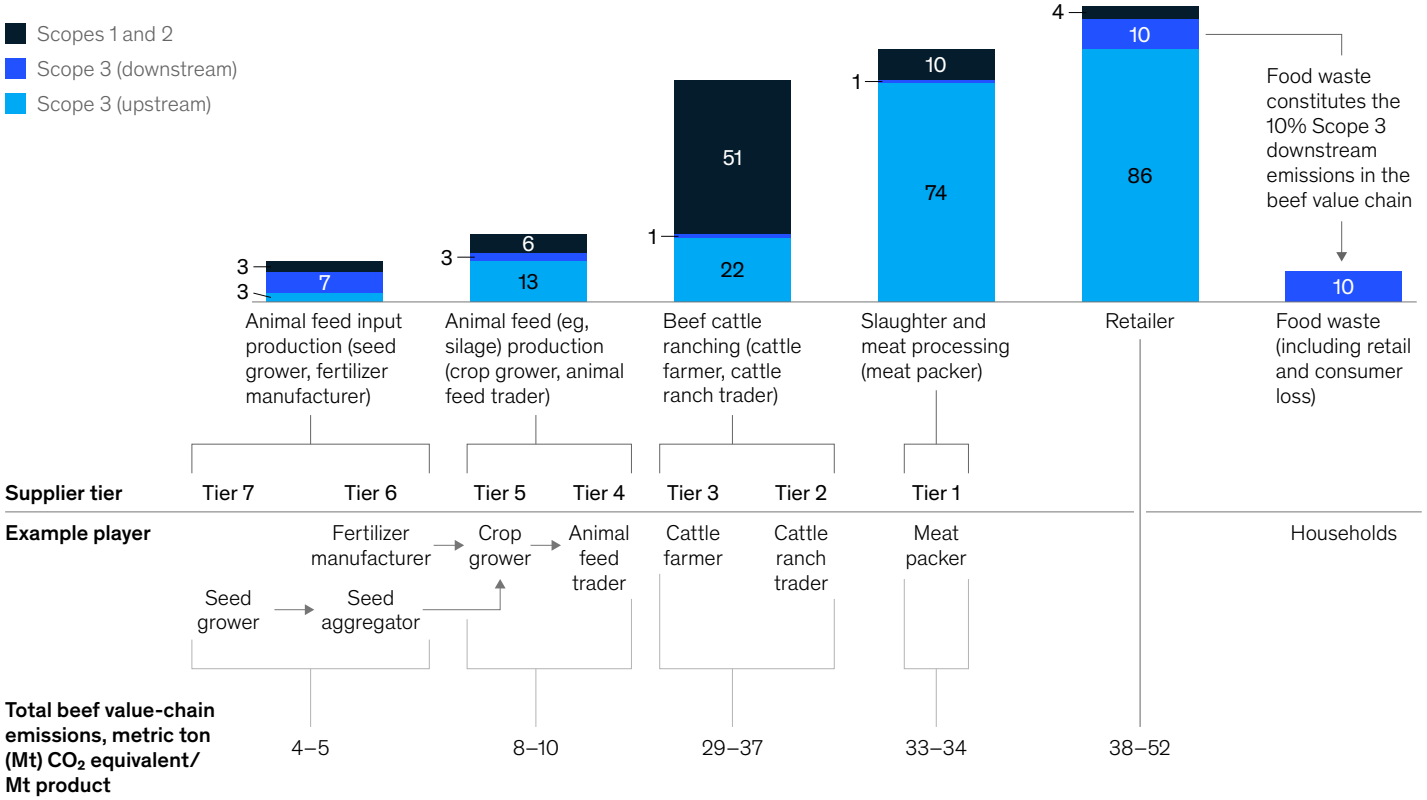
Consumers' use of products—powering electronics or washing and drying clothing, for example—is also captured in the Scope 3 emissions for retailers that carry such products. Thus, reducing downstream product value chain emissions often depends on influencing changes in consumer behavior or the energy sources powering the local electricity supply.

Among retailers' top 15 most commonly sold products, beef is one of the largest sources of Scope 3 emissions for retailers. Around 86 percent of beef value chain emissions are generated upstream by animal feed farming and production, fertilizer production, and cattle ranching, according to McKinsey analysis. Reducing ruminant methane emissions and shifting toward more efficient use of agricultural inputs, maximizing productivity, and adopting regenerative agriculture practices such as no- or low-till soil and cover cropping are key to realizing reductions in this value chain (Exhibit E3).

Exhibit E3

Around 86 percent of retailers' Scope 3 emissions from the beef value chain are generated by upstream suppliers.

Share of beef value-chain emissions by scope for given supplier or retailer, %



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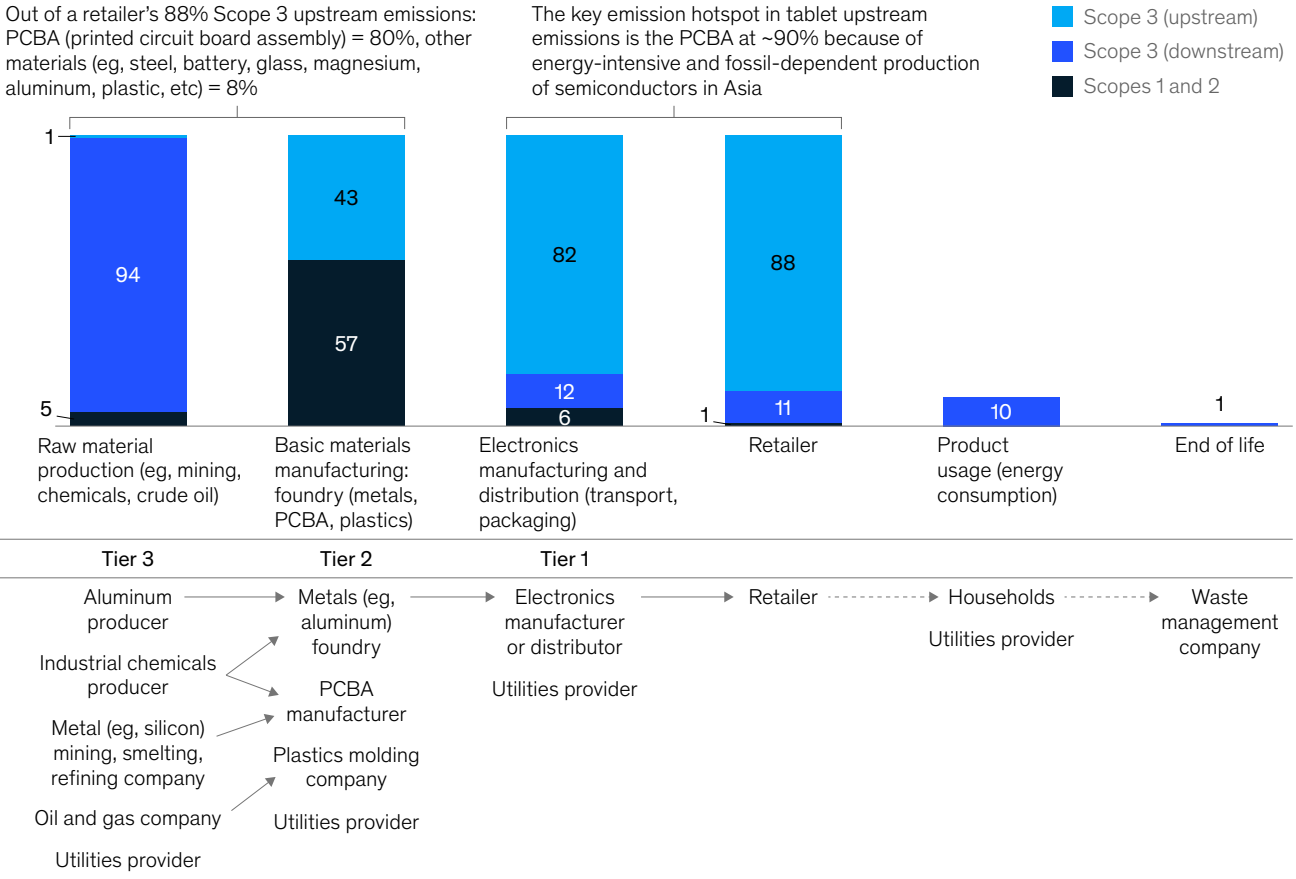
In electronics product value chains, decarbonizing power use is retailers' primary challenge. The majority (80 to 90 percent) of the average retailer's Scope 3 emissions for electronics products are generated upstream via suppliers in highly fragmented markets. Decarbonization in this stage of the value chain largely depends on the availability of renewable energy where suppliers operate (Exhibit E4).

Exhibit E4

More than 80 percent of emissions in the electronic equipment value chain are generated upstream, primarily by tier-two suppliers and above.

Share of electronic equipment value-chain emissions by scope for given supplier, retailer, or product lifecycle, %



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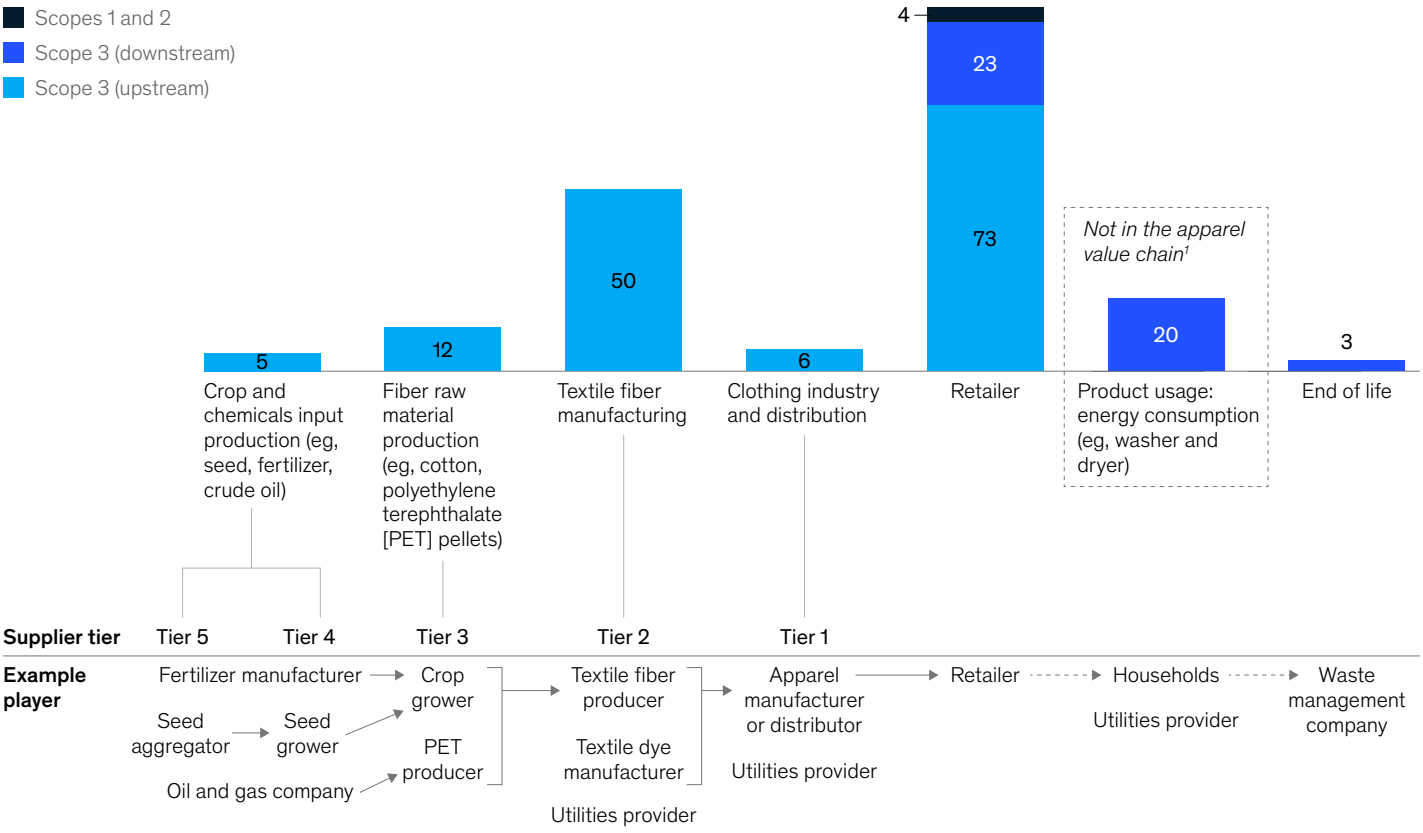
Likewise, in the apparel product value chain, around 62 percent of emissions are generated upstream via energy use among tier-two and tier-three suppliers engaged in garment processing and fiber production (Exhibit E5).

Thus, substantial reductions in retailers' Scope 3 emissions will require transformations in energy and land-use systems involving efforts among many value chain stakeholders.

Exhibit E5

Around 73 percent of retailers' Scope 3 emissions in the apparel value chain are generated upstream, mostly by tier-two suppliers and above.

Share of apparel value-chain emissions by scope for given supplier or retailer, %



[1]Scope 3 emissions for retailers who sell washers and dryers.

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Near-term opportunities for retailers: Reducing emissions across value chains

This report identifies seven decarbonization action themes for reducing the average retailer's Scope 3 emissions; the themes are based on analysis of technically feasible change levers in several product value chains. The highest reduction potential comes from transitioning to clean and renewable energy, reducing livestock emissions, and adopting regenerative agriculture practices. Examples are provided to illustrate emissions reduction opportunities (Exhibit E6).

As noted previously, if all were deployed at scale, these actions could propel a 55 to 65 percent reduction in the average retailer's Scope 3 emissions by 2030, although some actions carry sizable costs. Actions that reduce or do not increase costs in the system could yield a 12 to 17 percent reduction in the average retailer's Scope 3 emissions by 2030.

The highest reduction potential comes from transitioning to clean and renewable energy, reducing livestock emissions, and adopting regenerative agriculture practices.

Exhibit E6a

Deploying change levers within seven decarbonization themes could enable direct emissions reductions or catalyze reductions in value chain systems.

	Key examples of levers by enablers of emissions reduction[1]		
Decarbonization themes	**Economic resources**	**Natural and physical resources**	**Human resources**
Transitioning to clean and renewable energy	$150 per metric ton of CO_2 abated to electrify a meat plant outputting ~5 billion pounds of beef annually	~2× the current power generation capacity from renewables in the next few decades to fully clean grid and to support potential mill-decarbonization targets where most textile mills are located	Skilled workforce to fill 33 million projected job gains as power generation may roughly double by 2050
Reducing farming emissions from livestock management	$85,000 to $170,000 total investment, at a rate of $401 per metric ton of CO_2 abated, for a US beef cattle rancher with 50–100 cattle and 120–240 acres to reduce farming emissions from livestock management using current technology	3× more land and 30% more cattle for an extensive, unmodified grass-fed pasture system vs a feedlot system to produce the same amount of beef annually[4]	Training and skill development in areas such as efficiency breeding, adaptive grazing, and precision technologies to fill the projected 27 million jobs gained by 2050
Adopting regenerative practices in plant-based agricultural inputs	Potential savings of ~$180 per metric ton of CO_2 abated for a cotton grower in Asia with 1.5 hectares of land and an annual production of 445 kg of lint per hectare	1.035–1.055× more land than used in conventional agriculture to compensate for a potential 3.5–5.5% yield loss during the initial 3- to 5- year transition period to regenerative agriculture depending on crop, soil, and geographic context	Technical expertise in adopting precision farming, including use of variable-rate fertilization, predictive modeling, sensors, and GPS technology
Increasing circularity of products and packaging	~$201 per metric ton of CO_2 abated to use recycled cotton fibers, recycled PET,[2] and recycled cardboard in packaging in apparel manufacturing	122% increase in capacity for plastic packaging recycling for the EU to hit its 2030 target of recycling 55% plastic packaging	1 in 5 garments traded via a circular business model to align with a 1.5° pathway by 2030
Reducing waste and increasing process efficiency	~$59 per metric ton of CO_2 abated to reduce food waste in the beef supply chain by 15%–20%[3]	72%–73% increase in EU recycling rate, enabled by increases in capacity and technology to reduce pre- and postconsumer waste, to meet the EU's 2030 residual-waste target	40% improvement in waste collection by 2030 via training and incentives for garment factory employees
Reducing emissions in transportation	$111 per metric ton of CO_2 abated to electrify transport in the beef, electronics, and apparel value chains	384 new mines to supply rare earth elements for electric-vehicle (EV) batteries	Upskilling and training to ensure the number of drivers, operators, and others is adequate to deploy and maintain EVs at scale, ie, the skilled workforce to fill 9 million projected job gains in EV manufacturing and the mobility ecosystem (eg, smart charging) by 2050
Transitioning from animal protein to plant protein products	$30 billion to $55 billion in 2030 and $250 billion to $300 billion in 2050 in capital investment in alternative proteins (including plant-based, fermentation, and cultivated), with ranges based on achieving a 2°C pathway and a 1.5°C pathway and abating up to 7 metric gigatons of CO_2 equivalent	At least 810 factories with an average annual production of 30,000 metric tons to support scaling of plant-based protein production to achieve 2030 production targets	10–15× increase in current consumer adoption rate for plant-based proteins by 2030 to remain on a 1.5° pathway

[1]For further discussion of potential actions and roles for value chain stakeholders, see chapter 4 of this report.
[2]Polyethylene terephthalate.
[3]Approximation based on Environmental Protection Agency estimate that the median cost of food waste across all food categories is $1.17 per lb; average greenhouse gas emissions per ton of beef (2,000 lbs) = 40 metric tons of CO_2 equivalent.
[4]The amount of land needed could be significantly reduced if rotational grazing were adopted rather than an extensive unmodified pasture system. The acreage needed would depend on the number of cows per acre the rotational grazing system could support.
Source: Candace Adams, "How many acres do you need per cow when raising cattle?," Herdx, accessed May 30, 2024; Rory Clune, Viktor Hanzlík, and Raffael Winter, "Power," *McKinsey Quarterly,* August 1, 2022; ColumbiaClimate School; Environmental Protection Agency; European Environment Agency; *Fashion on climate: How the fashion industry can urgently act to reduce its greenhouse gas emissions*, a joint report from McKinsey and Global Fashion Agenda, 2020; Rachael D. Garrett and Matthew N. Hayek, "Nationwide shift to grass-fed beef requires larger cattle population," *Environmental Research Letters*, July 2018, Volume 13, Number 8; Good Food Institute; Industrial-innovation.com; Joshua Katz and Peter Mannion, "Food and agriculture," McKinsey, August 1, 2022; Russell Knight, "Sector at a glance," USDA Economic Research Service, updated August 30, 2023; Timo Möller and Patrick Schaufuss, "Road mobility," McKinsey, August 1, 2022; Project Drawdown; "Reducing agriculture emissions through improved farming practices," McKinsey, May 6, 2020; "Renewable energy in India," Invest India, accessed May 29, 2024; G. R. Sinha and Silvia Liberata Ullo, "Advances in smart environment monitoring systems using IoT and sensors," *Sensors*, 2020, Volume 20, Number 11; "The net-zero transition: What it would cost, what it could bring," McKinsey Global Institute, January 2022; "There's room for improvement in a popular climate-smart agricultural practice, Stanford-led study shows," Stanford Report, November 8, 2022; US Government Accountability Office; Bridget Vandenbosch, "Unlocking the circular economy's potential with a data-driven approach to recycling," Recycling Today, July 26, 2023; Steven Wallander and Christine Whitt, "Study examines how and where U.S. cow-calf operations use rotational grazing," USDA Economic Research Service, November 21, 2022; World Business Council for Sustainable Development; World Economic Forum; McKinsey analysis

Exhibit E6b

Deploying change levers within seven decarbonization themes could enable direct emissions reductions or catalyze reductions in value chain systems. *(continued)*

	Key examples of levers by enablers of emissions reduction[1]	
Decarbonization themes	**Low-carbon technology**	**Data transparency**
Transitioning to clean and renewable energy	A 4–7× increase in adoption of advanced technologies such as wind and solar to support manufacturing hubs	Use of big data analytics, AI, machine learning, and digital technology in the energy, materials, and mobility sectors to potentially reduce global emissions 20% by 2050
Reducing farming emissions from livestock management	4–7× higher adoption of farming technologies such as selective breeding, fat supplements in feed mix, red algae, systems for monitoring animal health, and adaptive grazing to contribute to a 20% reduction in total emissions from agriculture, forestry, and land use	A system for sharing tools, complete and reliable data, and reporting structures transparently among retail value chain stakeholders
Adopting regenerative practices in plant-based agricultural inputs	Increase in global adoption of silvopastures by 2050 to 720.55 million–772.25 million hectares from ~550.0 million hectares	Primary data to reduce the limitations imposed by applying generic data in tracking progress on regenerative agricultural practices
Increasing circularity of products and packaging	100% adoption of developing technologies such as recycled PET[2] and 4–7× higher adoption of recycled cardboard in packaging to reduce value chain emissions 5%–15% by 2030	Granular and accurate data for tracking the flow of materials and resources throughout their life cycles to support and enhance recycling and circularity
Reducing waste and increasing process efficiency	Adoption of precision-agriculture technologies to improve production efficiency via precise application of inputs, alongside investments in education, R&D, and funding to promote low-carbon technology adoption	End-to-end traceability on sources of waste generated along the value chain (enabled by access to granular data) to pinpoint opportunities to reduce waste
Reducing emissions in transportation	15,000 public and semiprivate EV chargers installed in Europe each week by 2030 to meet demand created by achieving the net-zero goal of EVs making up 75% of global passenger-vehicle sales	Use of digital technologies such as the Internet of Things, imaging, the cloud, geolocation, and AI to gather and analyze real-time data to improve decision making and route optimization to reduce global emissions by 5% by 2050
Transitioning from animal protein to plant protein products	Investment in new breeding technologies to develop next-gen plant-based protein product traits	Public, open-access databases to provide farmers with information on the characteristics and functions of various plants to optimize the availability of desirable crops for plant-based protein products

[1]For further discussion of potential actions and roles for value chain stakeholders, see chapter 4 of this report.
[2]Polyethylene terephthalate.
[3]Approximation based on Environmental Protection Agency estimate that the median cost of food waste across all food categories is $1.17 per lb; average greenhouse gas emissions per ton of beef (2,000 lbs) = 40 metric tons of CO_2 equivalent.
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Catalyzing broader decarbonization: Strategies and considerations for retailers

To help retailers prioritize decarbonization efforts, this report arranges levers that could be deployed by retailers and other stakeholders into four groups (labeled A, B, C, and D), each of which could enable strategic decarbonization actions. The report also illustrates these actions with examples of real-world initiatives involving retailers and their value chain partners. By focusing on the levers in groups A and B, the average retailer could accelerate efforts to achieve up to a 17 percent reduction in its Scope 3 emissions by 2030. However, deploying levers in groups C and D could unlock an additional 40 to 50 percent, highlighting the importance of multistakeholder collaboration to realize substantial impact (Exhibit E7).

To help retailers prioritize decarbonization efforts, this report arranges levers that could be deployed by retailers and other stakeholders into four groups, each of which could enable strategic decarbonization actions.

Exhibit E7

Up to about 17 percent of retailers' Scope 3 emission reductions could be enabled by applying cost saving or neutral levers.

Reduction potential,[1] %

Highlighted levers in Chapter 4

Reduction theme	Reduction potential	Cost saving or neutral[2]		Cost prohibitive	
		A **Lead and scale,** $0/metric ton (Mt) in tiers 1 and 2,[3] %	B **Convene value chain,** $0/Mt in tiers 3+, %	C **Collaborate and catalyze,** $0–$50/Mt in tiers 1–3, %	D **Advocate and support,** >$0/Mt in tiers 4+ and >$50/Mt across all tiers, %
Transitioning to clean and renewable energy	16.7	0.2	1.4	7.7	7.4
Reducing farming emissions from livestock management	16.2	<0.1	2.7	9.1	4.4
Adopting regenerative practices in plant-based agricultural inputs	8.9	<0.1	5.0	0.1	3.8
Increasing circularity and recycling	7.5	0.1	0.1	2.7	4.6
Reducing waste and increasing process efficiency	6.0	0.6	4.5	0.1	0.8
Reducing emissions in transportation	1.7	0.3	<0.1	<0.1	1.4
Switching from animal proteins to plant alternatives (feed or product)[4]	1.3	<0.1	<0.1	1.3	<0.1
Total reduction potential	**55–65%**	**1–2%**	**11–15%**	**19–23%**	**20–24%**

[1]Based on baseline emissions, reduction potentials, and costs of levers only for packaged products as received by retail store; does not include losses, consumer, or end-of-life emissions and levers.
[2]Cost neutral is defined as break-even ($0/Mt CO2 abated).
[3]Calculated based on levers that sit within retailers' tiers 1 and 2 supply network and levers that are "in the money" as well as cost neutral (ie, break-even).
[4]Reduction potential for the theme. Switching from animal protein to plant alternatives is calculated using beef category as proxy, assuming 4% adoption rate of alternative meat by 2030 and assuming an emission reduction potential of ~80–85% in beef.

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Group A: Cost-effective near-tier levers
Retailers could influence group A levers by engaging their direct suppliers, their direct suppliers' suppliers, and consumers in efforts to scale decarbonization solutions that would result in cost savings or have no impact on cost (cost neutral). If deployed at scale, levers in this group could help reduce the average retailer's Scope 3 emissions by up to 2 percent.

Examples of group A levers include forming partnerships that facilitate renewable-energy adoption; providing electric vehicle–charging infrastructure; supporting suppliers in implementing their net-zero objectives; and using consumer-focused marketing and tools to promote sustainable energy consumption habits and reduce waste.

