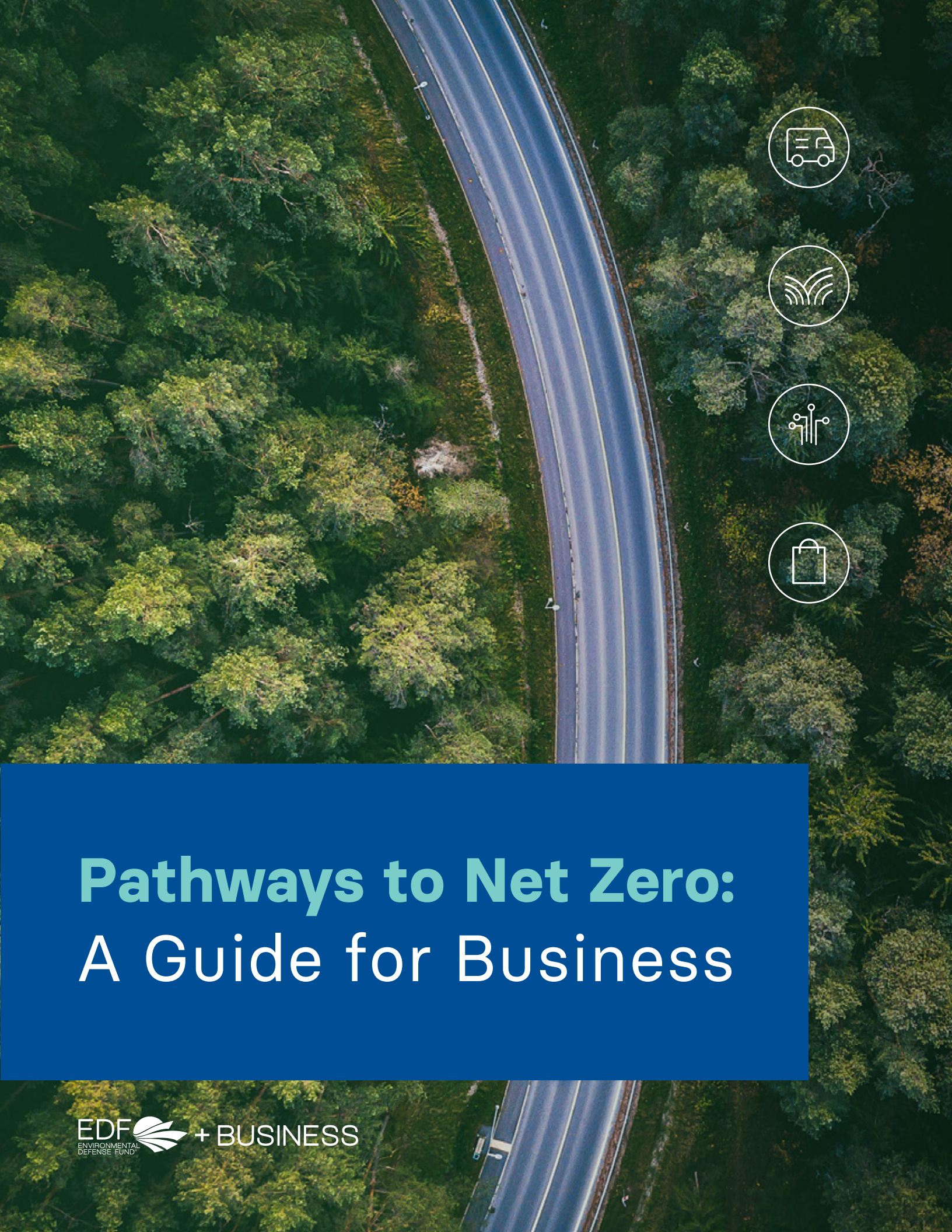

Pathways to Net Zero:
A Guide for Business

EDF ENVIRONMENTAL DEFENSE FUND + BUSINESS

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This report was produced by Environmental Defense Fund, with analytical and research support from Deloitte Consulting, LLP, and input from members of the **Transform to Net Zero** coalition. The views within the report are that of the Environmental Defense Fund, and do not necessarily reflect the views report partners. © December 2020.

This report is available online at: **business.edf.org/netzero**

Executive summary

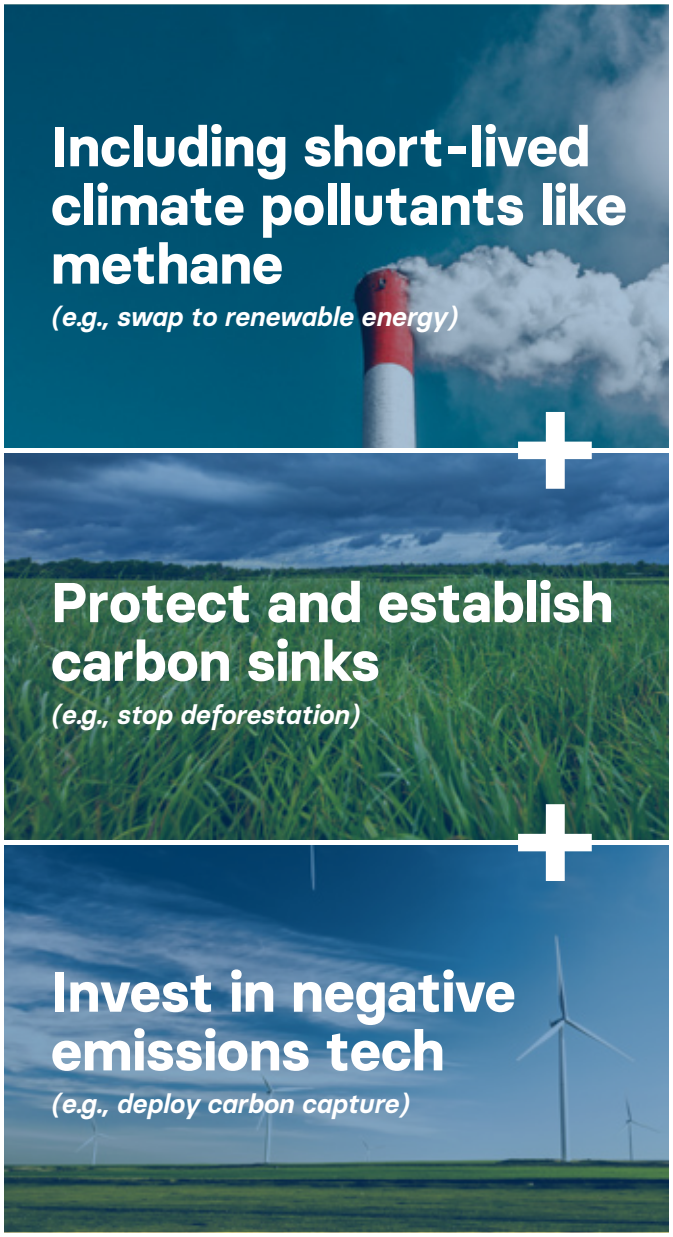
The **latest climate science reveals** that society and ecosystems will benefit greatly from limiting global temperature increases to 1.5° Celsius above pre-industrial temperatures. To achieve this, it is critical that the global economy reach net zero carbon dioxide emissions around 2050 and dramatically limit the release of short-lived climate pollutants in the interim.