Group B: Cost-effective far-tier levers
Retailers could influence actions in group B by engaging suppliers in tier-three levers and beyond (along with other industry partners) in efforts to deploy cost-saving or cost-neutral levers to facilitate adoption of sustainability levers. Deployed at scale, such efforts could potentially help reduce the average retailer's Scope 3 emissions by around 11 to 15 percent.

Examples of group B levers include providing training, education, and resource initiatives in regenerative agriculture practices and emissions reduction for farmers; sharing and collaborating with peer companies and other value chain stakeholders on best practices to reduce waste and maximize process efficiency; setting supplier standards under deforestation-free and conversion-free (DCF) policies; promoting lean-manufacturing adoption among in-network suppliers via supplier contracts; scaling decarbonization technologies with public and private sector support; and mobilizing value chains to reduce waste via systemwide collaborations.

Group C: Costlier near-tier levers
By engaging their tier-one, tier-two, and tier-three suppliers and other value chain partners, retailers could help spark innovation that could improve the feasibility of interventions that are technically achievable but not cost neutral (but whose costs still fall below the predicted global average carbon price in 2030).

Retailer levers in group C center on collaboration with value chain partners to potentially help reduce the average retailer's Scope 3 emissions by around 19 to 23 percent.

Examples of group C efforts include collaborating with value chain partners, not-for-profit organizations, and research institutions to support research in advancing sustainability measures; fostering private sector–led investment in emissions reduction innovations; advocating for public sector–led incentive programs aimed at helping value chain partners address costs or resource issues; encouraging and accelerating renewable adoption via supplier engagement; taking part in campaigns to stimulate consumer awareness of, and encourage greater consumption of, plant-based protein; and helping signal demand for alternative protein by engaging suppliers in long-term contracts for plant-based ingredients.

Group D: Cost-prohibitive far-tier levers
Group D levers are far removed from retailers and extremely costly to implement using today's technology, but retailers can nevertheless support, advocate, mobilize, and engage suppliers beyond tier three and other stakeholders to facilitate breakthrough innovation and solutions to realize systemwide changes. Group D levers deployed at scale could yield a 25 to 30 percent reduction in the average retailer's Scope 3 emissions.

Group D examples include launching public and private sector–led initiatives to encourage investment in and adoption of renewable technology and clean- and renewable-energy grids; collaborating with value chain partners and other private and public sector actors to invest in and expand circularity of materials by, for example, facilitating consumer access to recycling via collection centers and encouraging recycling via incentives; supporting recycling technology R&D; supporting rare earth recycling and sustainable sourcing; advocating for public sector–led incentives to promote regenerative agricultural practices; and encouraging start-up and technology company-led innovations to support precision agriculture for croplands through pilots and specifications.

Considerations for retailers: Measurement, accounting, and reporting
The complexity and scale of emissions captured in retailers' Scope 3 present practical challenges in precisely measuring, accounting, and reporting on emissions reduction progress.

Measurement challenges include variability in emissions resulting from changes made in production locations and methods, raw material

use and sourcing, energy use, equipment use, and modes of transportation; inconsistent data formats, measurement standards, and infrastructure for data storage and processing; and barriers that prevent retailers from connecting data to batches of commodities or products as they pass from one stage of the value chain to the next.

Accounting challenges for retailers can stem from a disconnect between industry averages and actual decarbonization project impacts in retailers' product supply chains or items, changes in historical estimates that require companies to revise and restate baseline data and create uncertainty around target setting and management, changes in and uncertainty around GHG accounting methodology, and emissions factor updates that lag behind changes in energy grids and agricultural systems.

Such measurement and accounting challenges can complicate reporting. For many retailers, determining their Scope 3 inventory can seem like a modeling exercise based on broad industry averages and historical emissions factors. It is often difficult for retailers to reconcile and report on actual emissions reductions in their value chains because of barriers to gathering and allocating reliable data and the lack of consistent methodology to adjust industry averages to account for particular decarbonization efforts. Retailers may also face potential competitive risks from disclosing sensitive sales or margin information in reporting category- or item-level emissions. As well, Scope 3 inventory figures can mask differences in decarbonization effort and results: a growing retailer that is decarbonizing its value chain may report the same percentage change in Scope 3 footprint as a shrinking retailer that has not done anything to decarbonize its value chain.

Despite these challenges, retailers are managing such complexity through the following actions:

— working with their individual suppliers and data aggregators to improve the quality and availability of data and the applicability of accounting and reporting standard

— simplifying methodologies to facilitate modeling where data is not available and providing order-of-magnitude estimations of Scope 3 footprint to highlight major concentrations of emissions and inform priorities for decarbonization

— providing supplemental information to demonstrate impact of decarbonization efforts to help stakeholders understand their Scope 3 decarbonization strategy and contribution and their role in emissions reduction

— improving the practicality of measurement, accounting, and reporting by engaging with carbon accounting standards bodies, reporting platforms, and regulators to help address challenges

Considerations for retailers: Engaging with the public sector

On many fronts, reductions in retailers' Scope 3 emissions are subject to public sector–led initiatives regarding energy and land-use systems; thus, retailers would be well served by a deep understanding of existing and proposed standards and guidelines. Retailers can determine whether or how public guidelines related to emissions affect their business outlook and the effectiveness of their efforts to decarbonize their value chains. Retailers can also help create change by advocating for national and international climate policies that address the interests of stakeholders in their business, value chains, and customer communities.

Decarbonizing retailers' value chains is feasible—but it cannot be done in isolation. At-scale deployment of the sustainability measures outlined in this report will require system-level change involving farmers and ranchers, manufacturers, suppliers, nongovernmental organizations (NGOs), public sector actors, energy companies, financial institutions, data and technology providers, and consumers. Coordinated multistakeholder action is imperative.

1

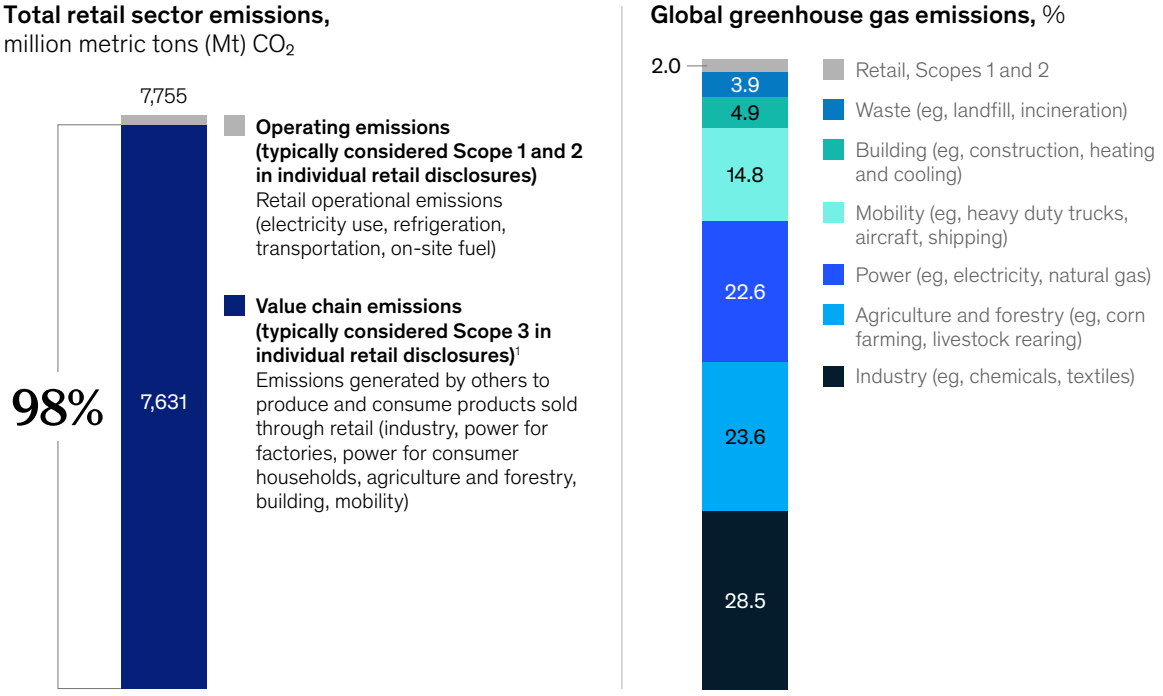
Retailers' Scope 3: A complex array of value chain emissions

Under the reporting requirements of Greenhouse Gas Protocol and ISO 14064, the international standard series for quantifying and reporting greenhouse gas emissions and removals, a retailer's Scope 3 emissions metric captures all greenhouse gas (GHG) emissions generated from sourcing, making, transporting, housing, selling, and using every product the retailer carries throughout its life cycle (Exhibit 1).

Consequently, the combined Scope 3 emissions from all retail channels account for nearly 20 percent of total global annual GHG emissions (Exhibit 2).[1]

Exhibit 1

A retailer's Scope 3 metric encompasses emissions generated by many industries.



Note: Gasoline retail was not included in calculations. Figures may not sum to 100%, because of rounding.
[1]Aggregate and sector emissions were considered on a regional basis rather than on a company-by-company basis, and double counting was avoided.
Source: "Climate change," Walmart, updated December 15, 2023; "Global greenhouse gas overview," United States Environmental Protection Agency, updated April 11, 2024; "The net-zero transition: What it would cost, what it could bring," McKinsey Global Institute, January 2022; *Walmart climate transition analysis*, Planet Tracker, November 3, 2023; *Walmart, Inc. - Climate change 2021*, CDP Disclosure Insight Action, 2021

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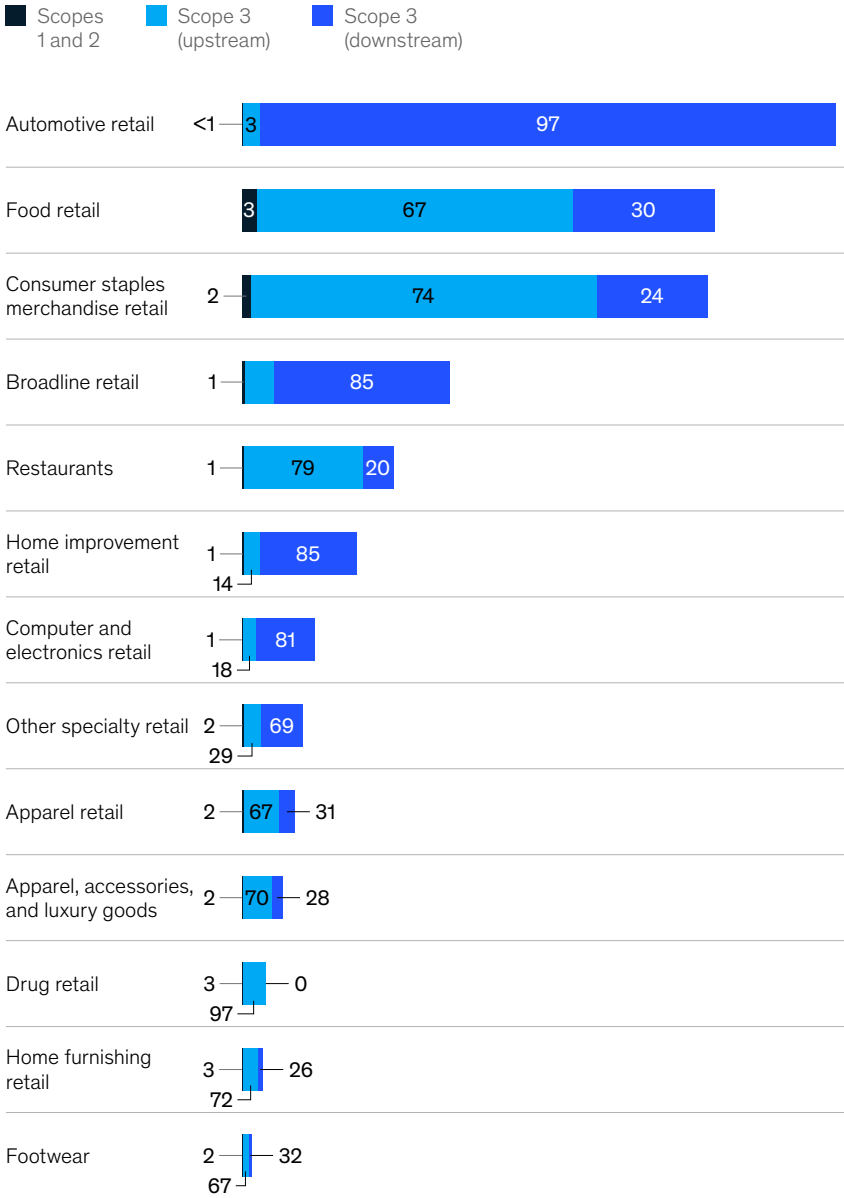
[1] Because there are regional differences among retailers and the retail industry—for example, in consumer preferences and behaviors, regulatory requirements, and governments—decarbonization measures and solutions may also vary by region.

Exhibit 2

Retailers' Scope 3 emissions reflect wide-ranging differences in production and consumption within product channels.

Total greenhouse gas (GHG) emissions, breakdown by 13 retail channels,[1] %



	100% in million metric tons CO_2 equivalent	Share of total global GHG emissions, %
Automotive retail	2,074	5.0
Food retail	1,649	4.0
Consumer staples merchandise retail	1,629	4.0
Broadline retail	724	2.0
Restaurants	527	1.0
Home improvement retail	400	1.0
Computer and electronics retail	253	0.6
Other specialty retail	213	0.5
Apparel retail	185	0.5
Apparel, accessories, and luxury goods	142	0.4
Drug retail	83	0.2
Home furnishing retail	73	0.2
Footwear	34	0.1

Note: Figures may not sum to 100%, because of rounding. Automotive reflects downstream fossil fuel use; food and staples reflect upstream manufacturing and farming.
[1]In the scope of this paper, the definition of "retail" based on the Global Industry Classification System includes automotive retail; consumer discretionary distribution and retail (including broadline retail, specialty retail, and home improvement retail); consumer durables, such as apparel and luxury goods (including accessories and footwear); consumer staples distribution and retail (including consumer staples merchandise retail, drug retail, and food retail); and restaurants.
Source: CDP Worldwide; McKinsey analysis

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For product categories such as food and general merchandise, retail value chains typically generate emissions within six major energy and land-use systems: agriculture and forestry, building, industry, mobility, power, and waste. This means that for a multicategory retailer, reducing Scope 3 emissions involves players from a broad swath of industries and entails decarbonization efforts within all six systems.[2]

The average retailer's Scope 3 emissions come from many types of upstream and downstream sources and can vary widely by retail format or channel depending on the mix of products carried.[3] Around 80 percent of Scope 3 emissions for an average retailer are generated upstream in value chains via feedstock production, materials and components, processing and manufacturing, and packaging. Around 20 percent of emissions are concentrated downstream, generated by transporting goods and by consumers' use of electronics and other electricity-consuming products (Exhibit 3).

Given that retailers routinely carry millions of SKUs across hundreds of product channels, it is perhaps unsurprising that the average retailer's Scope 3 emissions make up the overwhelming majority of total retail sector emissions: 98 percent. Just 2 percent of the sector's emissions are generated by retailer operating activities such as powering facilities, refrigeration, transportation, and on-site fuels.

Given that retailers routinely carry millions of SKUs across hundreds of product channels, it is perhaps unsurprising that the average retailer's Scope 3 emissions make up the overwhelming majority of total retail sector emissions: 98 percent.

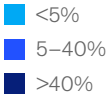
[2] While sharing energy and land-use systems with other industries is not unique to retail, the range and variety of inputs and product categories in the value chains of multicategory retailers are extensive.

[3] According to CDP guidance. See "CDP Climate Change 2023 Reporting Guidance, C5.2," CDP, accessed June 24, 2024.

Exhibit 3

Retailers' Scope 3 emissions are generated by six energy and land-use systems across product value chains, primarily upstream.

Variation in value chain emission[1] profiles by retail category, % of total emissions per step



Emissions attributed to energy and land-use systems (% share of global greenhouse gas emissions)	**Power** (22.6%)								
	Upstream suppliers					*Downstream suppliers*			
	Agriculture and forestry (23.6%)		**Industry** (28.5%)		**Building** (28.5%)	**Mobility** (14.8%)		**Waste** (3.9%)	
	Plant-based inputs	Livestock-based inputs	Materials and components	Processing and manufacturing	Packaging	Transportation and logistics	Product usage and retail and consumer loss	End of life	**Product total,**[2] metric tons (Mt) CO_2 equivalent/ Mt product
Electronics 1 tablet (500 g)			80–85	N/A[3]	1–2	8–10	10	1	89.0–148.0
Chemicals and pharma 100-pill bottle			85–95		2–4	<1	1–3	<1	17.0–83.0
Beef 1 pack (3 lbs)[4]	18–22	50–55		8–12	1–2	1–2	10	~0	38.0–52.0
Apparel 1 t-shirt (140 g)[5]	10–15		8–12	50–60	1–3	3–4	20	3	9.6–14.4
Frozen vegetables 1 pack (12 oz)	50–60			10–15	7–10	7–10	15	~0	1.1–1.3
Chicken 1 pack (3 lbs)[4]	50–60	7–10		10–15	1–3	5–8	12	~0	3.1–4.0
Dairy 1 gallon milk	10–20	40–50		1–3	1–2	1–2	20	~0	1.3–1.8
Tissue 8 pack of toilet rolls	8–12		3–4	60–70	1–3	10–15	~0	~0	1.0–2.0
Fresh vegetables 1 pack (12 oz)	65–75			1–3	5–6	10–15	10	~0	1.1–1.3
Packaged goods 12 pack of breakfast bars	50–60			10–15	15–22	10–15	~0	<1	0.7–1.1
Plastics 40 pack of water bottles[6]			60–70	<1	10–15	15–20	<1	<1	0.2–0.25

[1]Land-use change (LUC). LUC emissions included in products derived from agriculture and forestry sectors, such as beef, chicken, dairy, frozen and fresh vegetables, and tissue. Specifically in beef, dairy and chicken, LUC emissions included in feed production or plant-based inputs stage.
[2]Including product losses.
[3]Included in materials footprint.
[4]Boneless.
[5]60% cotton, 40% polyester.
[6]Assuming 16.9 oz (0.5 L) per bottle.

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2 Retailer challenges in focus: Delineating Scope 3 emissions in three value chains

In addition to the scope and scale of SKUs across product categories (ranging from food to apparel to electronics) and sourcing geographies, each of the product value chains whose emissions are captured in a retailer's Scope 3 includes multiple tiers. The value chains also include some highly fragmented markets and suppliers located far upstream or downstream from retailers. In addition, retailers may lack available, reliable emissions data for individual players. All of this complexity can make it challenging for retailers to influence how suppliers approach, track, or report on their emissions.

Consumers' use of products—powering electronics or washing and drying clothing, for example—is also captured in the Scope 3 emissions for retailers that carry such products. Thus, reducing downstream product value chain emissions can often depend on changes in consumer behavior.

Examining common value chain scenarios in three retail product categories—beef, electronic equipment, and apparel—provides insight into the challenges facing retailers and their value chain partners in addressing Scope 3 emissions.[4]

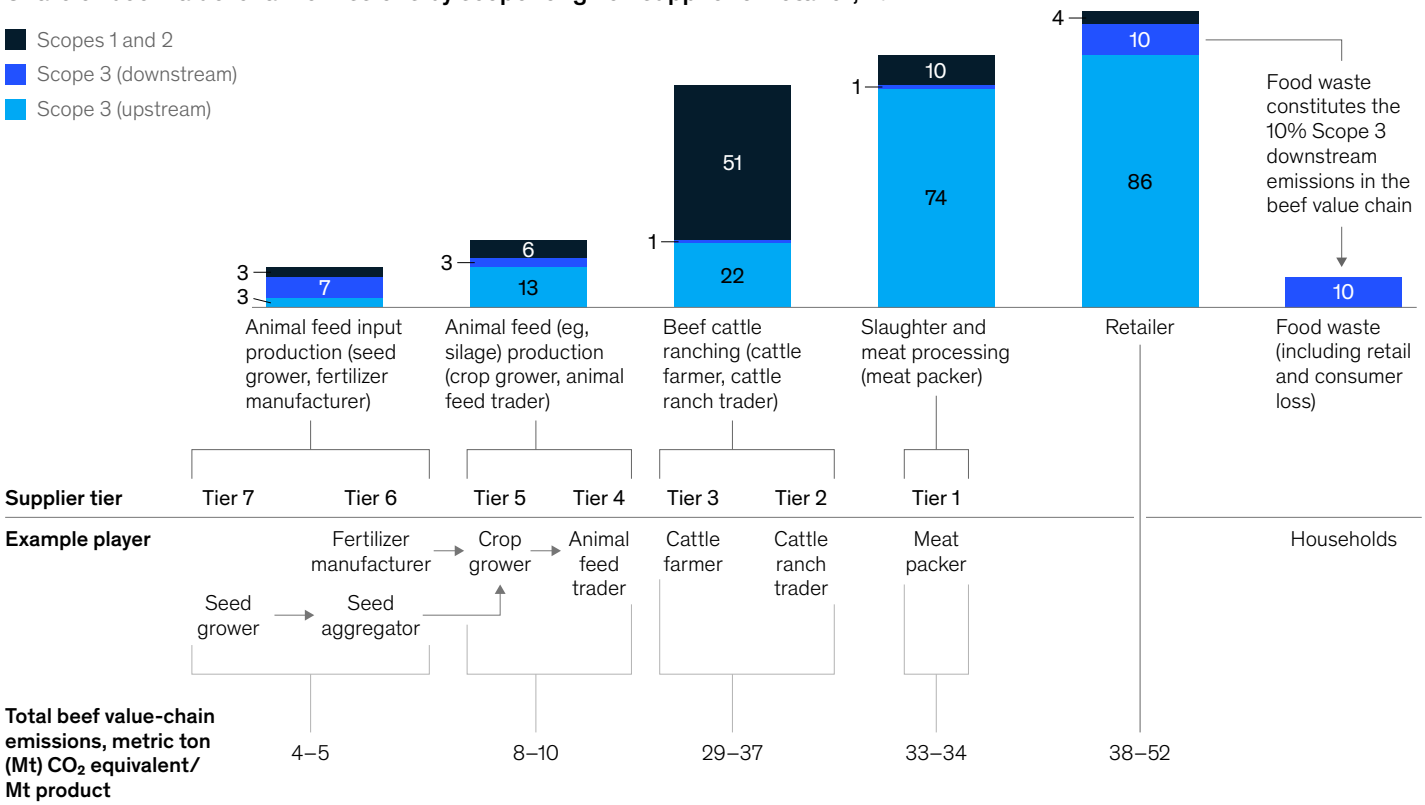
The beef value chain: Fragmentation and technical limits

Among retailers' 15 most commonly sold products, beef is one of the largest sources of Scope 3 emissions, and around 86 percent of beef value-chain emissions are generated upstream (Exhibit 4A).

Exhibit 4A

Around 86 percent of retailers' Scope 3 emissions from the beef value chain are generated by upstream suppliers.

Share of beef value-chain emissions by scope for given supplier or retailer, %



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[4] Value chain scenarios are representative of products purchased and used by North American consumers.

And although cattle ranchers and independent animal feed growers are part of beef value chain segments with the highest percentage of emissions, they may lack an efficient, standard means of tracking many of the sources of their emissions—including methane emitted by cattle. As a result, CDP disclosure numbers for such stakeholders may be scant or nonexistent. Smaller producers may lack capacity to pursue robust decarbonization efforts, including cost-saving levers such as variable-rate fertilization and low- or no-tillage soil.

To calculate their Scope 3 emissions, animal feed aggregators often must survey their small-scale suppliers to collect individual energy, chemical, and product consumption data to use as reporting inputs. Some smaller suppliers may lack the resources or standards needed to fulfill aggregators' requests; consequently, the resulting data may be incomplete or captured in various formats (Exhibit 4B).

According to McKinsey modeling based on technology and costs, the investment implied for beef value chain stakeholders to deploy decarbonization measures may exceed their annual revenue.[5]

The three illustrative examples that follow show the potential implications for hypothetical stakeholders in three segments of the beef value chain: cattle ranching, plant-based animal feed production, and fertilizer production for plant-based animal feed inputs.

Exhibit 4B

Suppliers within the beef value chain vary widely in terms of their fragmentation, production capacity, data disclosure, and level of emissions data disclosure.

Beef value chain: Characteristics of key supplier archetypes

Low Medium High

Supplier tier	Tier 7	Tier 6	Tier 5	Tier 4	Tier 3	Tier 2	Tier 1		
Key supplier archetypes	Seed grower	Fertilizer manufacturer	Crop grower	Animal feed trader	Cattle farmer	Cattle ranch trader	Meat packer	Retailer	Households
US market size, number of players	~3,000[1]	~10	1,000,000	<10[2]	~700,000	~20	4–5[3]		~140,000,000[4]
Number of contractors with retailer	~500	<5	>10,000	<5	~4,000	<5	<5		N/A
Degree of fragmentation[5]									
Capacity[6]									
Direct emissions[7]									
Level of data disclosure[8]									

[1]"Unleashing the potential of millions of smallholders with vegetables," Bayer, updated January 26, 2024.
[2]Top 10 players control majority of the animal feed market ("U.S. feed and livestock market," *Food Additives*, January 15, 2022).
[3]The majority (55–85%) of the meat processing market is highly concentrated in the US, according to US Department of Agriculture data (Brian Deese, Sameera Fazili, and Bharat Ramamurti, "Addressing concentration in the meat-processing industry to lower food prices for American families," The White House, September 8, 2021).
[4]As of 2023, the United States has 131.43 million households ("Number of households in the U.S. from 1960 to 2023," Statista, November 22, 2023).
[5]Degree of fragmentation is based on number of players and market size. Low = <10, medium = 20–5,000, high = >10,000.
[6]Capacity is estimated based on the average revenue size of a typical industry player within each tier. Low = <$1 million revenue, medium = $1–10 million revenue, high = >$10 million revenue.
[7]Direct emissions are based on value chain stage emissions determined through McKinsey analysis.
[8]Level of data disclosure is based on number of representative companies in the supplier archetype that report their emissions to CDP. Low if <10 or no data availability on CDP disclosures, medium if at least 10–20, high if >20.