The aim of net zero is to achieve no additional warming impact from greenhouse gases (GHGs) by a certain year. Increasingly, companies from all sectors of the economy are setting ambitious net zero commitments and embracing this target as a business imperative.

But net zero is not just a goal, it is a path.

Reduce ALL GHG emissions possible

Remove long-lived climate pollutants



= **Net Zero**

Net zero is the practice of a company, sector, or economy neutralizing the further climate impact of all of its GHG emissions beginning in a certain year by reducing all emissions possible and then offsetting residual emissions with removal strategies.

Net zero by 2050 refers to the goal of achieving no additional warming impact from GHGs by that year.

Net zero by 2050 is a journey where short-term milestones—such as halving global GHG emissions by 2030—are critical to set us on a good path to achieve a stable temperature for the planet. It will also require a focus on short-lived climate pollutants such as methane, in addition to CO_2.

Reaching this milestone will require:

International coordination and rule-setting to support the global and interconnected economy

Policy changes to incentivize timely, coordinated and equitable action, including carbon pricing

Fundamental changes to industrial systems, including low-carbon energy (electricity and fuels) to power all of the other sectors

In this current moment, **company leadership will remain essential to getting the world to net zero**. Business leaders must address emissions from their own operations and supply chains, invest in new business models and breakthrough technologies, and advocate for the policies and incentives needed to make this transition.

About *Pathways to Net Zero*

This report gives business leaders the clarification needed to accelerate the transition to a sustainable and just future by providing sector-specific pathways to reach 2050 targets and examining how the influential industries of technology and retail can scale progress.

It also offers a roadmap with action items that companies, industries and sub-sectors can take today relative to their own operations, investments, coordination and advocacy to drive the most meaningful impact toward net zero by 2050.

Key findings include:

Hard-to-abate sectors, such as air travel, will likely need to use high-quality carbon credits in the short- and medium-term to achieve net zero status, but all credits must have environmental integrity and be integrated in a clear pathway to decarbonization. **All sectors should have access to high-quality carbon credits** to accelerate near-term mitigation opportunities, *particularly for investment in prevention of tropical deforestation.*

The actual *path* to net zero is critical—the amount and type of GHGs emitted along that path as well as the timing of the emissions can lead to a range of temperature outcomes. The choices that companies make, especially in the near-term, can increase the likelihood of actions resulting in a better or faster outcome for the climate:

- **Companies should have shorter-term, science-based decarbonization goals** that address all GHGs and commit companies to decarbonize both their footprint and value chain.
- **Business must focus on short-lived climate pollutants** in addition to carbon dioxide, as 50% of warming over next two decades (from today's emissions) will be due to methane.
- **Business must also act with urgency to protect the world's current carbon stocks, such as tropical forests**, or the journey to a stable climate becomes much harder and longer.
- Individual **companies rely on major economic shifts** that can seem outside of their control, but have critical roles to play in **signaling demand**, participating in industry **collaborations** and **advocating for policy** to accelerate progress.
- **Marginalized groups and low-income communities bear the greatest impacts** of climate change. The path to net zero must incorporate just climate solutions for people of all genders, races and skills for a more sustainable and equitable future.

There are actions that companies can take today, based on their sector or industry, to maximize the return on investment to the climate. The reality is that each company's path to net zero is unique and there is still much to learn about challenges that companies will face along the way. But we *do* know much of what needs to happen *right now* to speed and scale climate action.

This report uses an analysis of two sectors—transportation and agriculture—and two industries—retail and technology—based on data from the United States, to make a broad global case for business action on the path to net zero. It details actions and policies specific to those sectors and industries and identifies areas where any business in any sector should focus and act now.

Emissions from energy are the largest sectoral source of GHG emissions. The case for a rapid shift away from fossil fuels is clear and well-documented. This analysis builds from that general understanding and focuses on other high climate impact sectors and influential industries to create a broader story of how our economies and our world can achieve net zero.

After energy, transportation is a key sector that must reduce emissions. In the United States, the transportation sector is responsible for almost 25% of current U.S. GHG emissions' impact on near-term warming, and almost one-third when considering long-term impacts of current U.S. emissions. This is because the emissions from this sector are largely long-term climate pollutants like carbon dioxide. **Globally, transportation is the fastest growing source of climate emissions.** The transportation pathway highlights the urgent need for electrification of this sector, moving assets away from fossil fuel-powered engines to those powered by batteries or hydrogen fuel cells.

In the near-term, food production plays an outsized role in driving climate change because of the large contribution of methane emissions that have a major impact on warming over a short period of time. The agriculture sector represents 20% of the total share of global GHG emissions when considering near-term impacts. The agriculture pathway emphasizes the need for companies in the food and agricultural sector and its partners to identify and incentivize methane-reduction activities now in order to slow the rate of increase in global climate temperatures in our lifetimes.

Industries are a critical group within the net zero by 2050 story. These groups of similar companies source and/or provide products and services from a range of economic sectors and can be part of accelerating progress on low-GHG activities through those roles.

For example, in order to hit its own net zero by 2050 targets, retailers will need low-GHG inputs from the energy, transportation, industrial, building and agricultural sectors. As retailers make their commitments to source climate-friendly products and services, **they can shift the companies that "win the future" in each of those sectors.**

Technology companies can drive toward net zero through their own efforts to decarbonize data centers and fleets and, more importantly, find ways to apply their technology to drive the transition to net zero in addition to showing the way for other companies on systems change such as policy and finance.

Overview

Climate risk and impacts are already here. 2020 is expected to be **one of the hottest years on record** and has already earned the title of the most active storm season on record. In 2017, the U.S. alone experienced multiple climate disasters, which had a cumulative cost of over $300B.

In addition, the ~200 largest global businesses estimate **climate change impacts will cost ~$1T** by as early as 2024. Further, a **Ceres report** found, "every major U.S. bank faces the potential for dramatic losses from the failure of the companies they loan to plan for a transition away from fossil fuels... which could translate into more than $100 billion in losses."

As of today, global temperatures have already risen 1°C and are on track to rise 3.5°C-5°C. In this scenario, scientists predict:

- **Total loss** of **coral reefs** and irreversible loss of biodiversity
- **Almost 800 million people** exposed to **water scarcity** and drought conditions and **175 million** people **impacted by flooding** annually
- **Half of cropland** may no longer be suitable **for agriculture**

Fortunately, many businesses see the writing on the wall. Although the COVID-19 pandemic and growing movement for equity and justice have tested corporate commitments and influenced priorities, they have also highlighted the vital role the private sector must play in tackling the climate crisis and rebuilding better.

The number of net zero pledges has doubled in less than a year, including more than 1,500 companies with a combined revenue of more than $11.4 trillion.

How does net zero by 2050 relate to...

Science-Based Targets (SBTs)

SBTs are actionable 5-15 year long targets that also align to the path set by latest climate science towards limiting global warming to well-below +2°C.

Science Based Targets

Carbon Neutrality

Refers to zero net anthropogenic carbon emissions within a stated time period, but does not take into account the other greenhouse gases (e.g., methane, which has nearly 30 times the climate impact as compared to carbon over a 100-year time horizon).