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[5] The dollar figures for investment implied are based on technology and costs as of December 2023.

Cattle ranching

Consider a hypothetical cattle ranch with 50 to 100 cattle, 120 to 240 acres, and an annual income of $40,000 to $70,000.[6]

Many decarbonization measures could ultimately bring substantial returns for this hypothetical cattle rancher and other ranchers—increasing efficiency and reducing costs as well as emissions. Potential measures include anaerobic manure digestion, efficiency-focused breeding and genetic selection, fat supplements in feed, feed processing for improved digestibility, nitrification inhibitors in pasture, animal health monitoring and illness prevention, regenerative silvopasture, minimized time in feedlots, and biodiesel farm machinery.

On the costlier side, switching from a conventional feedlot system to an extensive, unmodified grass-fed pasture system could require three times more land and 30 percent more cattle to yield the same quantity of beef annually as a conventional feedlot.[7] The transition could also require investment of $85,000 to $170,000 per year. Notably, the amount of land needed could be reduced if rotational grazing were adopted rather than an extensive unmodified pasture system. The required acreage would depend on how many cows per acre the rotational grazing system could support.[8]

Plant-based animal feed production

Consider a hypothetical independent animal feed grower producing four to five tons of grain per acre across 2,400 acres, with net cash flow of around $100,000 per year. If implemented at scale, cost-saving decarbonization measures—including variable-rate fertilization, low or no tillage soil, and cover crops—could save $127 to $150 per metric ton of CO_2 abated.[9] Using controlled-release and stabilized fertilizers and converting from flood to drip or sprinkler irrigation may cost $74 to $114 per metric ton of CO_2 abated, while using biodiesel in farm machinery and equipment could initially cost $216 per metric ton of CO_2 abated.[10] Implementing such measures would likely decrease yields initially, but after a four- or five-year transition period, yields would recover and this hypothetical feed grower could expect to save as much as $2 per metric ton of grain produced, or $24,000 per year.[11]

Many decarbonization measures could ultimately bring substantial returns for this hypothetical cattle rancher and other ranchers—increasing efficiency and reducing costs as well as emissions.

6 "Cattle & beef: Sector at a glance," Economic Research Service, US Department of Agriculture (USDA), updated August 30, 2023; "How many acres do you need per cow when raising cattle?," HerdX, September 20, 2023; "Farming and farm income," Economic Research Service, USDA, updated February 29, 2024; "Cattle industry: Who we are," Cattlemen's Beef Board and National Cattlemen's Beef Association, updated April 2009; "Farm sector income & finances: Farm business income," Economic Research Service, USDA, February 7, 2024.

7 Donald M. Broom, "The sustainability of cattle production systems," in Marie Haskell, ed., *Cattle Welfare in Dairy and Beef Systems*, Berlin, Germany: Springer, 2023; Rachael D. Garrett and Matthew N. Hayek, "Nationwide shift to grass-fed beef requires larger cattle population," *Environmental Research Letters*, July 2018, Volume 13, Number 8.

8 McKinsey analysis conducted in December 2023; Steven Wallander and Christine Whitt, "Farm practices & management," Economic Research Service, USDA, November 21, 2022.

9 McKinsey analysis conducted in December 2023.

10 Ibid.

11 The cost savings of all levers adopted by an animal feed grower is about $20 per metric ton of CO_2 equivalent abated. The reduction potential of all such levers is around 2.98 metric tons of CO_2 per metric ton of packed beef, and about 25 kilograms (kg) of animal feed are required to produce one kg of beef. Therefore, one metric ton of feed produces 0.04 metric ton of beef, and the cost savings per metric ton of grain or feed can be calculated as $20 x 2.98 x 0.04 = around $2 per metric ton of grain.

Industrial fertilizer production for plant-based animal feed inputs

Consider a hypothetical fertilizer supplier producing around ten million metric tons of nitrogen per year with revenue of $35 billion and cash flow of $5 million (assuming industry average margins). Currently, most nitrogen-based fertilizer is industrially produced using gray ammonia. Switching to nitrogen fertilizers based on green ammonia could abate 3 to 6 percent of total emissions generated in the beef value chain.[12] Decarbonizing could require as much as $1 billion in capital investment over a ten-year transition period to establish and implement a renewable energy–based power supply, ammonia electrolyzers, and a hydrogen substrate for ammonia hydrogen electrolyzers.[13] Ammonia hydrogen electrolyzer technology is currently in the early stages of development.

Decarbonization practices can clearly enhance resilience. In some instances, such as fertilizer optimization for feed, it can also lower costs. Nonetheless, the overall transition can present challenges to participants in the beef product value chain who may already face economic uncertainty due to weather events and market volatility (see sidebar "Reducing emissions in the beef value chain: A farmer's perspective").

Reducing emissions in the beef value chain: A farmer's perspective

Consider the circumstances of a hypothetical typical American animal feed grower—one of the most important stakeholder groups in the beef value chain.

A fourth-generation animal feed farmer in rural Indiana may be concerned with providing economic stability for family and workers, maintaining the family farm and passing it on to the next generation, and operating sustainably to enhance soil health and crop resilience. At the same time, this farmer may face any number of challenges, including weather events such as drought, heat, and flooding that threaten crop yields; debt or cash flow issues related to unexpected events and market volatility; and labor shortages.

To transition to lower-carbon farming practices, the farmer's economic risks and challenges would need to be addressed and technical support would be needed. These challenges could be addressed and decarbonization achieved by adopting cost saving and neutral solutions such as variable-rate fertilization, cover crops, and low or no tillage soil that can help decarbonize but also provide economic benefits and improved soil health through enhanced porosity and lower erosional losses. Technical support could be provided via land grants and certified crop advisers, building skills in adapting to climate change via planting varieties of shorter-duration crops as well as in other agricultural management practices. Finally, government grants for climate-adaptive agriculture could also boost cash flow.

[12] McKinsey analysis conducted in December 2023; "From green ammonia to lower-carbon foods," McKinsey, December 11, 2023.

[13] McKinsey analysis conducted in December 2023; Kevin Rouwenhorst, "Technology status: Ammonia production from electrolysis-based hydrogen," Ammonia Energy Association, January 31, 2023. For more information on green ammonia production, see Mohammad Ali Abdelkareem et al., "Recent progress in Green Ammonia: Production, applications, assessment; barriers, and its role in achieving the sustainable development goals," *Energy Conversion and Management*, February 2023, Volume 277.

The electronic-equipment value chain: Managing energy use

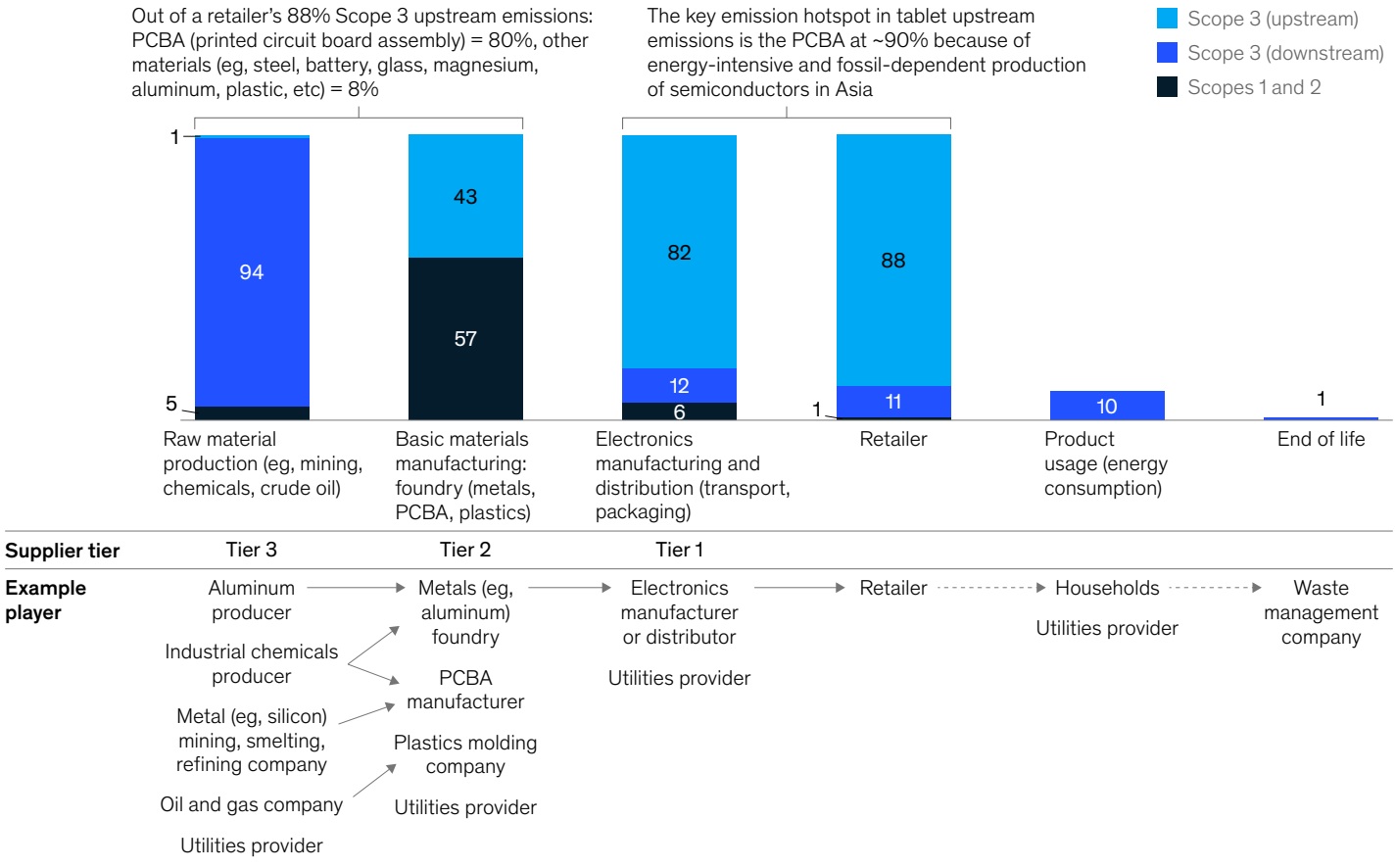
Decarbonizing power use—the largest source of emissions in this value chain—is the average retailer's primary challenge in the electronic-equipment category. These emissions are generated upstream via component manufacturing and downstream via consumer product use.

And more than 80 percent of the average retailer's Scope 3 emissions in this product category come from energy use by suppliers in highly fragmented markets. Downstream consumers generate around 11 percent of Scope 3 emissions, also almost entirely via electricity use (Exhibit 5A).[14]

Exhibit 5A

More than 80 percent of emissions in the electronic equipment value chain are generated upstream, primarily by tier-two suppliers and above.

Share of electronic equipment value-chain emissions by scope for given supplier, retailer, or product lifecycle, %



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[14] McKinsey analysis conducted in December 2023.

Abating emissions in the electronic-equipment value chain would involve reducing energy use and transitioning to clean and renewable energy in places where products are manufactured, sold, and used. Thus, decarbonizing this value chain largely hinges on the availability of renewable energy where suppliers operate (Exhibit 5B).

Suppliers include electronics component manufacturers located in many regions that have a wide range of infrastructure, grid composition, and approaches to decarbonization. One of the largest suppliers for silicon wafers, for example, is in a region where about 85 percent of electricity is generated by fossil fuels.[15] And because most semiconductor manufacturing is energy intensive and dependent on fossil fuels, 65 to 80 percent of emissions in an electronic-equipment value chain (such as one to produce a tablet) are generated at the printed-circuit-board (PCB) or printed-circuit-board-assembly (PCBA) component level.

Exhibit 5B

Suppliers within the electronics value chain vary widely in terms of their fragmentation, production capacity, data disclosure, and level of emissions data disclosure.

Electronic equipment value chain: Characteristics of key supplier archetypes

Low Medium High

Supplier tier	Tier 3			Tier 2		Tier 1					
Key supplier archetypes	Utilities provider	Oil and gas company	Mining company	Utilities provider	Metals foundry	Utilities provider	Electronics manufacturer	Retailer	Utilities provider	Households	Electronics manufacturer
US or region-specific market size, number of players	<20[1]	80–100[2]	~400[3]	~3,000[4]	~1,400[5]	~3,000[4]	~62,000[6]		~3,000[4]	~140 million[4]	~11,000
Number of contractors with retailer	<5[7]	<5	<10	40–50[8]	200–250[9]	50–100[10]	~20		N/A	N/A	N/A
Degree of fragmentation[11]											
Capacity[12]											
Direct emissions[13]											
Level of data disclosure[14]											

[1]Proxied based on the major government utility provider and since there are 9 independent power providers (IPPs) in Taiwan China ("Alternative energy & power 2023," Chambers and Partners, updated July 20, 2023).
[2]Includes upstream (~90) and integrated (both upstream and downstream business units).
[3]Approximated based on ~379 aluminum mining businesses ("Aluminum manufacturing in the US - Number of businesses," IBISWorld, updated April 18, 2024) and 6–7 silicon mining businesses ("Silicon" in *Mineral commodity summaries 2020*, U.S. Geological Survey, January 2020) in the US.
[4]"Electric utilities in the U.S. - statistics & facts," Statista, December 18, 2023.
[5]"Top aluminum casting companies and suppliers in the US and Canada," Thomas Publishing Company, June 18, 2023.
[6]"Tablet computers suppliers," GlobalSpec, accessed April 23, 2024.
[7]Approximated based on average industry player.
[8]Approximated based on geographic spread of metal casting companies across states in the US ("Location of U.S. facilities," United States Environmental Protection Agency, updated February 20, 2016).
[9]Approximated based on average industry player.
[10]Ibid.
[11]Degree of fragmentation is based on number of players and market size. Low = <10, medium = 20–5,000, high = >10,000.
[12]Capacity is estimated based on the average revenue size of a typical industry player within each tier. Low = <$1 million revenue, medium = $1–10 million revenue, high = >$10 million revenue.
[13]Direct emissions are based on value chain stage emissions determined through McKinsey analysis.
[14]Level of data disclosure is based on number of representative companies in the supplier archetype that report their emissions to CDP. Low if <10 or no data availability on CDP disclosures, medium if at least 10–20, high if >20.

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[15] "Distribution of electricity generation in Taiwan in 2022, by source," Statista, 2024.

PCB and PCBA

Within the PCB and PCBA supplier value chain segment, 57 percent of the average retailer's Scope 3 emissions can be attributed to suppliers' Scope 1 and 2 sources: purchased electricity, steam, heat, and cooling.

PCB and PCBA players could address these emissions by increasing the share of renewables in their electricity—through power purchase agreements (PPAs), energy attribute certificates (EACs), green-procurement contracts with utilities, or on-site energy system installations.[16] Similarly, by engaging downstream players such as transportation and mobility companies, processors, and waste management companies, PCB and PCBA companies could advance decarbonization in segments of the value chain for which emissions could be underestimated, underreported, and even unreported.

Consider a hypothetical PCBA company producing around 15 million wafers each year at ten facilities in several regions, with annual revenue of about $70 billion and cash flow of around $15 billion.

Potential decarbonization measures for this company might include take-back schemes that increase circularity, using clean and renewable electricity in the PCBA manufacturing process, and using low-GHG-emitting chemicals in fabrication. Implementing these measures at scale by 2030 could reduce emissions by around 24 percent. Successful implementation would depend on decarbonizing electricity grids such that clean- and renewable-energy-based output would account for around 20 percent of total energy capacity, increasing offshore wind power capacity to 50 times more than what is currently available, and increasing solar power capacity to around four times above current levels.[17] The full transition could take more than ten years and entail investment of more than $8 billion.[18]

Decarbonizing downstream emissions in the electronics product value chain similarly depends on reducing emissions from electricity use—almost all of which are generated by consumer use of electronic devices.[19] Reducing downstream emissions, which account for 11 percent of the average retailer's total Scope 3 emissions for the value chain, would involve influencing consumers to reduce their devices' energy use by disabling background apps and services and using battery-saver mode in addition to influencing shifts toward clean- and renewable-energy grids to power consumer households. In practical terms this could result in, for instance, more than 130 million US households using less energy and the transition of more than 3,000 utilities to clean and renewable energy.[20] Nonetheless, retailers may have little influence over how a local energy grid network generates power.

[16] A power purchase agreement (PPA) is a long-term contract (typical length is ten to 20 years) between a business and an electricity provider from which the business agrees to purchase energy at a prenegotiated price. Energy attribute certificates (EACs) are instruments that track the origin of renewable electricity and its environmental attributes. These documents tell buyers where and when a unit of electricity was produced, which technology was employed, and the age of the power plant that generated it, along with other characteristics. Unbundled EACs are typically sold by third-party retailers rather than electricity providers. Green procurement contracts with utility companies can include a utility green tariff, a contract between a utility and a customer that the customer will procure electricity, and EACs from a clean-energy project (energy generated from renewable sources). These projects can be utility- or third-party owned.Businesses can reduce their direct emissions by installing and operating renewable energy systems using solar, wind, geothermal, and other power sources onsite.

[17] Dennis Engbarth, "Taiwan details road map to carbon neutrality," Energy Intelligence Group, December 28, 2022.

[18] Dollar figures are based on technology and costs as of December 2023.

[19] McKinsey analysis.

[20] "Electric utilities in the U.S. - statistics & facts," Statista Research Department, December 18, 2023.

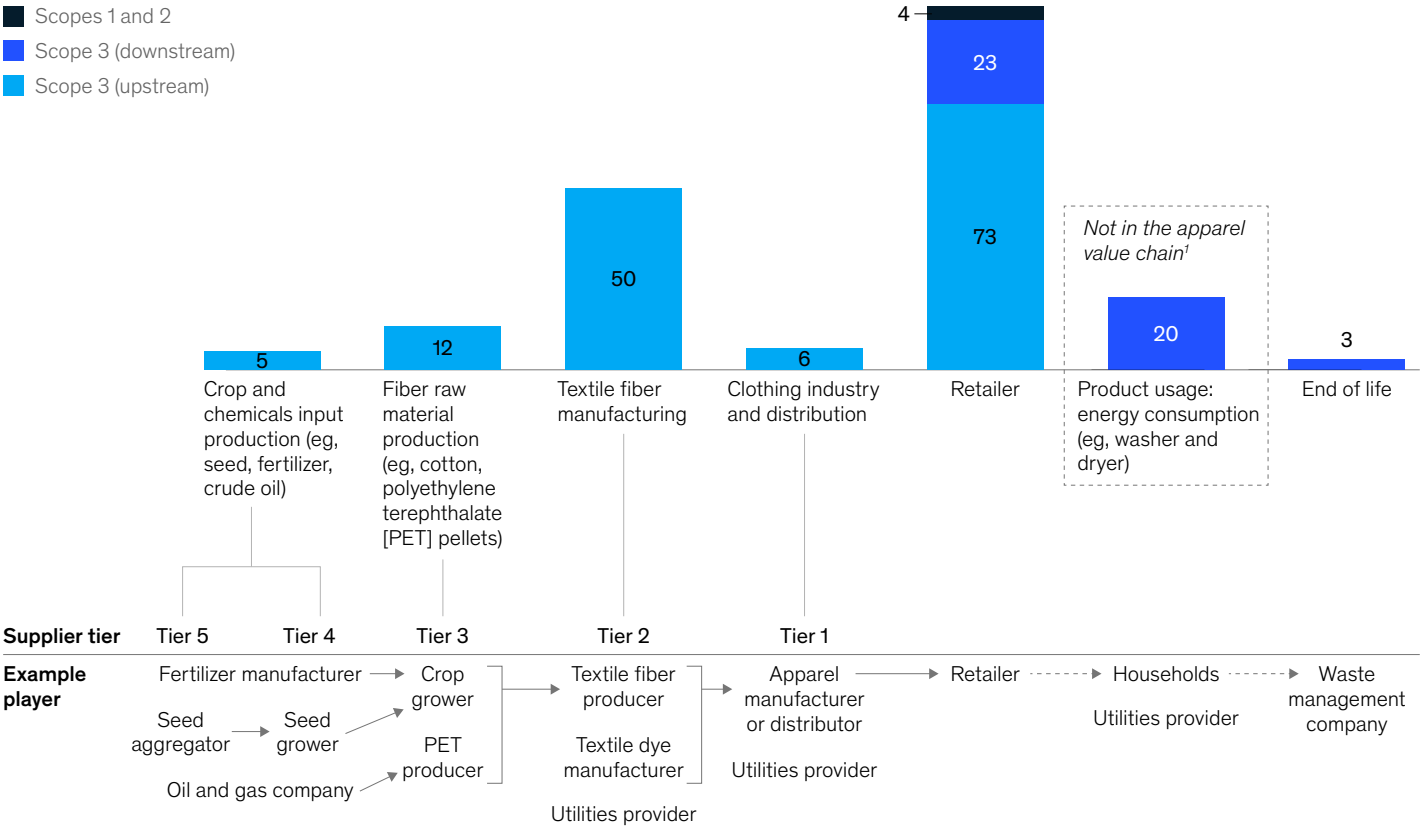
The apparel value chain: Shifting energy use and consumer behavior

In this product value chain, 60 to 70 percent of the average retailer's Scope 3 emissions are generated upstream through energy use among tier-two and tier-three suppliers in garment processing and fiber production (Exhibit 6A).[21]

Exhibit 6A

Around 73 percent of retailers' Scope 3 emissions in the apparel value chain are generated upstream, mostly by tier-two suppliers and above.

Share of apparel value-chain emissions by scope for given supplier or retailer, %



[1]Scope 3 emissions for retailers who sell washers and dryers.

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[21] McKinsey analysis conducted in December 2023.

Largely concentrated in Southeast Asia, where grid decarbonization is low, these upstream suppliers operate in a highly fragmented market with minimal capacity to implement their own decarbonization efforts or influence standards regarding the percentage of renewable energy in the power grid (Exhibit 6B).

Reducing the average retailer's downstream Scope 3 emissions within the apparel value chain is focused on product end of life: influencing consumers' habits on the purchasing and waste management fronts. Decarbonization measures could include manufacturing—and influencing consumers to purchase—durable, sustainably produced new apparel to reduce overall consumption, as well as promoting circularity in fashion via increasing awareness and availability of purchasing, reselling, renting, and recycling options for used apparel.

Around 73 percent of the average retailer's Scope 3 emissions in the apparel value chain are generated upstream by tier-two suppliers and beyond, highlighting the need for apparel manufacturing suppliers—especially wet processors and textile mills—to engage with their upstream suppliers to broadly decarbonize the apparel value chain.[22]

Exhibit 6B

Suppliers within the apparel value chain vary widely in terms of their fragmentation, production capacity, data disclosure, and level of emissions data disclosure.

Apparel value chain: Characteristics of key supplier archetypes

Low Medium High

Supplier tier	Tier 5	Tier 4	Tier 3	Tier 2		Tier 1					
Key supplier archetypes	Fertilizer manufacturer	Seed grower	Crop grower	Utilities provider	Textile fiber producer	Utilities provider	Apparel manufacturer	Retailer	Utilities provider	Households	Waste management companies
US or region-specific market size, number of players	~10	~3,000[1]	6 million	~200[2]	~6,500[3]	~3,000[4]	~26,000[5]		~3,000[4]	~140 million[4]	~11,000
Number of contractors with retailer	<5	~500	>10,000	N/A	~1,000[7]	N/A	20–40[7]		N/A	N/A	N/A
Degree of fragmentation[8]											
Capacity[9]											
Direct emissions[10]											
Level of data disclosure[11]											

[1]"Unleashing the potential of millions of smallholders with vegetables," Bayer, updated January 26, 2024.
[2]As of July 2023, India has 180 companies that generate power and 109 companies that supply power ("14 new discoms set up in last 10 years, says RK Singh," ETEnergyworld.com, July 21, 2023).
[3]As of January 9, 2024, India has 6,476 textile mills ("Textile industry in India: An overview," Gartex Texprocess India, accessed April 23, 2024).
[4]"Electric utilities in the U.S. - statistics & facts," Statista, December 18, 2023.
[5]As of May 2023, the US has 26,215 fashion companies ("Fashion companies," BoldData, accessed April 23, 2024).
[6]"Suppliers" in Inditex annual report 2022, Inditex, March 15, 2023.
[7]Approximated based on McKinsey analysis of large clothing retailers (Nathalie Remy, Eveline Speelman, and Steven Swartz, "Style that's sustainable: A new fast-fashion formula," McKinsey, October 20, 2016).
[8]Degree of fragmentation is based on number of players and market size. Low = <10, medium = 20–5,000, high = >10,000.
[9]Capacity is estimated based on the average revenue size of a typical industry player within each tier. Low = <$1 million revenue, medium = $1–10 million revenue, high = >$10 million revenue.
[10]Direct emissions are based on value chain stage emissions determined through McKinsey analysis.
[11]Level of data disclosure is based on number of representative companies in the supplier archetype that report their emissions to CDP. Low if <10 or no data availability on CDP disclosures, medium if at least 10–20, high if >20.

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[22] McKinsey analysis conducted in December 2023; McKinsey GreenGauge.