IPCC AR5 2013

Carbon Credits (i.e., Offsets)

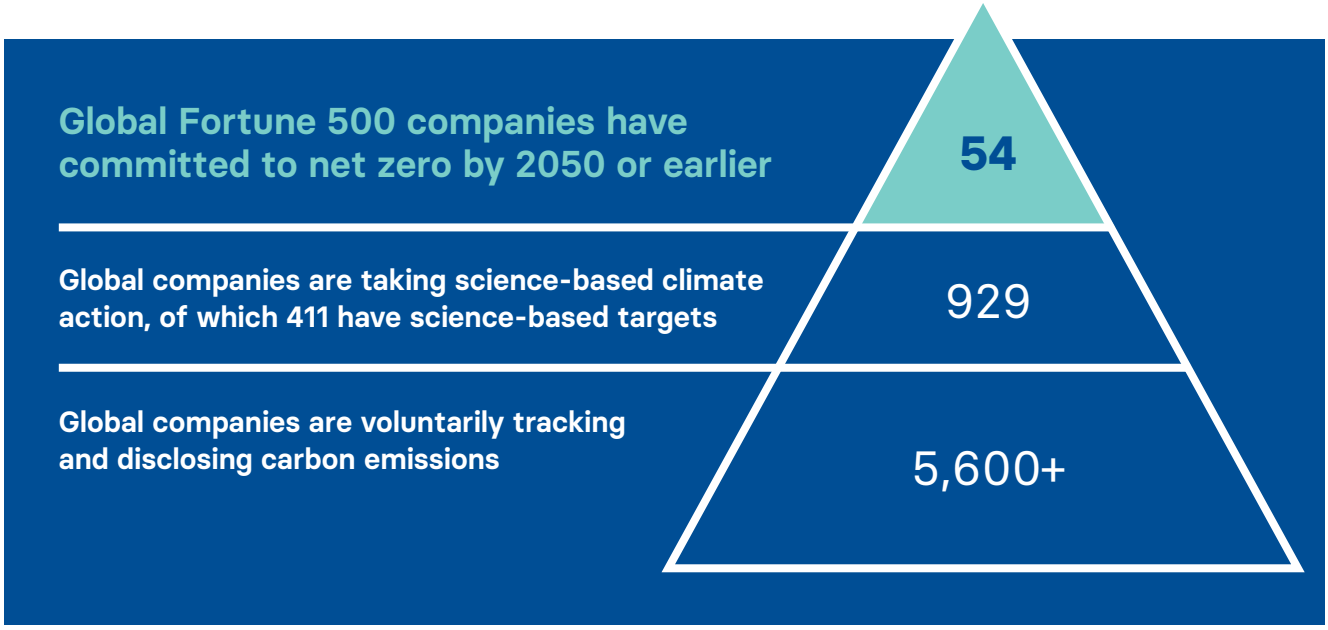
High-quality carbon credits can enhance reductions and removals in the near term, including for hard-to-abate industries, and can contribute crucial funding to activities that avoid, reduce, or remove GHG emissions. To ensure environmental integrity, systems must be in place to ensure that carbon credits are accurately and conservatively quantified, robustly accounted for and result in real, additional, permanent and verified mitigation.

More info | **Offset Guide**

Leading companies are setting science-based targets and committing to net zero

Historically, individual companies have set GHG reduction targets based on their relative ambition level. Companies are now moving toward science-based targets in line with the 1.5°C scenario, under which humans and nature will benefit greatly from limiting global temperature increases to that level.

Net zero by 2050 commitments, an extension of near-term science-based targets, are becoming the new gold standard as companies align with "well below" 2°C goal.



TECH	RETAIL	TRANSPORT	FOOD & BEVERAGE
NET ZERO COMMITMENTS			
Microsoft	IKEA, Nike	American Airlines	DANONE
Apple, Google	Walmart	Mercedes-Benz	STARBUCKS
salesforce, wipro	amazon	MAERSK	Unilever
	natura &co		

Notes: Companies include all members of the Transform to Net Zero Coalition, as well as a selection of other companies with public targets. Net Zero Element refers to companies that have set intentions for a portion of their company to be net zero by 2050, such as select geographies, business units, or locations

Sources: Environmental Defense Fund, **Carbon Disclosure Project**, **Science Based Targets Initiative**, United Nations Framework Convention on Climate Change (UNFCCC), Company Websites

54 Global Fortune 500 companies have committed to net zero by 2050 or earlier

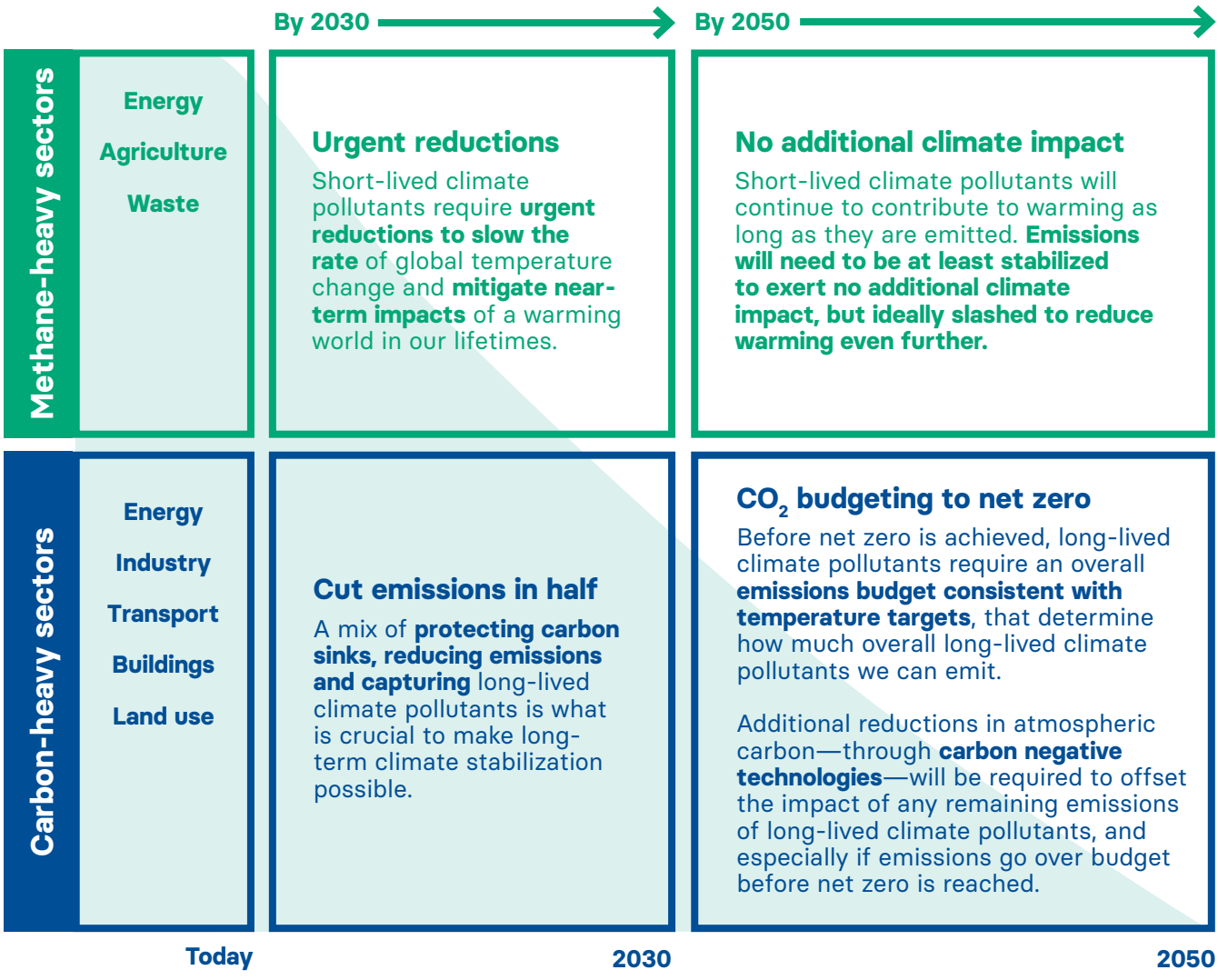
This surge in business commitments is due in part to companies recognizing the clear business benefits of climate action:

- Improving investment prospects
- Increasing regulatory readiness
- Enhancing brand reputation and sales
- Mitigating energy price volatility
- Creating supply chain resilience

Despite encouraging progress, companies need to engage in broader systems change outside of their four walls, in order to meet their climate goals, protect communities and stabilize our climate in a just and equitable way.

Carbon-heavy sectors must plan for net zero carbon emissions by 2050, which is key to limiting overall warming in the long-term, while **sectors that emit methane** must reduce emissions rapidly to slow the rate of global temperature change now.

Ambitious strategies to achieve net zero goals include near-term methane reductions and slashing CO_2 in half by 2030



Note: Other short-lived climate pollutants not included for simplicity and make up < 25% of global GHG emissions impact

Sources: EDF, US EPA, C2ES Report via EIA Data, WRI Global Emissions

It is also important to acknowledge that getting to net zero is not the sole responsibility of the private sector. Reaching this target will require action from the global community in setting rules of the road so that companies are incentivized to decarbonize and to create carbon markets, which **analysis shows can result in nearly double the climate ambition at the same overall cost**.

International coordination and standard setting can enable a high-quality carbon market. This involves:

- An agreed-upon climate accounting framework and alignment with the principles in the Paris Climate Accord and United Nations Sustainable Development Goals.
- Carbon pricing and emissions trading protocols that assign a clear value to the societal cost of GHG emissions.
- **Alignment on high-quality carbon credit terminology, timing and quality standards and accounting rules.** This is especially important as carbon credits can protect tropical forests, which are vital carbon sinks. Carbon credits should be real, additional, verified and permanent in a manner that avoids double counting.

National and sub-national policies can incentivize and fund progress, accelerating the transition to a clean energy economy (via utility-scale renewable electricity, low-carbon fuels, and low-carbon heating and cooling). This involves:

- Mandates and regulations to set expectations around renewable energy standards.
- Public investment in infrastructure including electric charging networks for light, medium and heavy vehicles.
- Public investment in tech R&D including electricity-based solutions for industry, commercial carbon capture and hydrogen technology development.

Sector pathways to net zero by 2050

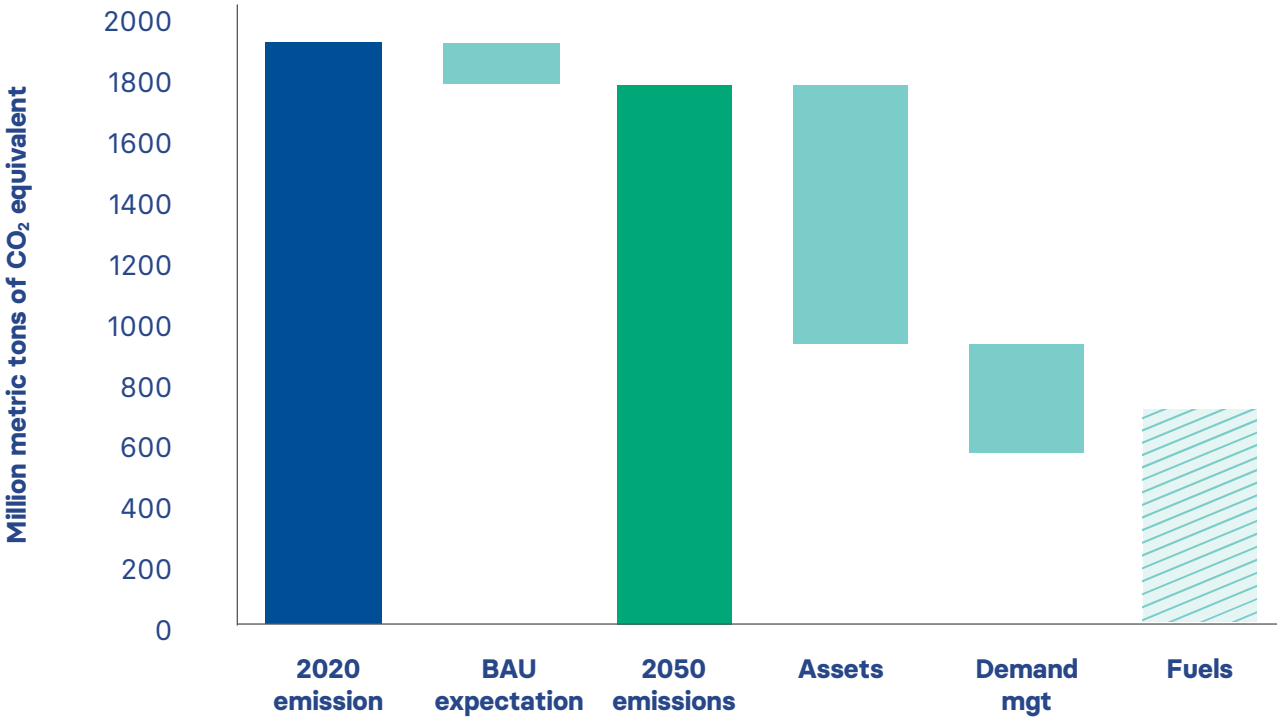
Transportation

Emissions from transportation are the **fastest growing source of global GHG emissions**, accounting for 25% of CO_2 emissions. Getting to net zero will require the transportation sector to reverse that trend and rapidly decarbonize.

The key levers to driving toward net zero by 2050 in the transportation sector include:

1. Creating more efficient and electrified assets
2. Managing energy demand through optimization and modal shifts
3. Closing the innovation gap through fuel switching where electrification is not possible

Net zero by 2050: U.S. transportation



Notes: Business as usual (BAU) increase assumes a decrease in emissions via an increase in sales of EV light road vehicles, but steady or increasing emissions from other modes including air travel; High-quality carbon credits can be used in the near-term to close gap; The COVID-19 outbreak has impacted transportation emissions but is not the focus of this long-term view.