The largest contributors to the average retailer's Scope 3 emissions in this value chain are purchased goods and services, which generate 58 percent of the average retailer's total Scope 3 emissions from the production of textiles, dyes, and other manufacturing inputs.[23] Production-related emissions could be reduced by sourcing more sustainable materials, such as organic cotton and recycled polyester, and by minimizing plastic and cardboard packaging.

Companies of all types and sizes in various segments of the apparel value chain could realize meaningful emissions reductions and efficiencies from implementing decarbonization measures, but there are potential obstacles to take into consideration. A closer look at hypothetical companies in two value chain segments provides insight.

Fiber raw material production

Consider a hypothetical small farmer producing 650 kilograms of cotton per year on 1.5 hectares in India, with annual income of around $6,700.[24] Decarbonizing such a grower's operations could include implementing regenerative agriculture practices and using biodiesel fuel for machinery and equipment. Depending on the cropping system, soil, and specific geographic context, the grower could need around 1.035 to 1.055 times more land than used in conventional agriculture to compensate for a potential 3.5 to 5.5 percent yield loss during the initial three- to five-year transition to regenerative agriculture.[25] Notably, there may be no net loss in crop yield and no further land required, and after the initial transition period the grower could achieve yield gains of up to 10 to 30 percent—again depending on the cropping system used, soil, and specific geographic context.[26] In addition to potentially more land, the grower could need training and education to implement and sustain renewable agricultural practices, predictive modeling, sensors, and GPS technology.[27] The annual cost to decarbonize this stage of the value chain could exceed $30,000; however, by implementing such measures at scale, the aforementioned grower could save about $37 per metric ton of CO_2 abated—around $50 per kilogram of cotton lint produced, or more than $32,000 per year.[28]

Garment manufacturing and wet processing

Consider a hypothetical wet processor in India that produces around 40 million meters of fabric per year in a single facility that employs 2,000 and generates annual cash flow of approximately $20 million.[29] To implement decarbonization measures such as using biomass boilers and biogas heating, using renewable energy for its operations, reducing its processing waste, using low-liquor dyeing machines, and redesigning its equipment to optimize efficiency, the company would need access to about 400 gigawatts of clean and renewable energy capacity by 2050—double India's installed non–fossil fuel capacity as of April 2024.[30] The company's transition could take ten years, but if all the measures listed were implemented at scale, the company could reduce its costs by $136 per metric ton of CO_2 abated, or $36 per meter of woven fabric—a total savings of around $1.4 billion per year.[31]

[23] McKinsey GreenGauge.

[24] "Annual yield of cotton in India from financial year 2014 to 2021, with an estimate for 2022," Statista, 2024. According to the USDA, the average size of an Indian cotton farm is 1.5 hectares; see *India: Cotton and products annual*, April 2, 2024, Foreign Agricultural Service, USDA. The average annual income of cotton farmers in Karnataka was 5.63 lakh Indian rupees ($6,748) in 2022. See "Explainer: Farmers' income has doubled over 5 years for cash crops in some states," *Times of India*, July 26, 2022.

[25] "There's room for improvement in a popular climate-smart agricultural practice, Stanford-led study shows," *Stanford Report*, November 8, 2022. Note: The land requirement "1.035 to 1.055 times" is not cited directly in the abovementioned source but is deduced based on the percentage yield loss figures; McKinsey analysis.

[26] McKinsey analysis conducted in December 2023.

[27] "The agricultural transition: Building a sustainable future," McKinsey, June 27, 2023.

[28] One bale of cotton—approximately 480 pounds (217 kg) of cleaned cotton lint—can make more than 1,200 medium-size (140 grams) 100 percent cotton T-shirts (see "Cotton sector at a glance," Economic Research Service, USDA, updated October 11, 2022). The same amount can make about 2,400 medium-size 60 percent cotton T-shirts—0.09 kg cotton lint per T-shirt. The reduction in cost per metric ton of CO_2 abated could be $37. The emissions reduction potential of all listed measures is 0.12258 metric tons of CO_2 equivalent. So the reduction in cost per T-shirt could be $4.53 ($37 x 0.12258 = $4.53), and the reduction in cost per kg of lint could be $50.33 ($4.53/0.09). Dollar figures are based on technology and costs as of December 2023.

[29] McKinsey analysis based on an average industry player producing 40 million meters of finished fabric per year and a net profit before extraordinary items and tax of around $21 million.

[30] "Sector: Renewable energy," Invest India, accessed June 27, 2024.

[31] Dollar figures are based on costs as of December 2023. Total reduction in costs realized by deploying all listed measures at scale could be $136 per metric tons of CO_2 abated, and the total emissions reduction potential could be 0.58857 metric tons of CO_2. Cost savings per T-shirt (and per the approximately 2.2 meters of woven fabric needed for a medium half-sleeve shirt) is around $80. Cost savings per meter of woven fabric, therefore, could be $36. For more, see "How much fabric do you need?," Fabrics by the Yard, February 23, 2019.

While not part of the apparel value chain, emissions generated by consumer use of electricity to wash and dry clothing are captured as Scope 3 emissions for retailers that carry laundry appliances. Addressing these emissions entails influencing widespread shifts in consumers' laundering practices (see sidebar "Reducing downstream emissions from laundry appliances: A consumer perspective").

Retailers' decarbonization trajectory: Present and accelerated

Because the average retailer's Scope 3 emissions capture the emissions generated by many other industries across six major energy and land-use systems around the world, the pace of retail value chain decarbonization will generally mirror the pace of societal decarbonization. The current pace of decarbonization efforts in the systems that affect retailers' Scope 3 emissions metrics could result in 10.1 billion metric tons of CO_2 equivalent (CO_2e) by 2030, consistent with a 1.9°C to 2.8°C global warming trajectory.[32] Staying within a 1.5° pathway could require 2030 emissions to drop to 5.2 billion metric tons of CO_2e—30 percent below 2022 levels and 48 percent below 2030 levels (estimated based on the current pace of decarbonization). And, according

Reducing downstream emissions from laundry appliances: A consumer perspective

When it comes to doing laundry, adults heading a hypothetical Midwestern American family of four with an annual household income of around $80,000 are likely motivated primarily by cost and convenience, aiming to minimize time and money, including expenses for energy and detergent.

Inspiring these consumers to reduce downstream emissions could involve encouraging them to launder their clothing in cold water and to dry it by hanging it up. Enhancing the performance of laundry detergents used in cold-water washing could motivate more consumers to choose this option. And high-performance laundry detergent formulations such as those that include cold-tolerant amylase and other enzymes could help achieve a 35 percent reduction in CO_2 emissions generated by washing.[1]

Appliance manufacturers and retailers can also apply decision science to influence consumers' laundering habits; for example, manufacturers could make cold-water wash the default setting for washers and retailers, and manufacturers could support consumers in switching to more energy-efficient appliances by offering financing, rebates, and trade-in incentives. Enhancing the overall energy efficiency of appliances can also help to maximize consumers' efforts to reduce their individual carbon footprint.

[1] The average estimated greenhouse gas emissions for washing using enzymatic laundry detergent is 500 grams of CO_2 per wash cycle at 60°C and 330 grams of CO_2 per wash cycle at 30°C. See Nazanin Ansari et al., "Enzymes for consumer products to achieve climate neutrality," Oxford Open Climate Change, March 2023, Volume 3, Number 1; Craig Bettenhausen, "The chemistry of cold-water washing," Chemical & Engineering News, January 28, 2024.

[32] Refers to estimates of the potential for emissions reduction if the retail industry continues its volume growth in line with growth forecasts and continues to scale its decarbonization efforts at the pace modeled in 2023. In this report, the estimate is based on: Intergovernmental Panel on Climate Change (IPCC) projected global emissions in 2030 under current pace and decarbonization policies of 53.25 billion metric tons of CO_2e. For more, see Mehdi Benatiya Andaloussi et al., "Near-term macroeconomic impact of decarbonization policies," International Monetary Fund, October 2022. Retail's share of global emissions in 2022 was 19 percent, which is used as a proxy to estimate its share of IPCC-projected global emissions in 2030.

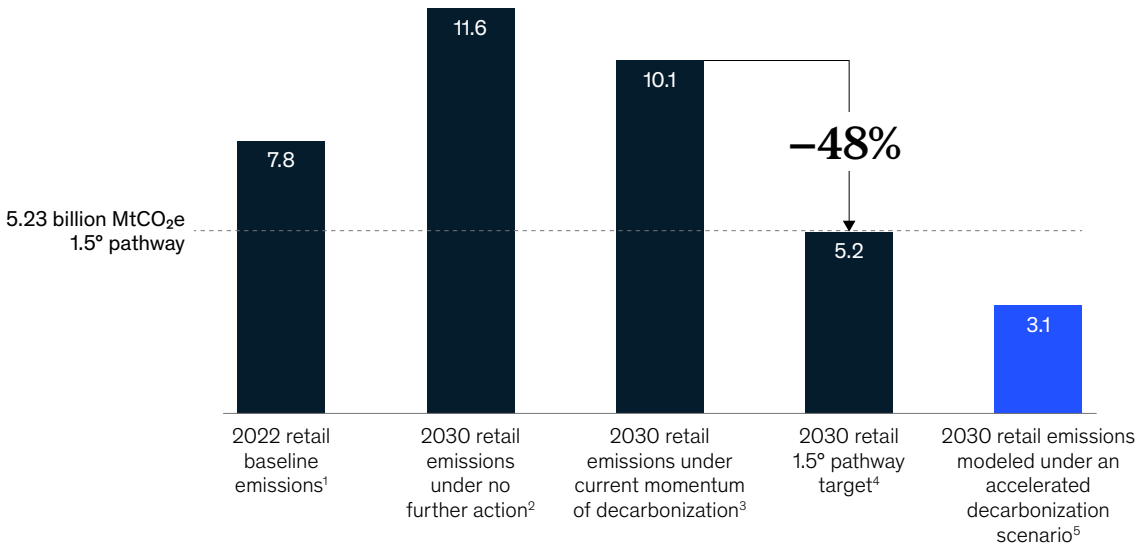
to a McKinsey modeled scenario for accelerated decarbonization, staying well below a 1.5° pathway (which climate scientists refer to as the 1.1°C to 1.7°C warming scenario) could require a 60 percent decrease in emissions from 2022 levels by 2030 (Exhibit 7).

As illustrated by the examples in this chapter, meaningful reductions in the average retailer's Scope 3 emissions will require transformations in energy and land-use systems and involve the efforts of many value chain stakeholders. The following two chapters outline opportunities for near- and long-term emissions reductions in retail value chains and discuss how retailers could work with value chain partners to catalyze them.

Exhibit 7

The 1.5° pathway would require a sharp reduction in retailers' Scope 3 emissions.

Billion metric tons of CO_2 equivalent ($MtCO_2e$)



Global temperature increase[6] linked to projected emission levels	2.9°C (2.4–3.5)	2.3°C (1.9–2.8)		<1.5°C (1.1–1.7)

[1]Based on CDP reported emissions of 85 retailers with credible Scope 3 data.
[2]Forecasted by using a 5.2% CAGR volume growth in retail sector and under no further decarbonization efforts from 2022 baseline year ("Global retail industry market size to reach $40.735 trillion by 2030, growing at a CAGR of 5.2%," EIN Presswire, February 21, 2024).
[3]Intergovernmental Panel on Climate Change (IPCC) projected that global emissions in 2030 under current pace and decarbonization policies are at 53.25 billion MtCO2e ("Chapter 3: Near-term macroeconomic impact of decarbonization policies" in *World economic outlook*, International Monetary Fund, October 2022). Retail's share of global emissions in 2022 is 19%, which is used as a proxy to estimate retail's share of IPCC projected global emissions in 2030.
[4]IPCC estimated global emissions in 2030 for 1.5° decarbonization. Pathway scenario is in the range of 25–30 billion $MtCO_2e$ ("Chapter 2: Mitigation pathways compatible with 1.5°C in the context of sustainable development" in *Global warming of 1.5 °C*, IPCC, 2018); mean of that is 27.5 billion $MtCO_2e$. Retail's 2030 1.5° pathway target is estimated using retail's share of 19% of global emissions.
[5]Retail industry's 2030 projected emissions from a 2022 baseline year, modeled under an accelerated abatement scenario calculated by using a representative retailer's decarbonization pathway until 2030, with the 60% abatement potential scenario based on energy trends from McKinsey's *Global Energy Perspective 2023*.
[6]Warming estimate is an indication of global rise in temperature by 2100 vs preindustrial levels (17th–83rd percentile range), based on IPCC assessments given the respective emission levels and assuming continuation of trends after 2050 but no net-negative emissions.
Source: *Global Energy Perspective 2023*, McKinsey, November 2023

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3 Near-term opportunities for retailers: Reducing emissions across value chains

At-scale achievement of any of the emissions reductions outlined in this chapter would require system-level changes that depend on the efforts of retailers, farmers and ranchers, manufacturers, suppliers, NGOs, public sector entities, energy companies, financial institutions, data and technology providers, and consumers.

McKinsey has identified seven themes for Scope 3 emissions reduction for the average retailer, based on analysis of technically feasible change levers in several product categories and value chains. If implemented at scale, such levers could drive a 55 to 65 percent reduction in the average retailer's Scope 3 emissions by 2030.

Levers that reduce or do not increase costs could drive 12 to 17 percent of these emissions reductions; the remaining 43 to 48 percent of reductions could be enabled by levers that may carry some costs or considerable costs.[33]

Examples in this chapter illustrate emissions reduction opportunities within the seven decarbonization themes that could be enabled by strategically deploying economic resources, natural and physical resources, human resources, low-carbon technology, and data transparency (Exhibit 8). Additional examples are included in the appendix of this report.

McKinsey has identified seven themes for Scope 3 emissions reduction for the average retailer, based on analysis of technically feasible change levers in several product categories and value chains.

[33] Reduction themes were derived from an in-depth marginal cost reduction analysis of more than ten product channels that are representative of a typical retailer's portfolio, including electronics, chemicals, beef, apparel, dairy, and packaged goods.

Exhibit 8a

Deploying change levers within seven decarbonization themes could enable direct emissions reductions or catalyze reductions in value chain systems.

	Key examples of levers by enablers of emissions reduction[1]		
Decarbonization themes	**Economic resources**	**Natural and physical resources**	**Human resources**
Transitioning to clean and renewable energy	$150 per metric ton of CO_2 abated to electrify a meat plant outputting ~5 billion pounds of beef annually	~2× the current power generation capacity from renewables in the next few decades to fully clean grid and to support potential mill-decarbonization targets where most textile mills are located	Skilled workforce to fill 33 million projected job gains as power generation may roughly double by 2050
Reducing farming emissions from livestock management	$85,000 to $170,000 total investment, at a rate of $401 per metric ton of CO_2 abated, for a US beef cattle rancher with 50–100 cattle and 120–240 acres to reduce farming emissions from livestock management using current technology	3× more land and 30% more cattle for an extensive, unmodified grass-fed pasture system vs a feedlot system to produce the same amount of beef annually[4]	Training and skill development in areas such as efficiency breeding, adaptive grazing, and precision technologies to fill the projected 27 million jobs gained by 2050
Adopting regenerative practices in plant-based agricultural inputs	Potential savings of ~$180 per metric ton of CO_2 abated for a cotton grower in Asia with 1.5 hectares of land and an annual production of 445 kg of lint per hectare	1.035–1.055× more land than used in conventional agriculture to compensate for a potential 3.5–5.5% yield loss during the initial 3- to 5- year transition period to regenerative agriculture depending on crop, soil, and geographic context	Technical expertise in adopting precision farming, including use of variable-rate fertilization, predictive modeling, sensors, and GPS technology
Increasing circularity of products and packaging	~$201 per metric ton of CO_2 abated to use recycled cotton fibers, recycled PET,[2] and recycled cardboard in packaging in apparel manufacturing	122% increase in capacity for plastic packaging recycling for the EU to hit its 2030 target of recycling 55% plastic packaging	1 in 5 garments traded via a circular business model to align with a 1.5° pathway by 2030
Reducing waste and increasing process efficiency	~$59 per metric ton of CO_2 abated to reduce food waste in the beef supply chain by 15%–20%[3]	72%–73% increase in EU recycling rate, enabled by increases in capacity and technology to reduce pre- and postconsumer waste, to meet the EU's 2030 residual-waste target	40% improvement in waste collection by 2030 via training and incentives for garment factory employees
Reducing emissions in transportation	$111 per metric ton of CO_2 abated to electrify transport in the beef, electronics, and apparel value chains	384 new mines to supply rare earth elements for electric-vehicle (EV) batteries	Upskilling and training to ensure the number of drivers, operators, and others is adequate to deploy and maintain EVs at scale, ie, the skilled workforce to fill 9 million projected job gains in EV manufacturing and the mobility ecosystem (eg, smart charging) by 2050
Transitioning from animal protein to plant protein products	$30 billion to $55 billion in 2030 and $250 billion to $300 billion in 2050 in capital investment in alternative proteins (including plant-based, fermentation, and cultivated), with ranges based on achieving a 2°C pathway and a 1.5°C pathway and abating up to 7 metric gigatons of CO_2 equivalent	At least 810 factories with an average annual production of 30,000 metric tons to support scaling of plant-based protein production to achieve 2030 production targets	10–15× increase in current consumer adoption rate for plant-based proteins by 2030 to remain on a 1.5° pathway

[1]For further discussion of potential actions and roles for value chain stakeholders, see chapter 4 of this report.
[2]Polyethylene terephthalate.
[3]Approximation based on Environmental Protection Agency estimate that the median cost of food waste across all food categories is $1.17 per lb; average greenhouse gas emissions per ton of beef (2,000 lbs) = 40 metric tons of CO_2 equivalent.
[4]The amount of land needed could be significantly reduced if rotational grazing were adopted rather than an extensive unmodified pasture system. The acreage needed would depend on the number of cows per acre the rotational grazing system could support.
Source: Candace Adams, "How many acres do you need per cow when raising cattle?," Herdx, accessed May 30, 2024; Rory Clune, Viktor Hanzlík, and Raffael Winter, "Power," *McKinsey Quarterly*, August 1, 2022; ColumbiaClimate School; Environmental Protection Agency; European Environment Agency; *Fashion on climate: How the fashion industry can urgently act to reduce its greenhouse gas emissions*, a joint report from McKinsey and Global Fashion Agenda, 2020; Rachael D. Garrett and Matthew N. Hayek, "Nationwide shift to grass-fed beef requires larger cattle population," *Environmental Research Letters*, July 2018, Volume 13, Number 8; Good Food Institute; Industrial-innovation.com; Joshua Katz and Peter Mannion, "Food and agriculture," McKinsey, August 1, 2022; Russell Knight, "Sector at a glance," USDA Economic Research Service, updated August 30, 2023; Timo Möller and Patrick Schaufuss, "Road mobility," McKinsey, August 1, 2022; Project Drawdown; "Reducing agriculture emissions through improved farming practices," McKinsey, May 6, 2020; "Renewable energy in India," Invest India, accessed May 29, 2024; G. R. Sinha and Silvia Liberata Ullo, "Advances in smart environment monitoring systems using IoT and sensors," *Sensors*, 2020, Volume 20, Number 11; "The net-zero transition: What it would cost, what it could bring," McKinsey Global Institute, January 2022; "There's room for improvement in a popular climate-smart agricultural practice, Stanford-led study shows," Stanford Report, November 8, 2022; US Government Accountability Office; Bridget Vandenbosch, "Unlocking the circular economy's potential with a data-driven approach to recycling," Recycling Today, July 26, 2023; Steven Wallander and Christine Whitt, "Study examines how and where U.S. cow-calf operations use rotational grazing," USDA Economic Research Service, November 21, 2022; World Business Council for Sustainable Development; World Economic Forum; McKinsey analysis

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Exhibit 8b

Deploying change levers within seven decarbonization themes could enable direct emissions reductions or catalyze reductions in value chain systems. *(continued)*

	Key examples of levers by enablers of emissions reduction[1]	
Decarbonization themes	**Low-carbon technology**	**Data transparency**
Transitioning to clean and renewable energy	A 4–7× increase in adoption of advanced technologies such as wind and solar to support manufacturing hubs	Use of big data analytics, AI, machine learning, and digital technology in the energy, materials, and mobility sectors to potentially reduce global emissions 20% by 2050
Reducing farming emissions from livestock management	4–7× higher adoption of farming technologies such as selective breeding, fat supplements in feed mix, red algae, systems for monitoring animal health, and adaptive grazing to contribute to a 20% reduction in total emissions from agriculture, forestry, and land use	A system for sharing tools, complete and reliable data, and reporting structures transparently among retail value chain stakeholders
Adopting regenerative practices in plant-based agricultural inputs	Increase in global adoption of silvopastures by 2050 to 720.55 million–772.25 million hectares from ~550.0 million hectares	Primary data to reduce the limitations imposed by applying generic data in tracking progress on regenerative agricultural practices
Increasing circularity of products and packaging	100% adoption of developing technologies such as recycled PET[2] and 4–7× higher adoption of recycled cardboard in packaging to reduce value chain emissions 5%–15% by 2030	Granular and accurate data for tracking the flow of materials and resources throughout their life cycles to support and enhance recycling and circularity
Reducing waste and increasing process efficiency	Adoption of precision-agriculture technologies to improve production efficiency via precise application of inputs, alongside investments in education, R&D, and funding to promote low-carbon technology adoption	End-to-end traceability on sources of waste generated along the value chain (enabled by access to granular data) to pinpoint opportunities to reduce waste
Reducing emissions in transportation	15,000 public and semiprivate EV chargers installed in Europe each week by 2030 to meet demand created by achieving the net-zero goal of EVs making up 75% of global passenger-vehicle sales	Use of digital technologies such as the Internet of Things, imaging, the cloud, geolocation, and AI to gather and analyze real-time data to improve decision making and route optimization to reduce global emissions by 5% by 2050
Transitioning from animal protein to plant protein products	Investment in new breeding technologies to develop next-gen plant-based protein product traits	Public, open-access databases to provide farmers with information on the characteristics and functions of various plants to optimize the availability of desirable crops for plant-based protein products

[1]For further discussion of potential actions and roles for value chain stakeholders, see chapter 4 of this report.
[2]Polyethylene terephthalate.
[3]Approximation based on Environmental Protection Agency estimate that the median cost of food waste across all food categories is $1.17 per lb; average greenhouse gas emissions per ton of beef (2,000 lbs) = 40 metric tons of CO_2 equivalent.
[4]The amount of land needed could be significantly reduced if rotational grazing were adopted rather than an extensive unmodified pasture system. The acreage needed would depend on the number of cows per acre the rotational grazing system could support.
Source: Candace Adams, "How many acres do you need per cow when raising cattle?," Herdx, accessed May 30, 2024; Rory Clune, Viktor Hanzlík, and Raffael Winter, "Power," *McKinsey Quarterly,* August 1, 2022; ColumbiaClimate School; Environmental Protection Agency; European Environment Agency; *Fashion on climate: How the fashion industry can urgently act to reduce its greenhouse gas emissions*, a joint report from McKinsey and Global Fashion Agenda, 2020; Rachael D. Garrett and Matthew N. Hayek, "Nationwide shift to grass-fed beef requires larger cattle population," *Environmental Research Letters*, July 2018, Volume 13, Number 8; Good Food Institute; Industrial-innovation.com; Joshua Katz and Peter Mannion, "Food and agriculture," McKinsey, August 1, 2022; Russell Knight, "Sector at a glance," USDA Economic Research Service, updated August 30, 2023; Timo Möller and Patrick Schaufuss, "Road mobility," McKinsey, August 1, 2022; Project Drawdown; "Reducing agriculture emissions through improved farming practices," McKinsey, May 6, 2020; "Renewable energy in India," Invest India, accessed May 29, 2024; G. R. Sinha and Silvia Liberata Ullo, "Advances in smart environment monitoring systems using IoT and sensors," *Sensors*, 2020, Volume 20, Number 11; "The net-zero transition: What it would cost, what it could bring," McKinsey Global Institute, January 2022; "There's room for improvement in a popular climate-smart agricultural practice, Stanford-led study shows," Stanford Report, November 8, 2022; US Government Accountability Office; Bridget Vandenbosch, "Unlocking the circular economy's potential with a data-driven approach to recycling," Recycling Today, July 26, 2023; Steven Wallander and Christine Whitt, "Study examines how and where U.S. cow-calf operations use rotational grazing," USDA Economic Research Service, November 21, 2022; World Business Council for Sustainable Development; World Economic Forum; McKinsey analysis

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Transitioning to clean and renewable energy

Sustainability measures to support the full potential emissions reductions within this decarbonization theme depend on adopting clean and renewable sources of energy, such as solar-, wind-, and hydro-generated electricity; bio-based feedstock; biogas; biomass boilers; and geothermal energy.

Examples of potential decarbonization measures to accelerate the energy transition are organized by the type of resource involved and include the following.

Economic resources

Electrifying a meat plant with an annual output of approximately five billion pounds of beef (about 20 percent of annual US beef production) could cost $150 per metric ton of CO_2 abated.[34]

Low-carbon technology

By 2030, the global development, integration, and adoption of clean and renewable energy technology such as wind and solar would need to increase four to seven times over 2023 levels to support manufacturing hubs on a 1.5° pathway.[35]

Data transparency

By using AI, retailers could glean greater detail regarding their sustainability metrics, gauge their progress against peers, and locate and circumvent risks. Using advanced data analytics could also enable better integration of renewable energy via improved forecasting of demand for the materials needed for clean and renewable energy technology. Using big data analytics, AI, machine learning, and digital technology could reduce global emissions in the materials, energy, and mobility sectors 20 percent by 2050.[36]

Reducing farming emissions from livestock management

Sustainability measures to support the full potential emissions reductions within this decarbonization theme include efficiency-focused breeding, anaerobic manure digestion, feed processing for improved digestibility, nitrification inhibitor use in pastures, fat supplement use in feed mix, animal health monitoring and illness prevention, regenerative silvopasture, and minimized time in feedlots for animals.[37]

Examples of potential decarbonization measures to reduce farming emissions from livestock are organized by the type of resource involved and include the following.