Sources: Energy Transitions, AECOM, Energy Innovation Policy Solutions Scenario Tool, Forbes via Energy Innovation, NRDC, US EIA

Key levers	Key activities
Assets **Efficient parts, design, and electrification** (Reduction lever)	• ZEV Cars, Trucks, Buses, Subways, Shipping, Commuter Rail, and Charging Networks • Fuel Efficiency • Thermodynamic Efficiency of New Engines • Aerodynamic Parts and Design • Wind Assistance (Shipping)
Demand **Energy demand mgt. and modal shifts** (Reduction lever)	• Route and Fleet Optimization • Modal Shifts (Air to Rail, Heavy Road to Rail and Shipping) • Load Factors Improvement (Air) • Consumer Demand Reduction
Fuels **Fuel switching** (Innovation gap)	• Sustainable biofuels and biodiesel - **E** • Synfuels - **E** • Liquid Hydrogen - **E** • Ammonia (shipping) - **E**

E = Transition to Low-Carbon Energy Sector Required to Realize Benefits (incl. electricity, fuels, heat, etc.)

The first lever — creating more efficient and electrified assets — is predicted to play the largest role in mitigating emissions on a path to net zero by 2050. Activities such as designing zero-emissions vehicles (ZEVs) as well as making all vehicles run more efficiently on less energy using fuel efficiency, aerodynamic parts, improved thermodynamic efficiency of new engines and wind assistance (in the case of shipping) **could reduce domestic transportation emissions by more than 40% over the next few decades**.

The second lever, managing energy demand, includes route and fleet optimization, modal shifts, consumer demand reduction and load factors improvement (for air). The key modal shifts are connected to the shipment of goods, including from air to rail or heavy road to rail or shipping. **This lever has the capacity to reduce GHGs in the transportation sector by another 20%.**

The third level, fuels (fuel switching), remains a critical innovation gap for the parts of the transportation sector that cannot be electrified in the near-term or which will have challenges with charging moving forward (e.g., long-distance air and sea travel). Fuel types in need of significant research and development attention include synfuels, sustainable aviation fuels, and liquid hydrogen and ammonia for shipping applications.

Transportation pathway: sub-sector roadmaps to net zero by 2050

	Near-term actions (2020-2025)	Mid-term actions (2025-2030)	Long-term actions (2030-2050)
Road: light and medium	• Set date for all ZEV fleets (see: **current commitments**) • Purchase high-quality carbon credits for remaining gap	• Advocate for power decarbonization	• Complete transition to all ZEV fleets
Road: heavy	• Adopt all logistics and energy efficiency solutions • Purchase low-carbon fuel • Send demand signals for ZEV development • Transition to ZEV adoption • Purchase high-quality carbon credits for remaining gap	• Set date for all ZEV fleets • Continue to purchase low-carbon fuels	• Complete transition to all ZEV fleets
Air	• Purchase low-carbon fuels that meet ICAO specifications and achieve > 60% GHG reduction • Implement operational improvements (e.g., taxiing) • Purchase high-quality carbon credits for remaining gap • Retrofit aircraft to boost efficiency (e.g., lightweighting), and enable use of more new fuels	• Build coalitions to finance aircraft retrofits, secure low-carbon fuel supplies and infrastructure • Set date for zero-emitting short-haul flights	• Transition to carbon-negative fuels and zero-emitting aircraft
Marine / shipping	• Set public industry commitments • Implement existing efficiency solutions (e.g. slower speed, optimized routes)	• Set date for all ZEV short-haul vessels • Cross sector R&D and piloting of sustainable tech	• Switch to all ZEV vessels using a hydrogen fuel carrier
Rail	• Implement intermodal infrastructure to support increase in freight movement • Implement logistics efficiency solutions	• Pilot zero emissions systems	• Switch to zero emissions systems

Sources: Energy Transitions; Deloitte and Shell; Science-Based Targets, Forbes, ICAO

Transportation pathway: sub-sector roadmaps to net zero by 2050

	Near-term actions (2020 – 2025)	Mid-term actions (2025 – 2030)	Long-term actions (2030 – 2050)
Advocate	• Demand management policies • Vehicle emissions standards • Biofuel or other low-carbon fuel/ fossil fuel disincentives (esp. aviation) incentives / fossil fuel disincentives • Funding for electric charging networks • City, state and federal clean transportation policies • Aviation decarbonization goals • Zero-emitting short-haul flights • Orient federal R&D to decarbonizing transport	• Advocate for power decarbonization • Demand management policies (e.g. public transit) • Rebates for efficient passenger vehicles • Renewable energy and biofuel incentives • Build on and strengthen aviation low-carbon fuel standards and incentives	• Rail incentives for freight and short-haul passenger trips • Green fuel mandates • Support policies that enable zero-emitting long-haul flights
Invest	• High quality biofuels • Hybrid drivetrains and eco-driving • Electric battery density and charging speed • Fuel cells and hydrogen tanks • Aircraft repurpose and retrofit • Electric (battery) short-haul aircraft	• Hydrogen energy storage and ammonia biodiesels • Green infrastructure development (e.g. vehicle charging, railway) • Zero-emitting aircraft and fuels	• Hydrogen and ammonia technologies • Green infrastructure development (e.g. vehicle charging, railway) • Carbon-negative aviation fuels and infrastructure

Sources: Energy Transitions; Deloitte and Shell; Science-Based Targets, Forbes, ICAO

Transportation pathway: acceleration through policy

	Assets
Example policy accelerators	• Vehicles pollution standards • Energy efficiency design standards for any new ships; operational standards for existing fleets • ZEV purchase incentives (e.g., tax credits and accelerated depreciation) • City policies: Zero-carbon bus fleets by 2035; pro-ZEV rules • Charging networks: Public investment and universal standards
Key sub-sectors for coalition building	• Road: Light (e.g., personal cars) • Road: Medium (e.g., city buses) • Road: Heavy (e.g., long haul trucks) • Rail • Air • Shipping
Value of industry engagement	• Weigh in on what incentives governments can provide to make the transition to higher fuel efficiency vehicles easier • Lower costs as compared to managing state-by-state requirements • Build industry alignment as early as possible on preferred charging technology • Ensure that any policies that provide financial incentives for ZEVs are going to resonate with target companies

Notes: ZEV stands for zero-emissions vehicles, which could be powered by a range of technologies from EV to fuel cells

Sources: ICCT, AECOM, Energy Innovation Policy Solutions Scenario Tool, Forbes via Energy Innovation

Demand	
Example policy accelerators	• City and development zoning and planning • Public transportation and walk/bike path funding and connectivity • Increasing parking fees and congestion pricing • Altering building codes (e.g., max parking spots) • Faster permitting and infrastructure for rail and ship freight • Investment in modal shifts (e.g., high speed rail to offset short-haul aviation shipments
Key sub-sectors for coalition building	• Air • Marine / Shipping • Road: Heavy • Rail • Logistics
Value of Industry Engagement	• Industry perspective on future of ZEV and charging networks incorporated into city planning and zoning • Industry pain points around rail and ship permitting and infrastructure clearly articulated to policymakers
Fuel	
Example policy accelerators	• Lifecycle fuel standards that specify 100% zero carbon fuel by 2050 • Taxes on fuel (revenue used to create EV infrastructure)
Key sub-sectors for coalition building	• Air • Marine / Shipping • Rail • Logistics
Value of industry engagement	• Bringing a perspective on maximizing biofuel effectiveness as a transportation fuel to build on insights from agricultural sectors about the options' environmental impacts

Transportation pathway: examples

SBTi-approved science-based goals:  **Lead**  **Invest**  **Advocate**

AIRBUS 

In September 2020, Airbus announced its ambitions to invest in a climate-neutral, zero-emission commercial aircraft to put into service by 2035. Airbus's ambitions are consonant with the European Union's 2020 Smart and Sustainable Mobility Strategy which envisions that large zero-emission aircraft will become market ready by 2035.

Cummins 

The engine company's journey to net zero carbon emissions by 2050 incorporates science-based targets for 2030, including reducing facilities and operations GHG emissions by 50%, reducing new product lifetime GHG emissions by 25%, and partnering with customers to reduce greenhouse gas emissions from products in the field by 55 million metric tons.

lyft 

Lyft has committed to achieving 100% electric vehicles on its platform by 2030 with a comprehensive plan involving collaborating with policymakers, businesses, and NGOs to accelerate EV cost-parity and increase access to EVs and charging. The transportation network company's commitment is expected to result in eliminating 16M metric tons of GHG emission reductions over the next 10 years.

Mercedes-Benz 

Mercedes-Benz's road to CO_2-neutrality by 2039 includes switching to renewable energy sources to achieve CO_2-neutral production in its own plants worldwide from 2022, aiming at more than 50% of its car sales from plug-in hybrids or all-electric models by 2030, and working with suppliers to incorporate CO_2 targets as key criteria in supplier decisions.

MAERSK 

Maersk path to net zero involves collaborating across its entire supply chain, from engine makers and shipbuilders to technology providers, to develop technologies to support commercially-viable operations of net zero emission vessels by 2030. Maersk also aims to cut its carbon footprint by 60% by 2030.

Ford 

Ford aims to achieve its Carbon Neutral by 2050 goal by spending more than $11.5 billion in electric vehicles through 2022, including introducing zero-emissions versions of two of their best selling vehicles by 2022. It also plans to power all manufacturing plants with 100% renewable energy by 2035 and to develop SBTi-approved emissions reduction goals.

Transportation pathway: company action planning

- [ ] How well do my *individual* corporate GHG-reduction **activities overlap with the key levers required for my *sector*** to hit net zero?
- [ ] Which of these key levers are ones that my company can **tackle on our own**?
- [ ] For levers where my company does not have direct control:
  - Which will require my company (and others) to **work with other companies within our sector** to develop and deploy solutions we can all leverage?
  - Where is a **change in another sector** required to deliver on our corporate targets?
- [ ] Where will companies like mine need to engage policy-makers to create the right incentives?

Does reviewing the sector-level pathway to net zero by 2050 change your thinking about the role of your individual company and its current GHG-reduction tactics?

Resources for Net Zero by 2050 in the Transportation Sector

Energy Transitions Commission:

Mission Possible: Reaching net zero carbon emissions from harder to abate sectors (November 2018)

Accelerating the low carbon transition (November 2019)

Getting to Zero 2030 Coalition (Global Maritime Forum, Friends of Ocean Action, World Economic Forum):

Industry Roadmap

Deloitte UK:

Global Electric Vehicles: Setting a Course for 2030

Environmental Defense Fund:

EDF's Green Freight Handbook

International Council on Clean Transportation:

US Transport Policy Overviews

EDF & ICCT:

Race to Zero report on zero-emission truck availability

International Civil Aviation Authority:

Aviation and the Environment - Outlook

Agriculture

Nearly 25% of global GHG emissions currently comes from agriculture and deforestation. If not addressed, agriculture could become the world's largest contributor to climate change given growing populations and the need for food.

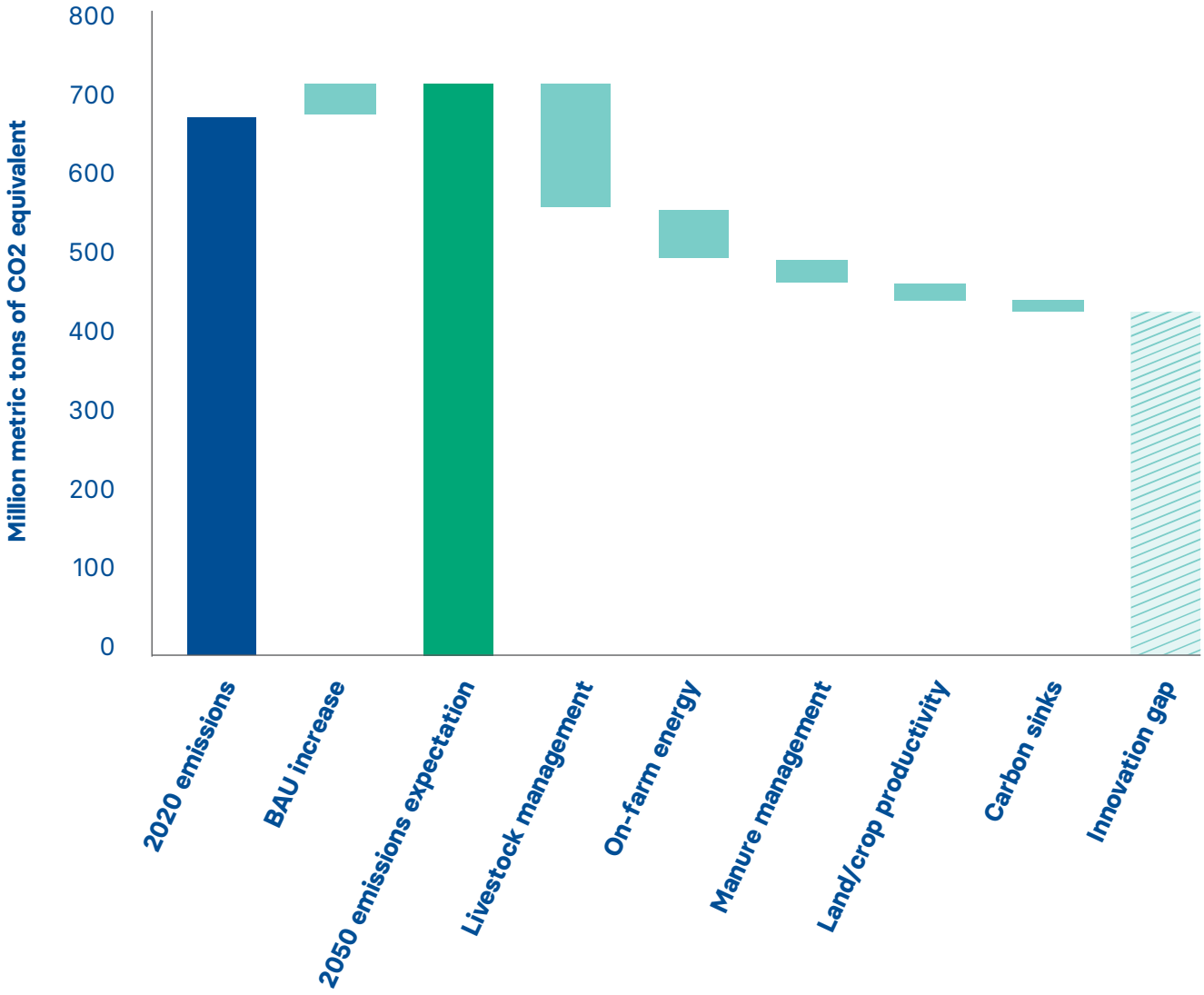
In the past few decades, U.S. agriculture has made dramatic efficiency gains. As a result, **levers for change on a path to net zero by 2050 can be broken into three different categories — those with significant potential, those driven by continuous improvement and those that require innovation breakthroughs**.