Economic resources

To reduce farming emissions from livestock management using current technology, a US beef cattle rancher with 50 to 100 cattle and around 120 to 240 acres could require a total investment of $85,000 to $170,000, at a rate of $401 per metric ton of CO_2 abated.[38]

Natural and physical resources

Adopting an extensive, unmodified grass-fed pasture system could require three times more land and 30 percent more cattle than a feedlot system to produce the same amount of beef annually.[39]

Low-carbon technology

The rising use of bioenergy could step up demand for biomass in the food and agriculture sector, creating a need for 12 percent annual growth in biomass production between 2030 and 2040.[40]

[34] Five billion pounds of beef is 20 percent of annual US beef production (2024 forecast: 25.8 billion pounds). See Steve Kay, "US beef industry may see more red ink in 2024," *Food Business News*, January 17, 2024.
[35] McKinsey analysis conducted in December 2023.
[36] "Digital for climate scenarios," World Economic Forum, accessed June 27, 2024.
[37] For more information on these practices, see "The agricultural transition," June 27, 2023.
[38] McKinsey analysis conducted in December 2023.
[39] "Nationwide shift to grass-fed beef," July 2018.
[40] Joshua Katz and Peter Mannion, "Food and agriculture," *McKinsey Quarterly*, August 1, 2022.

Adopting regenerative practices in plant-based agricultural inputs

Sustainability measures to support the full potential emissions reductions within this decarbonization theme include planting cover crops, using variable-rate fertilization, using controlled-release and stabilized fertilizers, using low- and no-tillage soil, and converting from flood to drip or sprinkler irrigation.

Examples of regenerative agriculture measures that could potentially enable emissions reductions are organized by the type of resources involved and include the following.

Natural and physical resources

During the initial transition from conventional to regenerative agriculture, there could be a temporary yield loss. This loss could range from net zero up to 30 percent, depending on the cropping system, soil, and geographic context. Additional land may be needed to mitigate this temporary yield loss—for example, a 30 percent yield loss could be compensated for with 1.3 times more land. After the initial transition period, there could be yield gains of up to 10 to 30 percent—again, depending on the cropping system, soil, and geographic context.[41]

Efficient management of crop land—such as using three times less fertilizer in the United States—could maximize the effectiveness of decarbonizing solutions like nitrification inhibitors and reduce global emissions by around 131 million metric tons of CO_2 by 2050.[42]

Reforesting 65 million acres of US land—some managed by the US Forest Service, Bureau of Indian Affairs, and other federal entities and some owned by state, local, tribal, and not-for-profit entities—could, alongside a number of other measures, help achieve a carbon-neutral US economy by 2030. To remain carbon neutral, 250 million acres could need to be reforested by 2050.[43]

Human resources

Technical expertise would be needed to support the adoption of precision farming, including use of variable-rate fertilization, predictive modeling, sensors, and GPS technology.[44]

Data transparency

New data architectures and the integration of recognized frameworks in internal reporting structures can help ensure data is available, standardized, and transparent across value chains. This could, in turn, help to identify and trace source materials and overcome limitations imposed by applying generic data in tracking progress on regenerative agricultural practices.[45]

Increasing circularity of products and packaging

Sustainability measures to support the full potential of emissions reductions within this decarbonization theme include adopting circular materials such as recycled cotton fibers, recycled polyethylene terephthalate (PET), and recycled cardboard in packaging, and using circular business models such as take-back schemes for PCBAs.

Examples of potential measures to enable emissions reductions by enhancing product and packaging circularity are organized by the type of resources involved and include the following.

Economic resources

Using recycled cotton fibers, recycled PET, and recycled cardboard in packaging in apparel manufacturing could cost $201 per metric ton of CO_2 abated, while using recycled cotton fibers in garment manufacturing could save around $25 per metric ton of CO_2 abated.[46]

[41] McKinsey analysis conducted in December 2023. For more, see "The agricultural transition," June 27, 2023.
[42] McKinsey analysis conducted in December 2023.
[43] "Roadmap to regeneration in the United States, 2020–2030," Regeneration International, February 2, 2021.
[44] "Precision agriculture: Benefits and challenges for technology adoption and use," US Government Accountability Office, January 31, 2024.
[45] *Scope 3 action agenda for the agrifood sector – tackling land-based emissions and removals*, World Business Council for Sustainable Development, January 2024.
[46] McKinsey analysis conducted in December 2023.

Natural and physical resources
New and expanded waste management infrastructure is needed to support increased circularity: for example, the European Union would need to increase its recycling capacity for municipal solid waste (MSW) by 60 percent to hit its 2030 target of 65 percent MSW recycling. It would also have to increase its capacity for plastic-packaging recycling by 122 percent to hit its 2030 target of recycling 55 percent of plastic packaging.[47]

Data transparency
Granular and accurate data would be needed to track the flow of materials and resources throughout their life cycles to support and enhance recycling and circularity.[48]

Reducing waste and increasing process efficiency

Sustainability measures to support the full potential emissions reductions within this decarbonization theme include minimizing waste throughout the value chain—in design, production, consumption, and end of life—by increasing efficiency and reducing the generation of waste.

Examples of potential measures to enable emissions reductions by reducing waste and increasing process efficiency are organized by the type of resources involved and include the following.

Economic resources
Reducing food waste in the global beef supply chain by 15 to 20 percent would cost around $59 per metric ton of CO_2 abated.[49]

Natural and physical resources
The capacity and technology to reduce pre- and postconsumer waste would need to be expanded and developed. For example, without expanded waste reduction efforts, the average EU recycling rate would have to increase to 72 or 73 percent to meet the European Union's 2030 residual waste target.[50]

And advanced, automated fiber sorting and preprocessing technology that can handle fiber blends, reduce costs, and improve the quality of output could vastly expand the amount of textile waste available for fiber-to-fiber recycling in Europe: potentially up to 18 to 26 percent of gross textile waste by 2030.[51]

Reducing emissions in transportation

Sustainability measures to support the full potential emissions reductions within this decarbonization theme include minimizing the environmental impact associated with the transportation of goods and materials throughout the value chain by transitioning to sustainable transportation alternatives such as electrification and alternative fuels.

Examples of potential measures to enable emissions reductions in transportation are organized by the type of resources involved and include the following.

Natural and physical resources
To meet the demand for rare earth elements in electric-vehicle (EV) batteries, 384 new mines could be needed by 2035.[52]

Low-carbon technology
To reduce CO_2 emissions from value chain transportation, transportation players will need to adopt supportive infrastructure and low-carbon technologies, including charging amenities and EV, hybrid, hydrogen fuel–based, and biofuel trucks.

In Europe, an estimated 24 new battery gigafactories would need to be established to meet local demands for passenger EV batteries, and 15,000 public chargers and semiprivate chargers (those in multifamily homes) would need to be installed each week by 2030 to meet demand created by achieving the European Union's net-zero goal for EVs to account for 75 percent of global passenger-vehicle sales.[53]

[47] Ibid.
[48] Bridget Vandenbosch, "Unlocking the circular economy's potential with a data-driven approach to recycling," *Recycling Today* July 26, 2023.
[49] Approximated based on the US Environmental Protection Agency (EPA) estimate that the median cost of food waste across all food categories is $1.17 per pound, and 40 metric tons CO_2e is the average GHG emissions for one ton (2,000 pounds) of beef.
[50] "Reaching 2030's residual municipal waste target — why recycling is not enough," European Environment Agency, April 26, 2022.
[51] "Scaling textile recycling in Europe—turning waste into value," McKinsey, July 14, 2022.
[52] Renée Cho, "The energy transition will need more rare earth elements. Can we secure them sustainably?," *State of the Planet*, Columbia Climate School, April 5, 2023.
[53] Timo Möller and Patrick Schaufuss, "Road mobility," *McKinsey Quarterly*, August 1, 2022.

Transitioning from animal protein to plant protein products

Within this decarbonization theme, sustainability measures to reduce animal-based protein production, consumption, and emissions while expanding plant-based protein production and consumption include developing new technology, scaling up plant-based protein production, and encouraging adoption.

Examples of potential measures to enable emissions reductions by transitioning from animal to plant protein in products are organized by the type of resources involved and include the following.

Economic resources

According to McKinsey analysis, capital investment in alternative proteins (including plant-based, fermented, and cultivated) of $30 billion to $55 billion by 2030 and $250 billion to $300 billion by 2050 (ranged based on achieving a 2°C scenario and 1.5°C scenario) could help abate up to seven metric gigatons of CO_2.

Natural and physical resources

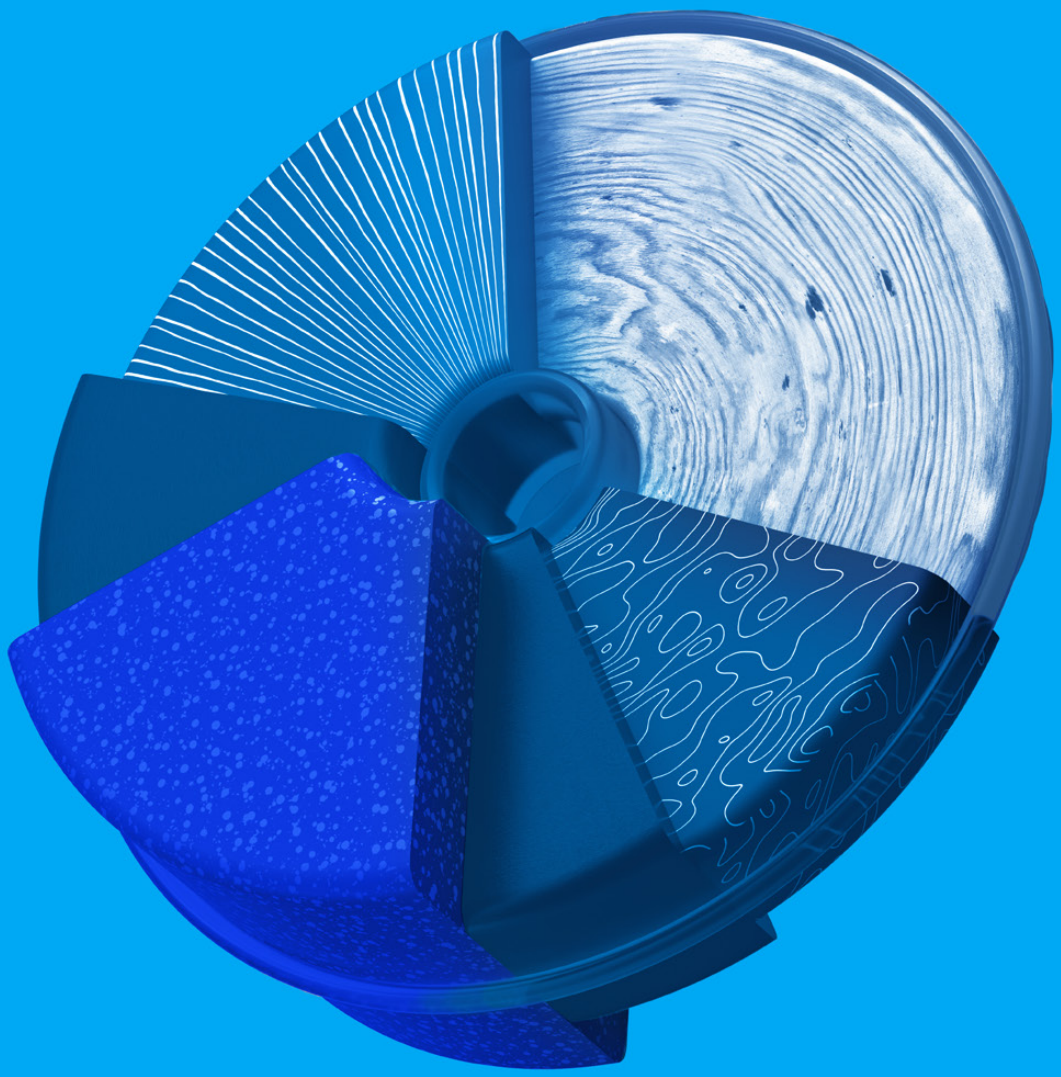
Shifting to plant-based protein production at the scale needed to meet demand and achieve 2030 production targets of at least 25 million metric tons of plant-based meat annually could require at least 810 factories with an average annual production of 30,000 metric tons of structured plant protein to serve as the base material for meat substitutes.[54]

Human resources

According to McKinsey analysis, the consumer adoption rate for plant-based proteins would need to increase ten- to 15-fold between 2023 and 2030 to remain on a 1.5° pathway.[55]

As the examples in this chapter illustrate, value chain stakeholders could deploy a number of potential levers to realize emissions reductions in the near term. The next chapter provides further details on how decarbonization could be approached, prioritized, and achieved. It also includes examples of some real-world initiatives.

[54] Blake Byrne et al., *Plant-based meat: Anticipating 2030 production requirements*, Good Food Institute, 2022.
[55] McKinsey analysis conducted in December 2023.



4 Catalyzing broader decarbonization: Strategies and considerations for retailers

Substantially reducing the emissions that fall within the average retailer's Scope 3 metric will require wide-ranging collaborations to transform various energy, land-use, and other social systems. Retailers' ability to catalyze such efforts through engagement of suppliers, customers, and other value chain stakeholders will vary, depending on their proximity to the value chain segment involved and the feasibility of the required change—for example, technology or cost.

To help retailers prioritize decarbonization efforts, this chapter arranges levers that retailers and other stakeholders could deploy into four groups. Each group of levers could enable strategic decarbonization actions, examples of which are illustrated later in this chapter by real-world initiatives involving retailers and their value chain partners.

— *Group A: Cost-effective near-tier levers.* Retailers could lead efforts with their direct suppliers and their direct suppliers' suppliers (as well as consumers) to deploy these levers and scale decarbonization solutions that are either cost neutral (creating benefits that offset costs) or cost saving (lowering costs). Because of the cost-effectiveness of levers in this group, retailers can consider taking immediate action to lead the deployment of these levers at scale, potentially reducing the average retailer's Scope 3 emissions by up to 2 percent.

— *Group B: Cost-effective far-tier levers.* Retailers could influence actions in this category by convening suppliers in tier three and beyond (along with other industry partners) to deploy cost-saving or cost-neutral levers to facilitate adoption of sustainability measures. Deployed at scale, such efforts could potentially help reduce the average retailer's Scope 3 emissions by around 11 to 15 percent.

— *Group C: Costlier near-tier levers.* Deployed at scale, group C levers could potentially help reduce the average retailer's Scope 3 emissions markedly: by around 19 to 23 percent. By collaborating with their tier-one, tier-two, and tier-three suppliers and other value chain partners (including those in other industries) to enhance feasibility, retailers could catalyze efforts that are costly to implement with existing systems or technology (but still lower in cost than the predicted global average carbon price) and realize potentially substantial decarbonization impacts.[56]

— *Group D: Cost-prohibitive far-tier levers.* Group D levers deployed at scale could help realize the largest reductions in the average retailer's Scope 3 emissions: 25 to 30 percent. Although changes in this group of levers are costly to implement with current systems or technology, retailers could support, advocate, mobilize, and engage suppliers beyond tier three and other stakeholders to facilitate breakthrough innovation and solutions to realize systemwide changes.

By focusing on the levers in groups A and B, retailers could lead and accelerate efforts to achieve up to 15 percent reduction in the average retailer's Scope 3 emissions by 2030. However, a 55 to 65 percent reduction could be unlocked if levers in groups C and D were deployed in addition to group A and B levers, highlighting the importance of multistakeholder collaboration to realize substantial impact.

Based on such considerations, retailers can determine where they intend to lead, convene, catalyze, or advocate actions to reduce emissions in the areas outlined in the previous chapter (Exhibit 9).

There are a number of real-world examples of actions taken in all four categories of collaborative emissions reduction efforts; many of these are discussed in the remaining sections of this chapter.

[56] The carbon price estimate is based on technology available as of December 2023 and assumes an average global carbon price of $50 per metric ton of CO_2, based on a World Bank report (*State and trends of carbon pricing 2023*, World Bank, 2023) that cites Network for Greening the Financial System's (NGFS) Net Zero 2050 scenario, which suggests that carbon prices need to be around $50 by 2030 in 2010 terms to achieve a below 2°C outcome; and on McKinsey analysis estimating the required global carbon price in 2020 at around $40 to $80 to limit warming to 1.5°C.

Exhibit 9

Up to about 17 percent of retailers' Scope 3 emission reductions could be enabled by applying cost saving or neutral levers.

Reduction potential,[1] %

Highlighted levers in Chapter 4

Reduction theme	Reduction potential	Cost saving or neutral[2]		Cost prohibitive	
		A **Lead and scale,** $0/metric ton (Mt) in tiers 1 and 2,[3] %	B **Convene value chain,** $0/Mt in tiers 3+, %	C **Collaborate and catalyze,** $0–$50/Mt in tiers 1–3, %	D **Advocate and support,** >$0/Mt in tiers 4+ and >$50/Mt across all tiers, %
Transitioning to clean and renewable energy	16.7	0.2	1.4	7.7	7.4
Reducing farming emissions from livestock management	16.2	<0.1	2.7	9.1	4.4
Adopting regenerative practices in plant-based agricultural inputs	8.9	<0.1	5.0	0.1	3.8
Increasing circularity and recycling	7.5	0.1	0.1	2.7	4.6
Reducing waste and increasing process efficiency	6.0	0.6	4.5	0.1	0.8
Reducing emissions in transportation	1.7	0.3	<0.1	<0.1	1.4
Switching from animal proteins to plant alternatives (feed or product)[4]	1.3	<0.1	<0.1	1.3	<0.1
Total reduction potential	**55–65%**	**1–2%**	**11–15%**	**19–23%**	**20–24%**

[1]Based on baseline emissions, reduction potentials, and costs of levers only for packaged products as received by retail store; does not include losses, consumer, or end-of-life emissions and levers.
[2]Cost neutral is defined as break-even ($0/Mt CO2 abated).
[3]Calculated based on levers that sit within retailers' tiers 1 and 2 supply network and levers that are "in the money" as well as cost neutral (ie, break-even).
[4]Reduction potential for the theme. Switching from animal protein to plant alternatives is calculated using beef category as proxy, assuming 4% adoption rate of alternative meat by 2030 and assuming an emission reduction potential of ~80–85% in beef.

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Group A: Cost-effective near-tier levers

As previously noted, retailers can—along with their suppliers in the tiers nearest to retailers in product value chains—lead sustainability measures that are either cost neutral or cost saving.

By leading efforts supported by their value chain partners to transition to renewable energy, reduce waste, optimize process efficiency, increase circularity and recycling, and decarbonize transportation, retailers can potentially help reduce the average retailer's Scope 3 emissions by up to 2 percent.

Transitioning to clean and renewable energy
Retailer-led efforts to replace fossil fuel–dependent energy with energy generated by wind, solar, and geothermal as well as implementing energy efficiency practices such as heat integration could lower the average retailer's Scope 3 emissions by around 0.2 percent (see sidebar "Investment to impact: Reduction potential for two retailer-led transitions to renewables").

Investment to impact: Reduction potential for two retailer-led transitions to renewables

The snapshots below highlight the cost (or savings) and impact of retailer-led efforts to implement renewable energy use among tier-one and tier-two suppliers in two retail product categories, modeled using McKinsey analysis.[1]

Apparel
Adopting geothermal energy in the tier-two wet processing stage within a blended-fabric T-shirt value chain could save around $62 per metric ton of CO_2e abated. Savings are net capital expenditure and operating expenses.

The potential impact? Around 9 percent Scope 3 emissions reduction in the apparel category for the average retailer.

Packaged goods
Using sugarcane bagasse for heat generation in the tier-two operation stage of a breakfast bars value chain could save around $145 per metric ton of CO_2e abated.

The potential impact? Around 5 percent Scope 3 emissions reduction in the packaged goods category for the average retailer.

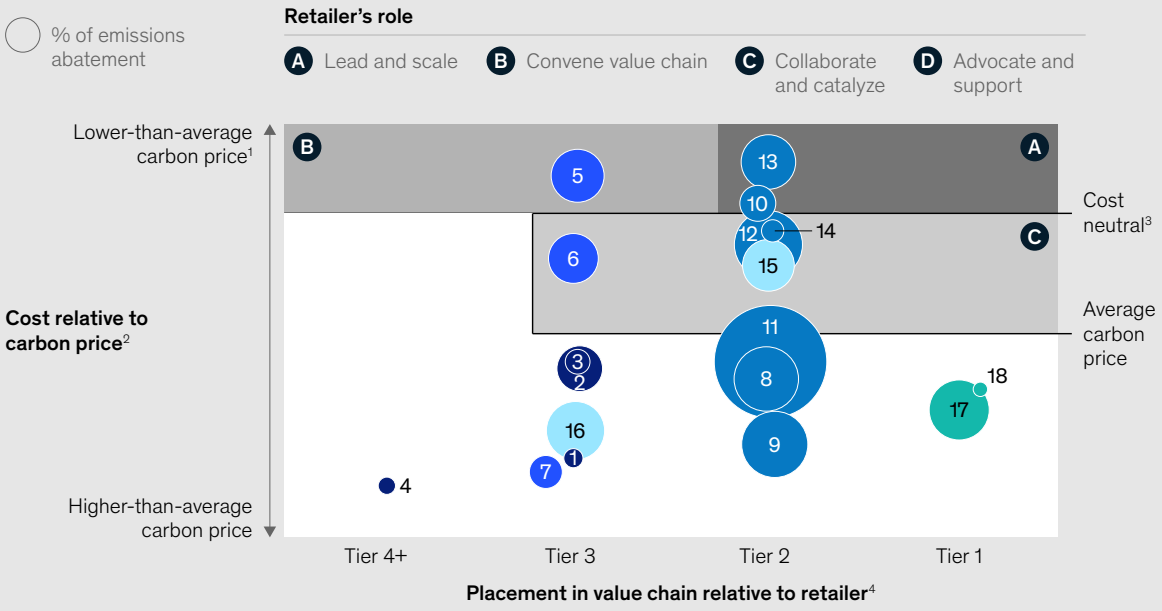
Several additional retailer-led sustainability measures could also help reduce the average retailer's Scope 3 emissions in tiers one and two of the apparel product value chain, from transitioning to regenerative and organic farming to using closed-loop recycled polyester (exhibit).

[1] Modeling for apparel based on a 140-gram T-shirt of blended fabric made of 60 percent cotton and 40 percent polyester, and modeling for packaged goods based a 12-pack of breakfast bars.

Investment to impact: Reduction potential for two retailer-led transitions to renewables (continued)

Exhibit

To reduce Scope 3 emissions from t-shirt production, retailers can prioritize actions based on their decarbonization potential and proximity in the value chain.



Abatement levers across the value chain[5]

Polyester production

1. Cracker carbon capture and storage
2. Biogas for heating
3. Renewable electricity
4. Biobased feedstock

Cotton cultivation

5. Regenerative agriculture
6. Organic agriculture
7. Switch to biodiesel in farm equipment and machinery

Garment manufacturing and logistics

8. Biomass boilers
9. Biogas for heating
10. Low-liquor dyeing machines
11. Renewable electricity
12. Geothermal energy
13. Manufacturing and processing waste reduction
14. Equipment efficiency redesign

Circular materials

15. Recycled cotton fibers
16. Closed-loop recycled polyester

Packaging and transportation

17. Electrification of transport[6]
18. Switch to recycled cardboard

Note: Based on production for 60% cotton, 40% polyester t-shirt.
[1]Using an average global carbon price of 50 $/metric ton (Mt) of CO_2 based on World Bank report that states that Network for Greening the Financial System's modeling suggests that carbon prices need to be around $50 by 2030 in 2010 terms to achieve a below 2°C outcome (*State and trends of carbon pricing*, World Bank, May 2023) and based on McKinsey analysis that the required global carbon price in 2020 is ~$40–$80 to limit warming to 1.5°C.
[2]Cost relative to carbon price is measured by benchmarking decarbonization costs against global average carbon pricing of $50 as the opportunity cost.
[3]Cost neutral refers to a reduction cost of $0/$MtCO_2$ equivalent.
[4]Tiers 1 and 2 represent a retailer's immediate supplier network (ie, direct suppliers and their direct suppliers); further upstream in the value chain are tier 3 and tier 4+.
[5]Based on marginal abatement cost curve that covers Scope 3 upstream emissions, including raw material extraction, agriculture, processing, manufacturing, packaging, and transportation; excludes retail waste and end-of-life emissions.
[6]Electrification of transport, though it has emissions distributed across whole value chain, is attributed to action taker closest to retailer (tier 1 supplier) because of high level of influence over entire supply chain.

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Irrespective of product category, there are numerous effective retailer-led actions that could reduce emissions in suppliers' value chains.

Retailer-led efforts to switch to clean and renewable electricity. Retailers can encourage their suppliers to adopt clean and renewable energy by working with value chain partners to enable suppliers' transition. For example, Walmart and Schneider Electric developed the Gigaton PPA program, and five suppliers collaborated under the program to purchase about 250,000 megawatt-hours of renewable energy annually from Ørsted, a renewable energy company, which is equivalent to avoiding carbon emissions from more than 450,000 gasoline-powered passenger cars driven for one year.[57] Levi Strauss & Co, a supplier that participated in this initiative, is projected to power its operations with 100 percent renewable electricity by 2025.[58]

Supporting suppliers' net-zero implementations. Retailers can assist suppliers in navigating the complex process of implementing sustainability measures in service of net-zero targets. Specifically, retailers can provide guidance for permitting, supplier due diligence, and training to help suppliers cultivate the technical skills and knowledge they need. One real-world example of this approach is Nike's partnership with the not-for-profit Clean Energy Buyers Institute (CEBI) to launch the Clean Energy Procurement Academy (CEPA), which helps equip companies and suppliers with the skills and knowledge they need to investigate their options and adopt renewable energy.[59]

Promoting sustainable consumption with consumer-focused marketing and tools. Retailer-led marketing campaigns and consumer-facing tools can raise consumer awareness about the benefits of adopting energy efficient products and shifting their habits to reduce their personal carbon footprints. These campaigns can effect considerable changes. For example, detergent maker Tide launched Turn to Cold, a joint campaign with Walmart to promote cold-water use in washing cycles. The goal was for 75 percent of North American laundry loads to use cold water by 2030, potentially avoiding 27 million metric tons of CO_2 emissions.[60]

Reducing waste and increasing process efficiency

Retailer-led efforts to reduce waste and optimize processing efficiency, particularly in packaging and postconsumer use, could realize substantial reductions—around 0.6 percent of the average retailer's Scope 3 emissions—in various retail product value chains (see sidebar "Investment to impact: Reduction potential for two retailer-led efforts to reduce waste and optimize processes").

[57] "Gigaton PPA: Walmart, Ørsted and Schneider Electric announce first cohort for renewable energy supply chain program," Walmart, October 18, 2022.
[58] "Climate action," *Sustainability report*, Levi Strauss & Co., accessed June 27, 2024.
[59] Mark Segal, "Apple, Nike, launch initiative to accelerate adoption of clean energy in supply chains," *ESG Today*, October 30, 2023.
[60] "Tide and Walmart team up to expand adoption of washing in cold with consumers: For the love of their laundry, their wallets and the planet," Procter & Gamble, April 22, 2024; "Turn to cold," Tide, accessed June 27, 2024.

Investment to impact: Reduction potential for two retailer-led efforts to reduce waste and optimize processes

The following snapshots highlight the cost (or savings) and emissions impact of retailer-led efforts to reduce waste and realize process efficiencies among tier-one suppliers in two retail product categories, modeled using McKinsey analysis.[1]

Tissue

It could cost a retailer nothing to switch to tier-one suppliers within the toilet tissue roll value chain with lower manufacturing-based emissions.

The potential impact? Around 9 percent Scope 3 emissions reduction in the toilet tissue category for the average retailer.

Apparel

Reducing waste in tier-one manufacturing and processing within a blended-fabric t-shirt value chain could save around $170 per metric ton of CO_2e abated.

The potential impact? Around 6 percent Scope 3 emissions reduction in the apparel category for the average retailer.

[1] Modeling for tissue based on an eight-pack of toilet tissue rolls and for apparel based on a 140-gram t-shirt made of blended fabric (60 percent cotton, 40 percent polyester).

Promoting suppliers' use of innovation to enhance efficiency. Retailers can engage with their major tier-one and tier-two suppliers on innovative approaches to improving efficiency. For example, Unilever worked with one of its suppliers to develop new enzyme solutions. The two enzyme innovations improved product performance and helped Unilever's customers save energy, thereby reducing CO_2 emissions.[61]

Collaborating to expand sustainable-packaging use. With their supplier partners, retailers can invest in capabilities and technologies to support sustainable packaging. Industry guidelines and incentives on sustainable packaging can facilitate adoption. For example, Nike's One Box design, which involves shipping shoes from online orders in the original shoe box (without an outer box), resulted in a 51 percent reduction in packaging waste.[62]

Empowering consumers to reduce waste via discounts and rewards. Retailers can introduce programs that enable consumers to reduce waste and provide monetary incentives such as pricing discounts and rewards to encourage them to engage with the programs.

For example, Patagonia's Worn Wear program allows customers of the outdoor-clothing company to reduce waste and refresh their wardrobes. As part of this program, the company accepts previously worn Patagonia clothing in good condition in exchange for credit toward purchases of new Patagonia items.[63] In addition, coffee retailer Starbucks provides a $0.10 discount to customers who use their own mugs. This not only reinforces sustainable habits but also reduces overall waste and yields cost savings on cups.[64]

Empowering consumers to reduce resource consumption via awareness campaigns. Retailers can establish marketing campaigns to help raise awareness of eco-friendly consumption and encourage adoption of eco-friendly habits. For example, clothing retailer Levi's partnered with not-for-profit Water.org on the Go Water<Less campaign to educate the public on water use and simple best practices to reduce personal water consumption. Levi's Water<Less process to reduce the amount of water used in denim finishing had saved more than 3.0 billion liters of water and recycled more than 1.5 billion liters by 2019.[65]

Decarbonizing transportation

Retailer-led efforts to reduce transportation emissions in retail product value chains could yield up to a 0.3 percent reduction in the average retailer's total Scope 3 emissions (see sidebar "Investment to impact: Reduction potential for two retailer-led efforts to reduce emissions from transportation").

Providing charging infrastructure to accelerate EV adoption. Retailers can provide charging infrastructure at their own depots and facilities to

[61] Agustin Gutierrez, Ashish Kothari, Carolina Mazuera, and Tobias Schoenherr, "Taking supplier collaboration to the next level," McKinsey, July 7, 2020.
[62] "Special delivery: How one box cuts packaging in half," Nike, Inc., updated April 13, 2022.
[63] "Worn wear," Patagonia, accessed June 27, 2024.
[64] Jordan Valinsky, "Starbucks will now let customers use personal cups for nearly all orders," CNN, January 4, 2024.
[65] "Levi's Water<LESS Campaign," Water.org, March 22, 2012; "How Levi's® is saving water," Levi Strauss & Co., March 25, 2019.

Investment to impact: Reduction potential for two retailer-led efforts to reduce emissions from transportation

The following snapshots highlight the cost (or savings) and potential impact of retailer-led efforts to reduce emissions from transportation among tier-one suppliers in two retail product categories, modeled using McKinsey analysis.[1]

Packaged goods

Electrifying the transportation of wheat used by tier-one suppliers in a breakfast bars value chain could save $101 per metric ton of CO_2e abated.

The potential impact? A 4 percent reduction in Scope 3 emissions in the packaged goods category for the average retailer.

Dairy

Electrifying transport from farm to processing and from processing to retail for suppliers in tiers one and two of a milk value chain could save $335 per metric ton of CO_2e abated.

The potential impact? Around 4.6 percent reduction in Scope 3 emissions in the dairy category for the average retailer.

[1] Modeling for packaged goods based on a 12-pack of breakfast bars and for dairy on a one-gallon container of milk.

accelerate EV adoption by their value chain partners. Retailers can also participate in joint ventures with leading fleet vehicle manufacturers to accelerate the implementation of charging infrastructure.

This is an increasingly popular option among retailers: Walmart, Target, and Costco have installed, or announced plans to install, EV charging stations at their stores and warehouses.[66] Walmart, in fact, has more than 1,300 charging stations in 280 facilities across the United States and has announced plans to build an EV fast-charging network at thousands of its locations by 2030.[67] Target has partnered with ChargePoint, Electrify America, and Tesla to deploy EV charging stations at its stores.[68] IKEA has installed 322 EV charging stations across 54 properties and has announced plans to install 500 public fast chargers and more than 300 fleet chargers.[69]

Group B: Cost-effective far-tier levers

As noted at the beginning of this chapter, efforts in this group are cost-neutral or cost-saving to implement but involve tier-three suppliers—those further removed from retailers in the value chain than retailers' direct suppliers or their suppliers.

By taking actions to encourage their tier-three value chain partners to reduce livestock farming emissions, adopt regenerative agriculture practices, reduce waste and optimize processes, and increase circularity and recycling, retailers could potentially help reduce the average retailer's Scope 3 emissions by around 11 to 15 percent.

Adopting regenerative practices in plant-based agricultural inputs

Retailer-accelerated efforts to encourage adoption of regenerative agriculture practices in tier-three plant-based product inputs could reduce the average retailer's Scope 3 emissions by around 5 percent (see sidebar "Investment to impact: Reduction potential for two retailer-accelerated efforts to encourage regenerative practices").

Investment to impact: Reduction potential for two retailer-accelerated efforts to encourage regenerative practices

The snapshots below highlight the savings and impact of retailer-accelerated efforts to adopt regenerative agriculture practices in tier-three plant-based input suppliers in two categories of retail products, modeled using McKinsey analysis.[1]

Packaged goods

Adopting no-tillage soil, biofertilizers, organic farming, straw management, dry seeding for rice, variable-rate fertilization for wheat, and rice water management (drip irrigation) in tier-three crop growing within a breakfast bar value chain could save $690 per metric ton of CO_2e abated.

The potential impact? Around 37 percent reduction in Scope 3 emissions within the breakfast bars category of packaged goods for the average retailer.

Apparel

Adopting regenerative agriculture and organic farming in tier-three cotton crop growing within a blended fabric t-shirt value chain could save $179 per metric ton of CO_2e abated.

The potential impact? Around 11 percent reduction in Scope 3 emissions in the apparel category for the average retailer.

[1] Modeling for packaged goods based on a 12-pack of breakfast bars and for apparel on a 140-gram t-shirt made from blended fabric, 60 percent cotton and 40 percent polyester.

[66] Brian Vines, "Some Costco, Ikea, Target, and Walmart stores now offer EV charging stations," *Consumer Reports*, March 6, 2024; Shannon Cuthrell, "Walmart's ambitious plans for nationwide EV fast-charging network," EEPower, March 4, 2024.
[67] "Walmart's ambitious plans," March 4, 2024; Vishal Kapadia, "Leading the charge: Walmart announces plan to expand electric vehicle charging network," Walmart, April 6, 2023.
[68] Fred Lambert, "Target partners with Tesla, ChargePoint and Electrify America to install over 600 chargers," Electrek, April 24, 2018.
[69] Thomas Lester, "EV stations are latest way Ikea expands environmental impact," Furniture Today, April 19, 2024.

Setting supplier standards under deforestation-free and conversion-free (DCF) policies. In their DCF policies, retailers can set standards for plant-based agricultural input suppliers to source commodities that are deforestation- and conversion-free.[70] For example, Walmart set goals and approaches for suppliers to source deforestation- and conversion-free commodities.[71]

Providing training and resource initiatives to help upskill farmers in sustainable practices. Retailers and their value chain partners provide training and resources to help upskill farmers in sustainable agriculture practices. For example, one value chain partner, American multinational Tyson Foods, provides training and education to farmers on measuring emissions from their value chain and regenerative practices to reduce emissions via its Local Grain Services (LGS) Sustain initiative.[72] Similarly, PepsiCo sponsors employees from its suppliers, bottlers, and contract manufacturers to participate in the Supplier Leadership on Climate Action (SLoCT) school.[73] Participants attend at least two cycles of seminars annually and have access to resources to guide efforts to address climate change and set science-based targets.

Providing emissions reduction training and education for farmers. Retailers can offer educational and training programs, including one-to-one coaching and webinars, to help ranchers reduce farming emissions. For example, Nestlé's training platform for more than 40,000 farmers participating in one of Nestlé's agripreneurship programs focuses on regenerative agriculture practices and improving farms' resilience to climate change impacts.[74]

Forming alliances to share and collaborate on best practices. Retailers can join with peer companies and their value chain stakeholders to share best practices for reducing waste and maximizing process efficiency. For example, the Retail Industry Leaders Association (RILA) has engaged its member companies on several sustainability topics, including zero waste and sustainable sourcing.[75]

Engaging feed aggregators via long-term contracts. Retailers can engage with feed aggregators via long-term contracts to help signal demand for sustainably grown crops, bolstered by private investor support. For example, PepsiCo signed a 7.5-year commercial agreement with agriculture and nutrition multinational ADM to expand the use of regenerative agriculture within their shared supply chains.[76]

Collaborating with suppliers to use incentives to promote sustainable farm practices. Retailers and their value chain partners can use incentives such as blended financing and carbon credit purchases to engage suppliers in implementing sustainable practices. Luxury goods retailer Kering did just that, providing grant support to help cotton and cashmere producers across one million hectares transition to regenerative agriculture practices.[77]

Standard setters and agencies could work with stakeholders to design farmer incentive programs that could be adopted and implemented broadly. For example, Farmer First Clusters—an initiative of the Soft Commodities Forum (SCF), composed of agribusiness companies ADM, Bunge, Cargill, COFCO International, Louis Dreyfus Company, and Viterra—provides farmers with incentives to implement climate-smart agricultural practices and restore degraded lands. Emissions generated by farms participating in the Farmer First Clusters initiative are traceable, and program outcomes have the capacity to abate the

[70] Tomasz Sawicki, "Is Deforestation and Conversion Free (DCF) the bottom line for commodity reporting?," CDP, June 15, 2023.
[71] "Regeneration of natural resources: Forests, land, oceans," Walmart, June 2, 2023.
[72] "LGS Sustain," Tyson Foods Local Grain Services, accessed June 27, 2024.
[73] "Supplier Leadership on Climate Action (SLoCT) – Guidehouse Climate School," PepsiCo, February 2024.
[74] "Nestlé unveils plans to support the transition to a regenerative food system," Nestlé, September 16, 2021.
[75] Kaela Martins, "Zero Waste Network," Retail Industry Leaders Association, accessed June 27, 2024.
[76] "PepsiCo, ADM announce groundbreaking agreement aiming to reduce carbon intensity by supporting regenerative agriculture practices on up to 2 million acres of farmland," ADM, September 14, 2022.
[77] "Regenerative Fund for Nature," Kering, accessed June 27, 2024.

average retailer's Scope 3 emissions along the soy value chain and deliver a market-based mitigation program within the value chain.[78]

Reducing waste and increasing process efficiency
Retailer-accelerated efforts to reduce waste and optimize processing efficiency in tier-three supplier operations could lower total Scope 3 emissions for the average retailer by around 4.5 percent (see sidebar "Investment to impact: Reduction potential for two retailer-accelerated efforts to reduce waste and optimize processes").

Promoting suppliers' adoption of lean manufacturing. Retailers can promote the adoption of lean manufacturing principles throughout their supply chains by engaging their in-network suppliers via supplier contracts. For example, Nike created the Nike Lean Supplier Capability program to promote the adoption of lean manufacturing practices among its suppliers, which resulted in a 50 percent reduction in defect rates, 40 percent faster lead times, and 20 percent improvement in productivity.[79]

Scaling decarbonization technologies to increase process efficiency via public–private collaboration. Public sector players can work with private sector players to improve efficiency. For example, SmartWay, a voluntary collaboration between the US Environmental Protection Agency (EPA) and truck and rail carriers, shippers, and logistics companies, seeks to improve fuel efficiency and reduce environmental impacts from moving goods. More than 3,000 logistics companies are registered with SmartWay.[80]

Mobilizing value chain partners to reduce waste via systemwide collaboration. Retailers can inform customers about storage methods and best-by dates to help reduce food waste, while partnering with food manufacturers to provide discounts on these products. For example, Canadian grocery retailer Loblaw partnered with digital discount food marketplace

Investment to impact: Reduction potential for two retailer-accelerated efforts to reduce waste and optimize processes

The snapshots below highlight the cost savings and impact of retailer-accelerated efforts to reduce waste and make processes more efficient among tier-three suppliers in two retail product categories, modeled using McKinsey analysis.[1]

Chemicals and pharmaceuticals
Increasing the manufacturing throughput rate via continuous manufacturing and waste reduction during tier-three suppliers' active pharmaceutical ingredient (API) production in an ibuprofen value chain could save $42 per metric ton of CO_2e abated.

The potential impact? Around 6 percent reduction in Scope 3 emissions in the chemicals and pharmaceuticals category for the average retailer.

Tissue
Improving post-press dryness by switching to steel Yankee technology in tier-three paper production within a toilet roll value chain could save $12 per metric ton of CO_2e abated.

The potential impact? Around 14 percent reduction in Scope 3 emissions in the toilet tissue category for the average retailer.

[1] Modeling for the chemicals and pharmaceuticals category based on one 100-tablet bottle of 250-milligram ibuprofen tablets and for the tissue category on an eight-pack of toilet rolls.

[78] "Six leading agribusinesses launch a financial model for deforestation-free soy in the Brazilian Cerrado," WBCSD, November 12, 2022.
[79] "Smart lessons on designing enterprise level interventions promoting productivity and working conditions in SMEs," International Labour Organization, 2017.
[80] *SmartWay Transport Partnership: Driving data integrity in transportation supply chains*, US EPA, September 2013.

Flashfood to sell products nearing their best-by date at a discount, eliminating 40 million pounds of potential food waste between 2019 and 2022.[81]

Group C: Costlier near-tier levers

As outlined at the beginning of this chapter, collaborative efforts in this group present opportunities to achieve substantial decarbonization impact: potentially around a 19 to 23 percent reduction in the average retailer's Scope 3 emissions, if implemented at scale. While these actions may carry implementation costs—still below the global average carbon price—given existing systems or technology, they also present opportunities for retailers to collaborate and innovate with their tier-one, tier-two, and tier-three value chain partners to lower the cost of adoption.[82] Actions include reducing livestock farming emissions, transitioning to clean and renewable energy, increasing circularity and recycling, replacing animal protein with plant protein in products, adopting regenerative agriculture practices, and reducing waste while optimizing processes.

Reducing farming emissions from livestock management

Collaborative efforts and investments to reduce emissions from livestock management in farming within tiers one to three could yield a 9.1 percent reduction in total Scope 3 emissions for the average retailer (see sidebar "Investment to impact: Reduction potential for collaborative efforts to reduce livestock farming emissions among suppliers in tiers one to three").

Investment to impact: Reduction potential for collaborative efforts to reduce livestock farming emissions among suppliers in tiers one to three

The snapshots below highlight the cost and impact of collaborative efforts to reduce livestock farming emissions among tier one to three suppliers in two categories of retail products, modeled using McKinsey analysis.[1]

Dairy

The cost to deploy management-intensive grazing within tier-three dairy cattle ranching in a milk value chain could be $36 per metric ton of CO_2e abated.

The potential impact? Around 16 percent reduction in Scope 3 emissions in the dairy category for the average retailer.

Beef

The cost to implement anaerobic manure digestion in tier-three beef cattle ranching in a beef value chain could be $11 per metric ton of CO_2e abated.

The potential impact? Around 12 percent reduction in Scope 3 emissions in the beef category for the average retailer.

There are several other sustainability measures that could help reduce the average retailer's Scope 3 emissions in the beef product value chain, from switching to recyclable plastics and modifying package designs to electrifying meat plants (exhibit).

[1] Modeling for dairy is based on a one-gallon container of milk and for beef on a three-pound package of boneless beef.

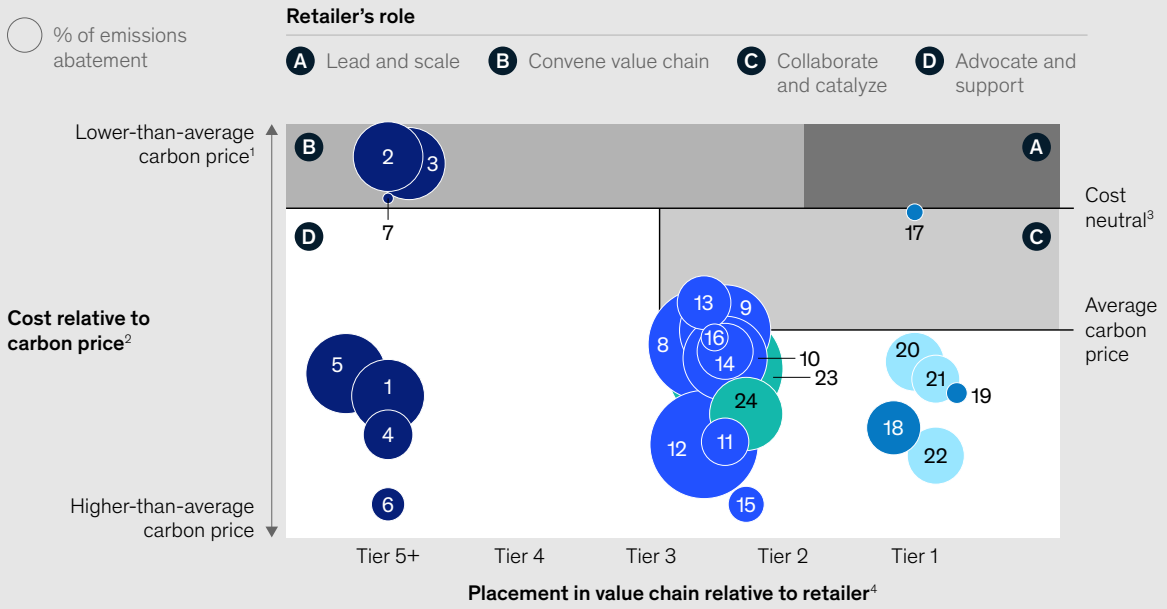
[81] "Loblaw and Flashfood divert 40 million pounds of food from landfill and save Canadians more than $110 million on groceries," Flashfood, November 8, 2022.

[82] The carbon price estimate is based on technology available as of December 2023 and assumes an average global carbon price of $50 per metric ton of CO_2, based on a World Bank report (*State and trends of carbon pricing 2023*, World Bank, 2023) that cites Network for Greening the Financial System's (NGFS) Net Zero 2050 scenario, which suggests that carbon prices need to be around $50 by 2030 in 2010 terms to achieve a below 2°C outcome; and on McKinsey analysis estimating the required global carbon price in 2020 at around $40 to $80 to limit warming to 1.5°C.

Investment to impact: Reduction potential for collaborative efforts to reduce livestock farming emissions among suppliers in tiers one to three (continued)

Exhibit

To reduce Scope 3 emissions from beef production, retailers can prioritize actions based on their decarbonization potential and proximity in the value chain.



Abatement levers across the value chain[5]

Animal feed

1. Controlled-release and stabilized fertilizers
2. Variable-rate fertilization
3. Low or no tillage
4. Conversion from flood to drip or sprinkler irrigation
5. Use of green ammonia in fertilizer production
6. Biodiesel for on-farm machinery and equipment (feed farm)
7. Cover crops

Beef farming

8. Anaerobic manure digestion
9. Efficiency-focused breeding
10. Feed processing for improved digestibility
11. Ionophores (monensin)
12. Fat supplements in feed mix
13. Animal health monitoring and illness prevention
14. Nitrogen inhibitors on pasture
15. Biodiesel for on-farm machinery and equipment (beef farm)
16. Minimized time in feedlots

Transportation and packaging

17. Optimized packaging design
18. Electrification of transport[6]
19. Switch to recyclable plastics

Processing

20. Renewable electricity in value chain (part cycle)
21. Renewable electricity in value chain (full cycle)[6]
22. Electrification of meat plants

Ecosystem

23. Management intensive grazing
24. Regenerative silvopastures

[1]Using an average global carbon price of 50 $/metric ton (Mt) of CO_2 based on World Bank report that states that Network for Greening the Financial System's modeling suggests that carbon prices need to be around $50 by 2030 in 2010 terms to achieve a below 2°C outcome (*State and trends of carbon pricing*, World Bank, May 2023) and based on McKinsey analysis that the required global carbon price in 2020 is ~$40–$80 to limit warming to 1.5°C.
[2]Cost relative to carbon price is measured by benchmarking decarbonization costs against global average carbon pricing of $50 as the opportunity cost.
[3]Cost neutral refers to a reduction cost of $0/$MtCO_2$ equivalent.
[4]Tiers 1 and 2 here represent a retailer's immediate supplier network (ie, direct suppliers and their direct suppliers), further upstream in the value chain are tier 3, tier 4, and tier 5+.
[5]Based on marginal abatement cost curve, which covers Scope 3 upstream emissions from a retail perspective and does not include levers for retail and consumer losses.
[6]Electrification of transport, though it has emissions distributed across whole value chain, is attributed to action taker closest to retailer (tier 1 supplier) because of high level of influence over entire supply chain.

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Participating in trade associations and engaging in discussions with cattle traders. By participating in trade associations and discussions with cattle traders, retailers can help boost long-term demand signals for sustainably produced beef, which could be supported by public incentives for farmers to increase sustainable beef farming production.[83] For example, Canada's largest grocery retailer, Loblaw, partnered with trade association Canadian Roundtable for Sustainable Beef (CRSB) to purchase three million pounds of beef from CRSB-certified farms.[84]

Collaborating with others to support research on advancing sustainability measures. Retailers can collaborate with value chain partners, not-for-profits, and research institutions on research and innovative processes to increase sustainable farming practices. For example, Cargill, McDonald's, and Target partnered with Colorado State University and the Nature Conservancy on a research project to regeneratively grow corn used in feed inputs.[85]

Supporting innovations that reduce farming emissions via public–private research collaborations. Research organizations can innovate to reduce farming emissions by using feed supplements in livestock farming with the support of private and/or public organizations. For example, the US Department of Agriculture (USDA) and a private nutritional-products manufacturing company supported the Department of Animal Science at Pennsylvania State University on in-depth research into the effects of adding 3-Nitrooxypropanol (3-NOP) to dairy cow feed, finding that the additive reduced enteric methane emissions by 25 percent. This researchsupported the approval of 3-NOP for use in the European Union and some South American countries.[86]

Helping value chain partners distribute costs and resources via public sector–led incentive programs. The Canadian government's $12 million investment in the Reducing Enteric Methane Emissions from Beef Cattle (REME) protocol is aimed at providing an incentive for actions not subject to carbon pricing mechanisms that reduce livestock emissions beyond the level required by law.[87]

Transitioning to clean and renewable energy

Supplier and value chain partner engagement to replace fossil fuel–dependent energy with energy generated by wind, solar, and geothermal could lower Scope 3 emissions for the average retailer by around 7.7 percent (see sidebar "Investment to impact: Reduction potential for three retailer-led transitions to renewables").