Changes in livestock management to things like feed mix and additives, reduced on-farm energy use and increases in renewable energy have the potential to get U.S. agriculture 30% of the way to net zero emissions by 2050. The continuous improvement of manure management, land and crop productivity, and practices that capture carbon will add an additional 10%. That leaves a sizeable innovation gap, where more research is needed to understand what role waste mitigation, diet changes and further improvements to feed additives and animal genetics can play.

The key levers to driving toward net zero by 2050 in the agricultural sector include:

1. Improving livestock management
2. Reducing on-farm energy
3. Improving manure management
4. Improving land and crop productivity and considering swaps
5. Protecting and improving land and crop carbon sinks
6. Closing the innovation gap for food waste, feed additives, animal genetics, and climate-friendly diet choices

Net zero by 2050: U.S. Agriculture



Notes: Business as usual (BAU) increase between 2020-2050 based on USDA Reference Scenario; Abatement by lever taken from global data and applied to US context; GHG emissions displayed would be significantly higher if emissions from on-farm electricity use attributed to agriculture vs. energy sector; High-quality carbon credits can be used in near-term to achieve Net Zero before innovation gap is closed; Land use conversion and restoration are not included in this agricultural sector pathway since the emissions are often categorized separately as 'Land Use, Land-Use Change and Forestry', however these activities are critical Net Zero pathway levers; It is critical to prevent the conversion of new lands from forest to agriculture using crop productivity and other measures. The COVID-19 outbreak has impacted agriculture emissions but is not the focus of this long-term view.

Sources: : EPA, National Sustainable Agriculture Coalition, McKinsey, Center for Climate and Energy Solutions, Food & Drink Federation

	Key levers	Key activities
Net zero levers	**Livestock management** (Reduction lever)	• Livestock Management Feed Mix and Additives • Livestock Production Efficiency (Machinery, etc.)
	On-farm energy (Reduction lever)	• Fuel Swaps - **E** • Machinery Upgrades • Management Practices to Reduce Machinery Use • On-farm Renewables
	Manure management (Reduction lever)	• Manure Management via Anaerobic Digestion • Solid Separation for Smaller Farms
	Land and crop productivity and swaps (Reduction lever)	• Fertilizer Application and Timing • Nitrogen Fixing Rotations • Crop Switching to lower-GHG crops • Crop and Microbiome Genetics and Productivity
	Land + crop sinks (Carbon Sink Lever)	• Conservation Tillage, No Till, etc. • Agroforestry; Alternative Mgt Plans (AMP) • Cover Crops
	Diet changes + waste management (Innovation Gap)	• System-level Shift from Eating Beef to Dairy Cow Meat • Diet changes that shift to a larger % of calories from plants • Waste Mitigation on-farm and across Value Chain • R&D on NextGen Livestock Feed and Additives • Livestock Genetics and Breeding
Transitional levers	**Reduce** Fuel Swaps - **E**	• Biogas in agricultural applications (when taken from manure applications that would otherwise be leaking methane)

E = Transition to Low-Carbon Energy Sector Required to Realize Benefits (incl. electricity, fuels, heat, etc.)

Livestock management

Livestock production is a massive source of methane emissions within the U.S. agricultural sector, and is relatively efficient due to large, industrial processes in the U.S. The remaining potential for efficiency gains — assuming the same volume of cows and land — will largely rely on livestock feed mix and additives, as well as a focus on genetics and breeding for lower-methane production. These remain critical research and innovation priorities for the sector, in terms of how solutions can be both developed and implemented.

On-Farm energy

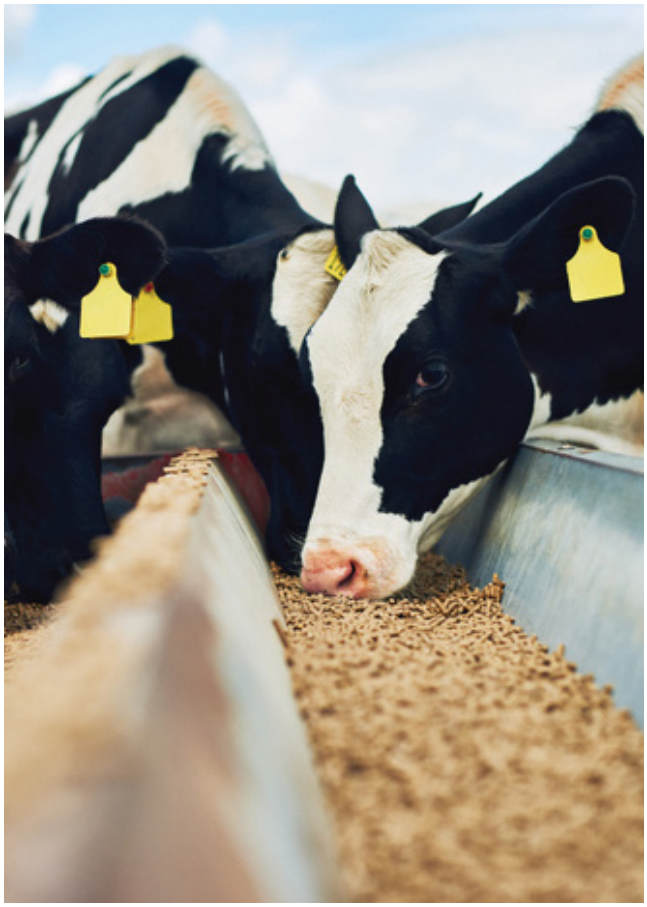
In addition to increasing renewable energy use on farms, there are still straightforward opportunities to reduce on-farm energy use through interventions like upgrades and more efficient use of machinery. Another consideration while transitioning is to use biogas as a fuel swap for on-farm energy until equipment can be electrified. It's important to note that this is only a net positive for the climate when biogas is taken from sources currently leaking methane into the atmosphere, such as manure, landfills and wastewater treatment plants.

Land productivity and carbon sinks

Though relatively smaller in emissions reduction opportunity overall, crop and land management such as fertilizer optimization and conservation tillage offer potential cost savings on expensive inputs such as fertilizer in addition to other environmental benefits, such as cleaner water and air.

Diet changes and waste management

After considering the levers that are technologically and financially feasible today, a significant innovation gap remains to get U.S.



agriculture to net zero by 2050. Some of this gap could be closed through additional efforts focused on animal genetics and breeding and feed mix and additives. Breakthroughs on reducing food waste, which represents about **a third of food produced each year**, could also make a sizeable dent in the gap.

Beyond these more traditional areas of innovation, an increasing focus on developing more alternative types of protein — such as plant-based or cell-based meats — could further decrease the GHG composition of U.S. agriculture, if done effectively.