Using supplier engagement criteria to encourage and accelerate renewable adoption. Retailers can set supplier engagement criteria that provide suppliers with compelling incentives to adopt renewable energy. Automaker Porsche did just that when it informed its approximately 1,300 series suppliers that it would consider signing contracts only with those that use renewable energy.[88] The automaker also includes sustainability ratings as a criterion for awarding all supplier contracts; consequently, more than 90 percent of Porsche's suppliers have a valid sustainability rating.[89] Similarly, Carrefour's 2026 strategic plan states that the company's top 100 suppliers must adopt a 1.5°C trajectory by 2026; suppliers that do not meet this criteria will be delisted.[90]

Retailers could also provide suppliers with incentives in the form of financing to accelerate suppliers' adoption of clean technology. Walmart, for example, integrated science-based targets into its supplier financing program. Walmart suppliers that set at least three sustainability goals and demonstrate efforts toward a science-based target on the 1.5° pathway may access favorable financing terms from Walmart's partner, HSBC Bank.[91]

Switching from animal proteins to plant proteins and reducing animal protein emissions

Retailer-accelerated efforts to shift the production and consumption of protein from animal-based to plant-based

[83] Leah Garden, "These US policies incentivize sustainable beef production," GreenBiz, February 5, 2024.
[84] "Loblaw expands commitment to sustainable beef sourcing," Loblaw, December 16, 2021.
[85] "The Nature Conservancy, Cargill, McDonald's and Target unite to support Nebraska farmers' regenerative agriculture practices to invest in an even more sustainable beef supply chain," Cargill, August 27, 2020.
[86] Jeff Mulhollem, "Feed supplement for dairy cows cuts their methane emission by about a quarter," Pennsylvania State University, February 20, 2020; Juan Tricarico, "Unlocking the dairy cow's potential to combat climate change," GreenBiz, February 15, 2023.
[87] "Government of Canada announces new economic incentive to reduce methane emissions from beef cattle," Government of Canada, December 10, 2023.
[88] "Porsche calls for suppliers to switch to green energy," Porsche, July 1, 2021.
[89] "Earth Day 2021: Seven ways Porsche is leading the sustainability charge," Porsche, June 16, 2021.
[90] "Carrefour 2026 Strategic Plan," Carrefour, November 2022.
[91] Jesse Klein, "HSBC, Walmart add science-based targets to supplier financing program," GreenBiz, December 28, 2021.

and to reduce emissions from animal protein production could achieve around 1.3 percent reduction in total Scope 3 emissions for the average retailer (see sidebar "Investment to impact: Reduction potential for a retailer-led effort to shift from animal to plant protein").

Facilitating the transition to plant-based protein. Retailers can take part in campaigns and help stimulate a consumer shift from animal-based protein to plant-based protein. Target, for instance, uses wellness icons on its physical and digital shelves and signage on its freezer and refrigerator cases to denote products that are cruelty free and vegan, including plant-based alternative proteins.[92] And Carrefour launched the Act for Food program in 2018 to facilitate the food transition to alternative protein, reporting €514 million in sales of plant-based alternatives in 2023. The retailer also created a new plant-based coalition that includes seven companies—Danone, Unilever, Bel, Andros, Bonduelle, Nutrition & Santé, and Savencia—with the goal of generating €3 billion in sales from alternative plant-based products by 2026.[93]

Engaging feed aggregators in long-term contracts for alternative-protein ingredients. To help signal demand for alternative protein, retailers and their value chain partners can engage suppliers in long-term contracts for plant-based ingredients. For example, in 2020 one value chain partner, food multinational Cargill, invested $75 million in PURIS, the largest pea protein producer in North America, to increase production of peas.[94]

Collaborating on promotional campaigns to raise consumer awareness about alternative plant proteins. Retailers could partner with not-for-profits such as the

[92] "Target introduces vegan and cruelty-free labeling to help customers make more ethical purchases," LIVEKINDLY, accessed June 27, 2024.
[93] "Carrefour exceeds target for sales of plant-based alternatives with €514m turnover," *vegconomist - the vegan business magazine*, February 27, 2024.
[94] "Cargill invests additional $75 million to propel PURIS pea protein production in the US to meet surging market demand," Cargill, August 28, 2019.

Investment to impact: Reduction potential for three retailer-led transitions to renewables

The snapshots below highlight the cost and impact of retailer-led efforts to implement renewable energy use among tier-one, tier-two, and tier-three suppliers in two retail product categories, modeled using McKinsey analysis.[1]

Electronics

The cost to transition to renewable electricity use in tier-two production within a tablet value chain could be $25 per metric ton of CO_2e abated.

The potential impact? Around 54 percent reduction in Scope 3 emissions in the retail electronics product category for the average retailer.

Apparel

The cost to transition to renewable electricity use in tier-three supplier garment manufacturing within a blended-fabric t-shirt value chain could be $25 per metric ton of CO_2e abated.

The potential impact? Around 26 percent reduction in Scope 3 emissions in the apparel category for the average retailer.

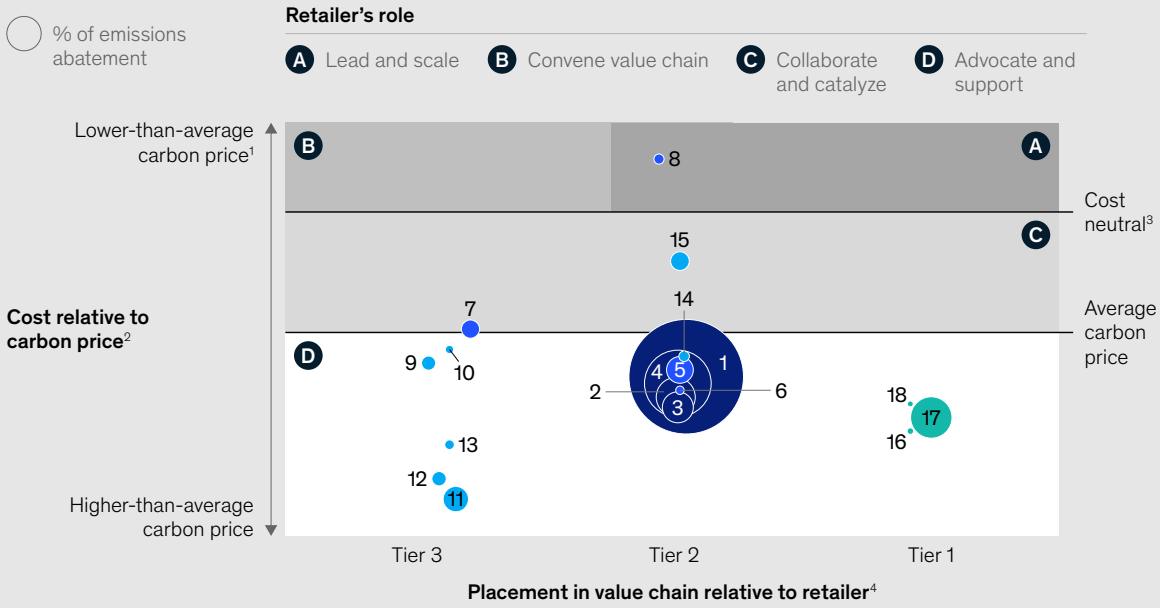
Several additional sustainability measures could help reduce the average retailer's Scope 3 emissions in the product value chain, including switching to renewable electricity in input, component, and device production; switching to biogas for heating; electrifying transport; and switching from plastic to recycled cardboard in packaging (exhibit).

[1] Modeling for the electronics category based on an average tablet of 500 grams and for the apparel category on a 140-gram t-shirt of blended fabric made of 60 percent cotton and 40 percent polyester.

Investment to impact: Reduction potential for three retailer-led transitions to renewables (continued)

Exhibit

To reduce Scope 3 emissions from electronics production, retailers can prioritize actions based on their reduction potential and proximity in the value chain.



Abatement levers across the value chain[5]

Printed circuit board

1. Renewable electricity in production
2. Perfluorocarbons gas best practice abatement
3. Low-greenhouse-gas chemicals in fab production
4. Take-back scheme

Battery

5. Renewable electricity in manufacturing
6. Biogas for heating
7. Recycled battery materials
8. Yield improvement and scrap recycling

Materials

9. Aluminum: electrification and renewable electricity
10. Steel: low CO_2 sourcing for steel (eg, hydrogen direct reduced iron, recycled)
11. Glass: biogas for heating
12. Plastic: low CO_2 sourcing
13. Aluminum: low CO_2 process tech
14. Glass: increased recycled content
15. Switch magnesium to aluminum

Packaging and transportation

16. Substitution of plastics with cardboard
17. Electrification of transport[6]
18. Switch to recycled cardboard

Note: Value chain to produce an electronic tablet.
[1]Using an average global carbon price of 50 $/metric ton (Mt) of CO_2 based on World Bank report that states that Network for Greening the Financial System's modeling suggests that carbon prices need to be around $50 by 2030 in 2010 terms to achieve a below 2°C outcome (*State and trends of carbon pricing*, World Bank, May 2023) and based on McKinsey analysis that the required global carbon price in 2020 is ~$40–$80 to limit warming to 1.5°C.
[2]Cost relative to carbon price is measured by benchmarking decarbonization costs against global average carbon pricing of $50 as the opportunity cost.
[3]Cost neutral refers to a reduction cost of $0/Mt$CO_2$ equivalent.
[4]Tiers 1 and 2 here represent a retailer's immediate supplier network (ie, direct suppliers and their direct suppliers), further upstream in the value chain are tier 3.
[5]Based on marginal abatement cost curve that covers abatement levers for Scope 3 upstream emissions from materials and components, incl manufacturing, as well as transportation and packaging. Switching from fossil feedstocks for plastics and other petroleum-based materials could address most of end-of-life emissions.
[6]Electrification of transport, though it has emissions distributed across whole value chain, is attributed to action taker closest to retailer (tier 1 supplier) because of high level of influence over entire supply chain.

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Good Food Institute (GFI), which uses evidence-based marketing to influence consumer behavior regarding alternative proteins.[95]

Group D: Cost-prohibitive far-tier levers

As outlined at this chapter's outset, collaborative efforts in group D could realize profound reductions in Scope 3 emissions for the average retailer: potentially 25 to 30 percent, if implemented at scale. These efforts entail systemic changes that can only be realized with coordinated multistakeholder actions, involving suppliers and value chain stakeholders that are beyond tier three in retailers' networks, as well as other public and private sector players. The initiatives are too costly to implement in the near term because the systems or technology to support them are either nonexistent or in the early stages of development. Nevertheless, these substantial and wide-ranging decarbonization impacts could be realized with a shared sense of urgency among all stakeholders to achieve systemic innovation through strategic, targeted advocacy and support; the mobilization of coalitions and initiatives; and convening actions to increase the use of renewable energy, regenerative agriculture practices, and recycling while reducing emissions from livestock, waste, and transportation.

Transitioning to clean and renewable energy

Replacing fossil fuel–dependent energy with energy generated by wind, solar, and geothermal could lower the average retailer's Scope 3 emissions by around 7.4 percent. Doing so would require infrastructure builds, developing new technology and processes, and shifting societal priorities, alongside demand management and long-distance interconnections to pool renewable assets across a larger geographic area. While timelines could be lengthy and total costs may be steep, the decarbonization potential is meaningful (see sidebar "Investment to impact: Reduction potential for three coalition-mobilized transitions to renewables").[96]

Engaging with local communities and other partners to secure feedstock for renewable energy. System-level engagement and collaboration with partners can help expand the use of renewables for feedstock. For instance, as part of BASF's Waste-2-Chemicals project, social entrepreneurs and local waste pickers gather plastic waste that is then sorted and processed into pyrolysis oil for use as feedstock for new plastic.[97]

Supporting grid greening and renewable technology via initiatives led by the public and private sectors. Public sector–led initiatives can help realize large-scale expansions in the use of renewable-energy grids. For example, India announced a target installation of 500 gigawatts (GW) of renewable-energy capacity by 2030 to reduce the use of coal and oil as sources of energy, aiming to reduce the emissions intensity of its economy by 45 percent and CO_2 emissions by one billion tons.[98] And in 2020, Canada created a decarbonization incentive program (DIP) that provides around $364,000 to $1.5 million in funding to support clean-technology projects aimed at reducing GHG emissions.[99]

Investment to impact: Reduction potential for a retailer-accelerated effort to shift from animal to plant protein

The snapshot below highlights the cost and impact of a retailer-accelerated effort to replace beef production with plant protein production, modeled using McKinsey analysis.[1]

Beef

Replacing beef volumes with alternative, sustainably produced meat-like proteins among tier-three suppliers could cost around $36 (incremental) per metric ton of CO_2e abated.[2]

The potential impact? Around 82 percent reduction in Scope 3 emissions in the beef category for the average retailer.

[1] Modeling based on pea protein.
[2] Incremental means the cost to produce additional units is marginal.

[95] Good Food Institute website, accessed June 27, 2024.
[96] "The net-zero transition: What it would cost, what it could bring," McKinsey Global Institute, January 2022.
[97] "ChemCycling saves fossil fuels," BASF, accessed June 27, 2024.
[98] Fatih Birol and Amitabh Kant, "India's clean energy transition is rapidly underway, benefiting the entire world," International Energy Agency, January 10, 2022.
[99] "Decarbonization Incentive Program (DIP 2.0 Intake): Applicant guide," Government of Canada, accessed June 27, 2024.

Investment to impact: Reduction potential for three coalition-mobilized transitions to renewables

The snapshots below highlight three transitions to renewables requiring the mobilization of a coalition of private and public sector players, modeled using McKinsey analysis.[1] Lead times are long because technology, infrastructure, or other enablers are nonexistent or in very early stages of development, but innovations could potentially shorten the timelines.

Chemicals and pharmaceuticals
The cost to switch to biogas in all tier-three supplier production within an ibuprofen value chain could be around $120 per metric ton of CO_2e abated.

The potential impact? Around 31 percent reduction in Scope 3 emissions in the chemicals and pharmaceuticals category for the average retailer.

Chicken
Switching to renewable electricity throughout tier-one suppliers' value chains in a chicken value chain could cost around $55 (incremental) per metric ton of CO_2e abated.

The potential impact? Around 14 percent reduction in Scope 3 emissions in the chicken category for the average retailer.

Beef
The cost of switching from gray to green ammonia in fertilizer production among suppliers in tier four and beyond within a beef value chain could be around $45 (incremental) per metric ton of CO_2e abated.

The potential impact? Around a 6 percent reduction in Scope 3 emissions in the beef category for the average retailer.

[1] Modeling for the chemicals and pharmaceuticals category based on one 100-tablet bottle of 250-milligram ibuprofen tablets; for the chicken category on one three-pound package of boneless chicken; and for the beef category on a three-pound package of boneless beef.

Private sector initiatives can make substantial impacts on grid greening via targeted community-level projects and beyond. As part of its energy transformation strategy, in March 2024 Walmart announced the addition of two community solar and distribution portfolios developed by Pivot Energy and Reactivate to its existing renewable-energy investment portfolio. The included projects' total output will be 70 megawatts of alternating current from 26 new community solar and distributed-generation installations in six states. When operational, the installations will provide about 160,000 megawatt-hours (MWh) of clean energy each year to around 13,000 US households in support of community solar subscriptions. The resulting $6 million in cost savings is expected to benefit low- to moderate-income communities.[100]

Increasing circularity and recycling
Coalition-mobilized efforts to increase circularity and recycling could reduce total Scope 3 emissions by around 4.6 percent for the average retailer (see sidebar "Investment to impact: Reduction potential for two actions to increase circularity and recycling").

Collaborating with suppliers and value chain partners to improve circularity. Retailers can engage suppliers to act further on circularity and recycling by collaborating to initiate reuse and promote sales of refurbished items. For example, Walmart recently launched Walmart Restored, a program that enables

[100] Vishal Kapadia, "Walmart accelerates clean energy purchases and investments with nearly 1 gw of new projects across the U.S.," Walmart, March 26, 2024.

Investment to impact: Reduction potential for two actions to increase circularity and recycling

The snapshots below highlight the cost and impact of actions to increase circularity and recycling among suppliers in two retail product categories, modeled using McKinsey analysis.[1]

Chemicals and pharmaceuticals

The cost to implement mechanical recycling at tier-four suppliers within an ibuprofen value chain could be around $57 per metric ton of CO_2e abated.

The potential impact? Around a 3 percent reduction in Scope 3 emissions in the chemicals and pharmaceuticals category for the average retailer.

Apparel

The cost to implement the use of closed-loop recycled polyester by tier-two suppliers in a blended-fabric t-shirt value chain could be around $148 per metric ton of CO_2e abated.

The potential impact? Around a 7 percent reduction in Scope 3 emissions in the apparel category for the average retailer.

[1] Modeling for the chemicals and pharmaceuticals category based on one 100-tablet bottle of 250-milligram ibuprofen tablets and for the apparel category on a 140-gram t-shirt made from blended fabric (60 percent cotton and 40 percent polyester).

consumers to purchase renewed and refurbished products that have been inspected, tested, and cleaned by either the manufacturer or manufacturers, a manufacturer-authorized party, or other qualifying sellers or suppliers. Each purchase comes with a 90-day free return or replacement guarantee.[101]

Facilitating access to recycling options. Retailers can use store locations as collection centers for recyclable materials and provide incentives for consumers to engage in recycling behaviors. Carrefour partnered with Greenbig, a French plastics recycling robotics start-up, to install B:Bot XXL recycling machines, each with a storage capacity of 50,000 bottles, at 31 Carrefour hypermarket parking lots, where customers can recycle plastics that are then used to produce straws, bottles, and textile fiber. Consumers receive $0.02 for each container they scan, and the amount they accumulate can be converted into a donation to an association or a voucher that is valid at the point of sale.[102]

Establishing joint ventures to support rare earth element recycling and sustainable sourcing. Partnering with renewable-energy-technology companies, retailers can help foster the capacity to recycle rare earth elements (REE) and provide alternatives to supplies concentrated in one or a few geographic areas. For example, BMW i Ventures, a subsidiary of BMW group, co-led a $27 million investment in a circular supply chain company focused on recycling REE.[103]

Helping fund circular initiatives and investments in recycling projects via private sector alliances. Closed Loop Partners, one such alliance, spans multiple industries. It has established a foundation for physical infrastructure expansion, launched local recycling with PepsiCo to expand recycling access, and established the Center for the Circular Economy, an effort to accelerate innovation and research, which launched a composting consortium aimed at reducing GHG

[101] Kaarin Vembar, "Walmart launches product refurbishment program," Retail Dive, August 1, 2022; "Walmart Restored," Walmart, accessed June 27, 2024.
[102] Justine Bessaudou, "GreenBig équipe 31 hypers Carrefour de b:bot XXL" ("GreenBig equips 31 Carrefour hypermarkets with b:bot XXL"), Rayon Boissons, July 13, 2022.
[103] "BMW i Ventures co-leads investment in circular supply chain company Cyclic Materials," BMW Group, April 25, 2023.

emissions. Through its venture capital fund, Closed Loop Partners has kept 740,000 metric tons tons of materials in circulation, avoided 736,000 metric tons of CO_2, and saved 1.1 billion liters of water over the past decade.[104]

Investing in a circular economy via private sector initiatives and coalitions. Coalitions of financial institutions and private investors can also take action to improve the circular economy. For example, the World Bank issued a $100 million, seven-year bond to support plastic-recycling projects. Through the project, investors are providing approximately $14 million in up-front financing to increase capacity at existing recycling facilities and to expand to new collection and recycling sites. In return, investors receive annual coupons for a fixed amount plus payments linked to the sale of a portion of the recycled products and carbon credits produced by the projects.[105]

Recycling is another key lever that can help reduce the impact of the retail value chain on nature, because plastics pollution increases the acidification of oceans, which kills fish and reduces the efficacy of the carbon sink that currently captures 31 percent of CO_2 emissions.[106] Reducing the amount of plastic in packaging, implementing new delivery models, expanding mechanical and chemical recycling of plastics, and using compostable bioplastics could help the retail sales and services sector address 52 percent of the overage in plastic pollution while improving nature conservation.[107]

Adopting regenerative practices in plant-based agricultural inputs

The actions outlined in this section to adopt regenerative agriculture practices for plant-based product inputs could reduce total Scope 3 emissions for the average retailer by around 3.8 percent (see sidebar "Investment to impact: Reduction potential for adopting regenerative agriculture practices in plant-based input production")

Promoting regenerative agricultural practices via public sector–led incentives. Public sector–led incentives can help enable the implementation of regenerative agriculture practices, which are critical to scaling many of the solutions outlined in this report and beyond. The US Agricultural Resilience Act (ARA), for example, aims to expand USDA support for farmers to combat climate change and regenerate ecosystems by providing grants up to $500,000 to support soil carbon restoration, farmland elimination, and greenland conversion as part of other efforts to help achieve the ARA's stated goal of net-zero emissions from US agriculture by 2040.[108] And the USDA's

Investment to impact: Reduction potential for adopting regenerative agriculture practices in plant-based input production

The snapshot below highlights the costs and impact of actions to adopt regenerative agriculture practices in the beef retail product category, modeled using McKinsey analysis.[1]

Beef

The cost to deploy the use of controlled-release and stabilized fertilizers in animal feed among suppliers in tier four and beyond could be around $74 per metric ton of CO_2e abated.

If suppliers in tier four and beyond were to implement variable-rate fertilization, it could save around $150 per metric ton of CO_2e abated.

If suppliers in tier four and beyond were to adopt low- or no-tillage soil, it could save around $147 per metric ton of CO_2e abated.

The potential impact? Each of the above levers could result in about a 3 percent reduction in Scope 3 emissions in the beef category for the average retailer.

[1] Modeling based on one three-pound package of boneless beef.

[104] *Accelerating a circular future: Closed Loop Partners 2022 impact report*, Closed Loop Partners, March 2023.
[105] Beatriz Santos, "World Bank issues $100 million bond to finance plastic recycling projects," *Sustainable Plastics*, January 25, 2024.
[106] "Nature in the balance: What companies can do to restore natural capital," McKinsey, December 5, 2022; Katherine Bucko, "Plastic pollution is making the ocean more acidic," Earth.com, September 22, 2022; "Quantifying the ocean carbon sink," NOAA National Centers for Environmental Information, August 26, 2022.
[107] "Nature in the balance," December 5, 2022.
[108] "Agriculture Resilience Act," 117th Congress, 2021; NSAC's Blog, "The Agriculture Resilience Act in 2023," National Sustainable Agriculture Coalition, March 29, 2023; *The Equation*, "6 ways the Agricultural Resilience Act equips farmers to fight the climate crisis with science," blog entry by Marcia DeLonge, Union of Concerned Scientists, March 6, 2020.

Transition Incentives Program (TIP) aims to assist the transition of expiring Conservation Reserve Program (CRP) land from an owner or operator to a beginning, veteran, or socially disadvantaged farmer or rancher to return it to production for sustainable grazing or crop production.[109]

Supporting precision agriculture for cropland via innovations led by start-ups and technology companies. Start-ups and technology companies can develop new tools and capabilities to support regenerative practices. For example, Instacrop, a Latin America–based start-up, developed precision technology that enables real-time crop data monitoring for more than 1,200 users. The company has reported saving five billion liters of water from the 70,000 acres of farmland connected to its platform.[110]

Decarbonizing transportation

The actions outlined in this section to decarbonize transportation could reduce total Scope 3 emissions by around 1.4 percent for the average retailer (see sidebar "Investment to impact: Reduction potential for two actions to decarbonize transportation").

Providing incentives for the production, distribution, and ownership of electric vehicles via public sector–led initiatives. Electrifying transportation is a vital lever to reducing mobility sector emissions worldwide, and incentives can offer a wide-reaching means of encouraging EV adoption. For example, the US Department of Energy offers grants and loan guarantees for the domestic production of efficient hybrid vehicles, plug-in hybrid electric vehicles, and all-electric vehicles. There is also a $3,700 to $7,500 US federal tax credit for purchases of some all-electric and plug-in hybrid vehicles.[111] Faster Adoption and Manufacturing of Hybrid and Electric Vehicles in India (FAME India), meanwhile, was launched in 2015 under the country's National Electric Mobility Mission Plan to provide financial incentives to purchase of electric and hybrid vehicles.[112]

Investment to impact: Reduction potential for two actions to decarbonize transportation

The snapshots below highlight the cost and impact of actions to decarbonize transportation among suppliers in the packaged goods and electronics product categories, modeled using McKinsey analysis.[1]

Packaged goods

The cost for tier-three suppliers within a breakfast bars value chain to electrify transportation could be around $111 per metric ton of CO_2e abated.

The potential impact? Around a 33 percent reduction in Scope 3 emissions in the packaged goods category for the average retailer.

Electronics

The cost for tier-one suppliers within a tablet value chain to electrify transportation could be around $111 per metric ton of CO_2e abated.

The potential impact? Around a 7 percent reduction in Scope 3 emissions in the electronics category for the average retailer.

[1] Modeling for the packaged goods category based on a 12-pack of breakfast bars and for the electronics category on an average 500-gram tablet.

Considerations for retailers: Measurement and reporting

The complexity of global energy and land-use systems makes it challenging for retailers to measure and report progress on their Scope 3 emissions footprint with precision. Retailers often base their Scope 3

[109] "Conservation Reserve Program – Transition Incentives Program fact sheet," USDA Farm Service Agency, December 2019.
[110] "Instacrops one pager," Instacrops, June 2020; Instacrops website, accessed June 27, 2024.
[111] "Electricity laws and incentives in federal," Alternative Fuels Data Center, US Department of Energy, accessed June 27, 2024.
[112] "FAME India: Faster adoption and manufacturing of (hybrid &) electric vehicles in India," Government of India, July 11, 2022.

estimates on extrapolation of supplier data, publicly available emissions factors based on broad industry averages, and assumptions in line with standards such as the GHG Protocol. Thus, for many retailers, assessing their Scope 3 emissions footprint is more of a modeling exercise based on broad and shifting aggregate assumptions than a measurement exercise.

Because Scope 3 does not allow retailers to manage action plans but only prioritize their main emission sources, transparency is vital in presenting carbon footprint figures—the methods used and the level of data precision and estimation, for example—as the figures are not indicators of performance but rather an estimate of major Scope 3 items.

Year-over-year fluctuations in modeled footprint due to shifting assumptions and methodologies should trigger a base-year footprint recalculation and often exceed the annual rate of emissions reductions companies are expected to report to stay on pace with a 1.5° or 2° pathway, which can make it difficult to demonstrate progress.

Based on the GHG Protocol, the Scope 3 metric does not include the emissions impact of company initiatives outside of retail operations and product supply chains, such as nature restoration, customer food waste, renewable-energy projects in communities (such as community solar), or expansion of EV charging capacity for customers. The decarbonization impact from such initiatives can be substantial; while a company may report them separately from a GHG Protocol inventory, their impact is not currently reflected in the Scope 3 footprint metric. However, the GHG Protocol and the market-based accounting approaches workstreams in the revision process are considering both the impact of reductions and the best way to accurately account for and report the impact of supply-shed reductions or activities outside of a company's value chain.

Similarly, carbon accounting protocols require companies to account for global deforestation that occurred before the date a retailer's deforestation-free sourcing procedures went into effect, whether or not a retailer has sourced commodities from affected regions. According to the Intergovernmental Panel on Climate Change (IPCC), emissions from single events of land-use change, such as deforestation, are amortized over 20 years to attribute the emissions to the activities that occur over the year of use. This means that a retailer that has set 2020 DCF policies and is sourcing from farmers who practice sustainable policies could have emissions attributed to year-over-year land use for the 20-year period of the amortization (see sidebar "Retailers' measurement, accounting, and reporting challenges").

Retailers' measurement, accounting, and reporting challenges

Beyond previously detailed challenges—such as fragmented supply chains with numerous SKUs and lack of accurate data on consumer use (energy consumption, for example)—and upstream supplier data challenges, such as technical know-how and resource constraints, retailers face some challenges in Scope 3 emissions measurement, accounting, and reporting.

Measurement

— *Variability.* Variability can occur over time, which can present challenges to quantifying and accounting for emissions. Certain seasonal events, such as low harvest yields or drought, can alter the carbon emission intensity of land use as well as of some inputs used in production. Additionally, diversifying a supplier base to build supply chain resilience can result in changes in emissions. Changes to methods and locations of production and changes in transportation can also create variations.

— *Inconsistent data format and measurement standards.* Where data is collected, the units often vary and consensus is lacking on the emissions impacts of certain decarbonization efforts (for example, carbon sequestration in soil). For instance, data inputs can vary because they are based on different emission factors, primary versus secondary data, and global warming potentials (GWPs). Allocation methods can be physical or economic, for example. Cutoffs and boundaries can vary when functional units are defined differently. And finally, the type of data can vary based on the calculation method, which could, for example, be spend-based, activity data–based, site-specific, fuel-specific, asset-specific, or waste-type-specific.

Accounting

— *Disconnect between industry averages and project impacts.* While emissions factors and other simplifying assumptions based on industry averages make it possible for retailers to estimate their total Scope 3 footprint without measuring the individual footprint of hundreds of millions of items, such estimations typically do not reflect the impact of specific decarbonization projects in a retailer's product supply chain or items. Accounting for the impact of decarbonization projects is not possible using secondary emission factors from third-party lifecycle inventory (LCI) databases.

  Additionally, retailers cannot extrapolate measurements from specific projects to estimate their total emissions because of significant variation across items and product supply chains. While companies and service providers are experimenting with hybrid methodologies that mix actual data and industry averages, such approaches rely on additional assumptions that may make it more difficult for accounting controls, assurance, or comparability across companies.

— *Changes in baselines.* From time to time, shifts in scopes and publicly available emissions factors affect historical estimates, requiring companies to revise and restate baseline data. Such shifts in the baseline create uncertainty for target setting and management. When there is an acquisition or a session of a business unit, it is often difficult to integrate the new business unit with the same data precision. For climate change, for example, the baseline year must be recalculated using data for the new business unit—data that often is not available and must be estimated.

— *Changes in greenhouse gas accounting methodology.* As the science and data evolve, standard setters update carbon accounting methodologies. For example, the GHG Protocol is undertaking a revision of guidance to measure emissions from food and land use (FLAG protocols).[1] Open questions about accounting methodologies can create uncertainty for companies and make it difficult for them to set performance targets, especially publicly.

— *Lagging emissions factors.* For many retailers, Scope 3 emissions are generated by energy grids and land use around the world and are estimated using emissions factors that are updated at different times, based on different standards; these factors tend to lag behind actual changes in energy grids and agricultural systems.

Reporting

— *Incorporating decarbonization efforts in estimated totals.* There is currently no consistent methodology for adjusting industry averages to account for portions of a retailer's supply chain that may differ due to particular decarbonization efforts.

— *Limited influence.* Given the nature of retail Scope 3 emissions, year-over-year emissions reductions will largely be driven by the greening of electricity grids and widespread adoption of regenerative agriculture practices. Other major factors, such as emissions related to deforestation, are based on historical industry averages that will not change significantly year over year. These factors are largely beyond a retailer's realm of influence. Retailers can separately report the results of actual initiatives in their value chains, but it is not possible to reconcile or reflect these results in the modeled aggregate numbers.

— *Internal data quality.* Unlike with financial data, retailers do not manage data internally on the physical properties of the products they carry. It can be difficult to access comprehensive and reliable databases to obtain this information. Obtaining quality databases on product properties—such as product weight, raw materials' points of origin and weights, and the weight and composition of product packaging—requires significant investments in retailers' IT tools and shared databases with suppliers. And while

[1] "Land sector and removals guidance," Greenhouse Gas Protocol, accessed June 27, 2024.

retailers must report product-level metrics to differentiate themselves, such granular information may not be available and retailers may fear disclosing competitively sensitive information.

— *Headwinds from business growth.* Because its overall emissions footprint could expand, a company that is significantly reducing emissions per unit but growing market share (and its emissions footprint) could appear to be performing worse on emissions than a company that is not reducing emissions but is also not growing. Similarly, the impact of replacing carbon-intensive products with carbon-efficient products is not reflected in GHG inventory accounting; in the absence of a standardized way to account for these product-level nuances, companies have difficulty reporting on them.

Despite these challenges, retailers are managing such complexity via a number of initiatives, outlined as follows.

Supporting efforts to improve data
Retailers are working with others to improve the quality and availability of data and the applicability of accounting and reporting standards. For example, many retailers are engaging their suppliers in projects to pilot and scale new measurement approaches.

Using order-of-magnitude estimations for Scope 3 footprint reporting
By referring to widely adopted and authoritative standards such as the GHG Protocol for consistency and comparability in reporting the Scope 3 footprint while taking advantage of simplifying methodologies such as spend-based method to facilitate modeling of Scope 3 footprint where data is not available, retailers can provide order-of-magnitude estimations of Scope 3 footprint. These estimations are sufficient to highlight major concentrations of emissions and inform priorities for decarbonization.

Providing supplemental information to demonstrate impact of decarbonization efforts
Reporting supplementary information can help stakeholders understand retailers' Scope 3 decarbonization strategy and contribution and role in Scope 3 emissions reduction, especially because the total Scope 3 footprint will not necessarily show year-over-year progress if estimated using industry averages. For example, retailers are reporting percentage of suppliers engaged in decarbonization, reductions in emissions intensity overall or for key categories, results of particular decarbonization projects that illustrate changes to methods of production that could be scaled across supply chains, and the assortment mix (percentage of items certified as energy efficient or deforestation- or conversion-free).

Improving practicality of measurement, accounting, and reporting
Engaging with carbon accounting standards bodies (such as the GHG Protocol), reporting platforms (such as CDP), and regulators can help address the previously noted challenges regarding measurement, accounting, and reporting.

Considerations for retailers: Engaging with the public sector

On many fronts, reductions in retailers' Scope 3 emissions are subject to public sector–led initiatives regarding energy and land-use systems. Therefore, retailers would be well served by a deep understanding of existing and proposed standards and guidelines. Retailers can determine whether or how public guidelines related to emissions affect their business outlook and the effectiveness of their efforts to decarbonize their value chains. Retailers can also help to create change by advocating for national and international climate policies that address the interests of stakeholders in their businesses, value chains, and customer communities.

Decarbonizing retailers' value chains is feasible—but it cannot be done in isolation. At-scale deployment of the sustainability measures outlined in this report will require system-level change involving retailers, farmers and ranchers, manufacturers, suppliers, NGOs, public sector actors, energy companies, financial institutions, data and technology providers, and consumers. Coordinated multistakeholder action is imperative to realize the goals of the retail sector and contribute to the ambitious but essential overarching objective: a net-zero planet.

Appendix

Exhibit 2: Methodology and assumptions

High-level methodology is CDP compliant and includes data accuracy measures to select reliable data points.

Data collection

— An initial data set of 1,000 global retailers was evaluated.

— A final data set of 85 global retailers was used for the report analysis.

- The data was divided into four broad retail categories—consumer staples, consumer discretionary, restaurants, and apparel—to show category-specific retailer emissions.
- Category-specific data was further divided into 13 subcategories (product categories): apparel; apparel, accessories, and luxury goods; automotive; broadline; computer and electronics; consumer staples; drugs; food; footwear; home furnishings; home improvement; other specialty; and restaurants.
- Data for the top ten global retailers by revenue was also categorized.

Assumptions

— Scope 3 emissions data was included if the retailer's reported Scope 3 GHG emissions exceeded at least 95 percent of its total (Scope 1, 2, and 3 combined) GHG emissions, implying credible Scope 3 data since the majority of retailers' Scope 3 emissions come from their supply chain.[113]

— In instances in which a Scope 3 upstream and downstream emissions split for a company was not available, we used theoretical proxies based on averages for similar company type.

Calculations

— GHG emissions were calculated using the following CDP approved methodology: estimated total emissions of global retailers = (average GHG emissions per $ revenue) x (total revenue of top 1,000 global retailers).

Chapter 3: Examples of emissions reduction opportunities, organized by theme

Examples in this appendix supplement those provided in Chapter 3. They illustrate potential emissions reduction opportunities, organized within the seven decarbonization themes and the types of resources involved: economic resources, natural and physical resources, human resources, low-carbon technology, and data transparency.

Transitioning to clean and renewable energy

Economic resources examples

— It could cost $490 per metric ton of CO_2 abated to electrify an electronics components manufacturer with an annual output of about 13 million wafers.[114]

— It could cost $518 per metric ton of CO_2 abated to electrify a garment manufacturer with an annual output of about 40 million meters of fabric.

— It could require could require $4 trillion invested annually in clean energy by 2030 to hit 2050 net-zero targets.[115]

Natural and physical resource examples

— In the next few decades it could require twice the power generation capacity from renewables available in November 2023 to support potential mill decarbonization targets in India, where most textile mills are located.[116]

[113] Scope 3 emissions account for 90 percent, and sometimes up to 98 percent of retailers' greenhouse gas emissions. See Ben Unglesbee, "'We have to do something': Can retail close the gap on supply chain emissions?," *Retail Dive*, July 18, 2022.
[114] Unless otherwise indicated, sources for figures in this appendix are derived from McKinsey analysis conducted in December 2023.
[115] *Net zero by 2050: A roadmap for the global energy sector*, International Energy Agency, May 2021.
[116] "Sector: Renewable energy," accessed June 27, 2024.

— It could require 50 gigawatts of renewable-energy capacity developed annually in India, including establishing wind power capacity of at least ten gigawatts per year, to achieve 500 gigawatts in power generation capacity by 2030.[117]

Human resources examples

— About nine million direct jobs could be gained in EV manufacturing and new jobs created in the mobility ecosystem (such as in smart charging) by 2050.[118]

— Of note, 90 percent of offshore oil and gas workers have skills that are highly transferable for offshore wind farms and the capacity for retraining in other forms of renewable energy.[119]

Low-carbon technology examples

— To align with a 1.5° pathway, by 2030 the development, integration, and utilization of clean and renewable energy would need to increase ten- to 15-fold for technologies in early adoption stages such as geothermal energy and advanced fuels and 300 times for renewable hydrogen.

— By 2030, the cost to produce emerging clean and renewable technologies such as green hydrogen may fall from $5.00–$7.00 per kilogram to $2.00–$2.60 per kilogram for projects with on-site generation, and the cost of mature technologies such as solar panels and wind turbines could fall by 40 percent and 27 percent, respectively.[120]

Reducing farming emissions from livestock management

Natural and physical resources examples

— To yield the same amount of beef annually, a fertilized irrigated pasture system would require the same amount of land as used in feedlot systems.[121]

— A semi-intensive silvopastoral system could require four times less land than a feedlot system to yield the same volume of beef annually.[122]

Human resources examples

— To meet the projected demand for 27 million job gains by 2050, training and skill development on efficiency breeding, adaptive grazing, and precision technologies would be needed.[123]

Low-carbon technology examples

— To align with a 1.5° pathway, by 2030 the adoption of technologies such as selective breeding, fat supplements in feed mix, red algae, animal health monitoring systems, and adaptive grazing may need be four to seven times higher than adoption rates as of December 2023.[124] Adoption of technologies such as adaptive grazing and animal health monitoring systems ranges from 40 percent to 69 percent, per a November 2022 USDA study.[125]

Data transparency examples

— Primary data could allow retailers to track reductions in their Scope 3 emissions at the farm level; such data could also be used to provide incentives for farmers to employ sustainable-farming policies. Farms could then be tracked using GPS polygon mapping to ensure compliance.

Adopting regenerative practices in plant-based agricultural inputs

Economic resources examples

— For an animal feed grower in the United States with four to five metric tons of annual grain production per acre and 2,000 to 2,400 acres of land, adopting regenerative practices could generate a cost savings of more than $200 per metric ton of CO_2 abated.

— For a cotton grower in Asia with 1.5 hectares of land holdings and an annual production of 445 kilograms of lint per hectare, adopting regenerative practices could generate cost savings of about $180 per metric ton of CO_2 abated.[126]

[117] "Government declares plan to add 50 GW of renewable energy capacity annually for next 5 years to achieve the target of 500 GW by 2030," Ministry of New and Renewable Energy, Government of India, April 5, 2023.
[118] "Road mobility," August 1, 2022.
[119] "Majority of offshore workforce 'in low carbon energy roles by 2030,'" BBC, May 25, 2021.
[120] Benjamin Craig McLellan and Moe Thiri Zun, "Cost projection of global green hydrogen production scenarios," *Hydrogen*, 2023, Volume 4, Number 4; Rachel Parkes, "'Green hydrogen will cost $2/kg by 2030 — but only from producers with dedicated renewables supply': DNV," *Hydrogen Insight*, October 12, 2023.
[121] Donald M. Broom, "Land and water usage in beef production systems," *Animals (Basel)*, June 2019, Volume 9, Number 6.
[122] Ibid.
[123] "Food and agriculture," August 1, 2022.
[124] McKinsey analysis conducted in December 2023.
[125] Steven Wallander and Christine Whitt, "Study examines how and where U.S. cow-calf operations use rotational grazing," Economic Research Service, USDA, November 21, 2022; Xiaoping An et al., "A review on information technologies applicable to precision dairy farming: focus on behavior, health monitoring, and the precise feeding of dairy cows," *Agriculture*, 2023, Volume 13, Number 10.
[126] McKinsey analysis conducted in December 2023.

Natural and physical resources examples

— Efficient management of crop land—such as reducing the overfertilization of crops in the United States by threefold—can maximize the effectiveness of decarbonizing solutions like nitrification inhibitors, and reducing application of fertilizers can reduce global emissions by around 131 million metric tons of CO_2 by 2050.[127]

Low-carbon technology examples

— Increased adoption of low-carbon technology such as sprinkler irrigation and regenerative silvopasture on small-scale farms could reduce emissions considerably.[128] For example:

  - According to McKinsey analysis, replacement of flood irrigation with emerging technologies such as sprinkler irrigation—100 percent adoption in high-income countries and 75 percent adoption in low- and medium-income countries—could reduce emissions by around 85 million metric tons of CO_2 by 2050.
  - If global adoption of silvopasture increased by 2050 to 720.55 million to 772.25 million hectares from an estimated 550.00 million hectares, the result could be an annual emissions reduction of 0.55 to 1.07 gigatons of CO_2.[129]

Increasing circularity of products and packaging

Economic resources examples

— Reducing CO_2 emissions in electronics production and packaging via take-back schemes for PCBAs, recycled batteries, and more could cost around $264 per metric ton of CO_2 abated, while substituting magnesium for aluminum in electronics manufacturing could save around $50 per metric ton of CO_2 abated.

Natural and physical resources examples

— Improved recycling technology is needed to ensure plastics and metals are recycled into higher-value applications to achieve net-zero targets in 2030 and 2050.

Human resources examples

— A workforce skilled in deploying large-scale infrastructure would be needed to support at-scale increases in recycling and reuse.[130]

— In addition to other efforts to influence changes in consumer behaviors, to align with a 1.5° pathway by 2030, one of every five garments produced worldwide would need to be traded through a circular business model.

— Streamlining logistics around waste collection and transportation costs to facilitate ease of access to recycling could increase recycling rates—for example, addressing reasons that consumers typically do not recycle items purchased from a specific brand at that brand's recycling centers.

Low-carbon technology examples

— Large-scale production and adoption of low-carbon technology and materials such as recycled cotton fibers, recycled PET, and recycled cardboard in packaging, along with circular business models such as take-back schemes for PCBAs, could enable substantial emissions reductions.

— To remain on a 1.5° pathway and achieve a 5 to 15 percent reduction in total Scope 3 emissions for the average retailer, by 2030 developing technologies such as recycled PET would need to achieve 100 percent adoption (as of 2022, the adoption rate was 38 percent in North America), and the use of recycled cardboard in packaging would need to increase four to seven times over 2023 rates.[131]

Reducing waste and increasing process efficiency

Economic resources examples

— Adopting yield improvement in battery manufacturing in the electronics value chain for a typical battery manufacturer production output of 100 gigawatt-hours could save around $260 per metric ton of CO_2 abated.[132]

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[127] Ibid.

[128] Junaid Nawaz Chauhdary et al., "Advances in sprinkler irrigation: a review in the context of precision irrigation for crop production," *Agronomy*, 2024, Volume 14, Number 1.

[129] "Silvopasture," Project Drawdown, accessed June 27, 2024.

[130] McKinsey analysis conducted in December 2023.

[131] "NAPCOR'S 2022 pet recycling report demonstrates bottle-to-bottle circularity continues on the rise," National Association for PET Container Resources (NAPCOR), December 13, 2023; McKinsey analysis conducted in December 2023.

[132] For an operation with a production output of 100 gigawatt-hours.

— Using low-liquor dyeing machines and redesigning equipment for efficiency for a garment manufacturer in the apparel value chain in Asia could save around $364 per metric ton of CO_2 abated.

Natural and physical resources examples

— Reductions in post-consumption waste could be achieved by adopting compostable product packaging made with biodegradable materials such as cellulose, wood, sugarcane, bamboo, mushroom, and seaweed, and plant-based packaging made from corn, maize, bagasse, and organic cotton. It is important to note that this material shift can fail to deliver impact (particularly for consumer packaging uses) in communities in which composting infrastructure has not scaled.

Human resources examples

— New initiatives and campaigns to influence customers and engender substantial changes in traditional human behaviors could increase emissions reduction potential considerably: in a model aligned with a 1.5° pathway, for example, 21 percent of the emissions reduction potential in fashion is tied to changes in consumer actions.[133]

— A 40 percent improvement in waste collection in the fashion value chain could be achieved with better training and incentives for factory employees—one of many efforts in the fashion industry needed to reduce emissions 50 percent by 2030.[134]

Low-carbon technology

— To help optimize farm and production processes and reduce waste, investment and development are needed for advanced technology and tools, including emerging technologies such as the Internet of Things (IoT) and smart sensors to monitor soil health, analyze moisture, detect water contamination, and determine water quantity levels, as well as smart recycling systems (distributed broadly) for consumers to recycle everyday plastics such as bottles and cans.[135]

Data transparency

Granular data and end-to-end traceability on sources of waste generated along the value chain can help identify opportunities to reduce waste. Sources could include waste from inefficient production processes, damage from operations and transportation, and postconsumer waste from spoilage and disposal.

Reducing emissions in transportation

Economic resources examples

— Electrifying transport in the beef, electronics, and apparel value chains could cost around $111 per metric ton of CO_2 abated but would help achieve 2030 net-zero targets.[136]

Natural and physical resources examples

— By 2035, the largest auto markets would need to be fully focused on EV sales, and adoption of advanced fuels would need to be ten to 15 times higher to meet demand if EVs accounted for 75 percent of new passenger car sales globally by 2030.[137]

— By 2030, a 4,000 percent increase in the use of lithium and graphite in manufacturing EV batteries could be needed to meet demand for EVs and a 175 percent increase in the supply of other rare earth elements could be needed to meet manufacturing demands for wind turbine production.[138]

Human resources examples

— Drivers, operators, and others would need to be upskilled and trained to support large-scale EV deployment, operation, and maintenance.

Low-carbon technology examples

— According to the NGFS Net Zero 2050 scenario, increasing sales of battery electric vehicles (BEVs) and fuel cell electric vehicles (FCEVs) from the current 5 percent of new car sales to almost 100 percent of sales by 2050 could cut CO_2 emissions from vehicles by around half.[139]

[133] *Fashion on climate*, McKinsey, 2020.
[134] Ibid.
[135] "Precision agriculture," January 31, 2024; G. R. Sinha and Silvia Liberata Ullo, "Advances in Smart Environment Monitoring Systems Using IoT and Sensors," *Sensors*, 2020, Volume 20, Number 11.
[136] McKinsey analysis conducted in December 2023; "Road mobility," August 1, 2022.
[137] McKinsey analysis conducted in December 2023.
[138] "The energy transition will need more rare earth elements," April 5, 2023.
[139] Eric Hannon, Mekala Krishnan, Jwalit Patel, and Shivika Sahdev, "Mobility's net-zero transition: A look at opportunities and risks," McKinsey, April 25, 2022.

Data transparency examples

— The use of digital technologies such as the IoT, imaging, cloud-based computing, geolocation, and AI to gather and analyze real-time data to improve decision making and route optimization could reduce global emissions 5 percent by 2050.[140]

Transitioning from animal protein to plant protein products

Economic resources examples

— Shifting from producing animal-based proteins such as beef to plant-based proteins such as pea protein could cost around $36 per metric ton of CO_2 abated. By 2030, alternative proteins are expected to be ubiquitous, offered as menu options in fast-food and fine-dining establishments.[141]

— In livestock feed diets, using red seaweed, which suppresses methanogenesis and reduces the amount of methane cattle emit, could cost $99 per metric ton of CO_2 abated.

Natural and physical resources examples

— Shifting cultivation of cropland to grow peas, beans, lentils, and soy can help meet demand for plant-based protein products.

— According to McKinsey analysis, shifting half the global protein market share to alternative protein and the associated innovations in infrastructure, cost reductions, and increased yields and demands could mitigate five metric gigatons of CO_2 emissions annually by 2050.[142]

— A global shift in protein consumption—swapping beef and dairy-based protein for poultry, eggs, fish, and plant-based proteins—could reduce agricultural land use by 75 percent.[143]

— Replacing dry matter consisting of corn and soymeal cultivated using traditional land-use practices with additives such as red seaweed, which does not require fertilizer, fresh water, or arable land, could reduce emissions from farming.[144]

Human resources examples

— Consumer awareness, education, and behavioral changes would need to be realized on a global scale to ensure scale-up in demand for and adoption of alternative protein products.

— Standards and guidelines to list the carbon intensity of food on product labels could help increase demand via increasing consumer awareness of the origins and impacts of the foods in their diets and influencing consumer behavior changes.[145]

Low-carbon technology examples

— New breeding technologies require investments to support the development of next-gen plant-based protein product traits and technology and to fast-track technological advances and at-scale deployment.[146]

Data transparency examples

— Data on consumers' sentiments about plant-based protein—such as willingness to pay and concerns about safety, health, taste, and quality—is needed to facilitate the shift from animal to plant protein. This data could inform product developments to improve the texture and mouthfeel of plant proteins and ensure that the nutritional content meets consumers' expectations for providing the amount of protein and other nutrients they equate with animal protein.

— Open-access databases that provide links between plant protein structure and function could provide farmers with comprehensive data on the characteristics and function of proteins from various crops and support an overall understanding of how these parameters are affected by growing conditions and extraction.[147]

[140] "Digital for climate scenarios," accessed June 27, 2024.
[141] "Food and agriculture," August 1, 2022.
[142] "Environmental impacts of alternative proteins," Good Food Institute, accessed June 27, 2024.
[143] Hannah Ritchie, "If the world adopted a plant-based diet, we would reduce global agricultural land use from 4 to 1 billion hectares," Our World in Data, March 4, 2021.
[144] "Seaweed farming in Alaska," USDA Northwest Climate Hub, accessed June 27, 2024; McKinsey analysis conducted in December 2023.
[145] McKinsey analysis conducted in December 2023.
[146] Ibid.
[147] "The science of plant-based meat," Good Food Institute, accessed June 27, 2024.

July 2024

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