This lever remains an innovation gap as policymakers, NGOs and businesses struggle with how to shepherd in the behavior changes needed to see progress in these areas and may not have interest in tackling topics that are driven by individual consumer choice or issues that may have become politicized.

Agriculture pathway: roadmaps to net zero by 2050

Consider what your sub-sector must get right in the near-term to activate its path to net zero by 2050, including operational changes, policy support and investments in technology

	Near-term actions (2020-2025)	Mid-term actions (2025-2030)	Long-term actions (2030-2050)
Livestock	• Advocate for demand and price of biomethane • Transition ruminants to higher-fat diets • Reduce overgrazing to improve land productivity • Optimization and expanded application of existing manure management opportunities • Implement livestock production efficiencies	• Expanded use of manure management • Employ greenhouse gas-focused genetic selection and breeding • Improved yield (e.g., feed conversion efficiency, antibiotics) • Methane production minimization (e.g., feed additives, vaccines, propionate precursors) • Implement livestock production efficiencies	• Apply nitrification inhibitors on pasture • Implement livestock production efficiencies
Land and crop	• Fertilizer optimization, e.g. controlled-release, stabilized • Soil health improvement practices • Introduce low- and no-tillage practices • Incorporate cover crops as standard practice	• Adopt zero-emissions on-farm machinery and equipment • Scale low- and no-tillage practices in effective environments • Improve use of low-productivity crop land by increasing crop diversity, converting to CRP grasslands, and/or introducing silvopasture and agroforestry	• Expand zero-emissions on-farm machinery and equipment • Improve use of low-productivity crop land by increasing crop diversity, converting to CRP grasslands, and/or introducing silvopasture and agroforestry
Produce	• Fertilizer optimization, e.g. controlled-release, stabilized • Pilot low and no-tillage practices	• Adopt zero-emissions on-farm machinery & equipment • Scale low- and no-tillage practices in effective environments	• Expand zero-emissions on-farm machinery and equipments

Agriculture pathway: roadmaps to net zero by 2050

	Near-term actions (2020 – 2025)	Mid-term actions (2025 – 2030)	Long-term actions (2030 – 2050)
Advocate	• Support federal policies that encourage and scale adoption of farming practices that improve soil productivity, reduce emissions, protect water quality, increase yields and strengthen farm resilience • Fund USDA Conservation Programs, and direct USDA to set voluntary goals for GHG emissions reductions and carbon sequestration in the agricultural sector • Prioritize funding for State Forest Action Plans	• Clear system of credits to activate funding into low-GHG agricultural solutions • Ensure a robust crop insurance system incentivizes GHG reduction and climate-resilient agriculture	• Incentives for electrified on–farm solutions • Support for sustainable production funding for conservative stewardship programs
Invest	• Innovation of plant-based food products • Platforms to support healthy and sustainable eating habits • Mobile applications to reduce food waste • Ensure that public and private sectors work together to maximize impact"	• New technologies to reduce food loss and waste • Alternative protein growth and cell-based meat • Gene editing for disease resistance/carbon sequestration • Regional/jurisdictional soil carbon protocols; USDA carbon Bank - public/private partnership	• Innovation in technologies that increase livestock production efficiencies • Nitrification inhibitors on pasture

Sources: EDF, McKinsey, National Sustainable Agriculture Coalition, Center for Climate and Energy Solutions, Food & Drink Federation, EPA

Agriculture pathway: acceleration through policy

Ensure that your company is building a policy plan to match its net zero aspirations, including broad climate reforms passed by Congress and on some of the specific agricultural levers that could be greatly accelerated through policy actions.

Livestock	
Example policy options	• Reducing the complexity of the overall regulatory framework • Ecosystem services market payments or credits for GHG reduction • Establishing long-term certainty on demand for, and price of, biomethane and soil carbon, for example, via USDA Carbon Bank • Provide financial incentive for building anaerobic digestion and other manure management facilities • Developing program to reduce impacts of CAFOs in concentrated areas through buyout programs and alternative commercial opportunities to address environmental and public health risks
Value of industry engagement	• Weigh in on what incentives governments can provide to incentivize capture and use of on-farm energy using latest technologies • Industry difficulties in biomethane market (e.g., pricing and lack of demand) clearly articulated to policymakers
Forestry	
Example policy options	• Prioritize funding for State Forest Action Plans • Restore funding for conservation stewardship programs • Provide financial incentive to farmers to pursue and expand agroforestry practices • Agroforestry tax credits
Value of industry engagement	• Bringing an industry perspective on how to support farmers interested in conservation programs and payment rates for practices

Sources: McKinsey, National Sustainable Agriculture Coalition, Center for Climate and Energy Solutions, Food & Drink Federation, EPA

Land and crop	
Example policy options	• Fund USDA Conservation Programs, and direct USDA to set voluntary goals for GHG emissions reductions and carbon sequestration • Working capital grants for soil management practices and cropping systems that promote soil health • Fund research into seeds adapted to regional climate regimes and climate-friendly farming systems • National goal for increasing carbon stored in soils • Tax breaks on cover crop seeds
Value of industry engagement	• Industry perspective on what data would be most helpful for driving action
Waste management	
Example policy options	• Food waste mitigation incentives • Support composting of on- and off-farm sourced organic residues
Value of industry engagement	• Ensure that any policies that provide financial incentive for landfill diversion will resonate with target companies
Energy	
Example policy options	• Energy efficiency policies and Low Carbon Fuel Standard to incentivize shifts in on-farm energy use • Support for liquid fuels that are less carbon intensive than current gasoline
Value of industry engagement	• Developing energy policies that have the right incentives specifically for farmers

Agriculture pathway: examples

SBTi-approved science-based goals: Lead Invest Advocate

Danone has set an ambition for zero net carbon emissions across its full value chain by 2050, including an absolute reduction of Scope 1 and 2 emissions by 30%, and a 50% reduction in emission intensity full scope by 2030 (compared to 2015). The company's 2030 reduction targets were approved by the Sciences-Based Targets initiative in line with 2°C warming. Danone is currently working on new reduction targets in-line with 1.5C.

The global pork producer has committed to becoming carbon negative in U.S. operations by 2030 with renewable natural gas ventures and implementing regenerative agricultural practices, improvements in its animals' diets, renewable electricity purchases, and streamlining its transportation, logistics and packaging. They must continue to improve manure management to address public health and environmental risks.

The company is in the process of developing its plan to reach its net zero by 2050 goal, and has stated that it will include producing more environmentally-friendly products, scaling up agricultural initiatives that store carbon, and using 100% renewable electricity in its operations.

Starbuck's aspiration is to be resource positive, including storing more carbon than it emits. The near-term path includes a 50% reduction in carbon emissions in direct operations and supply chain by 2030, and pursuing plant-based menu options, regenerative agriculture and more efficient operations.

Unilever is on track to achieve net zero emissions from all of its products by 2039, with interim targets to eliminate carbon emissions from its own operations and halve the GHG footprint of its value chain products by 2030. To accelerate action, it is investing €1B to a climate fund and developing a carbon footprint system for all products and services.

Kellogg Company's long-term climate target is 65% absolute reduction in emissions by 2050. To achieve this goal, Kellogg has set tangible, science-based targets for the short- and intermediate-term, including reducing emissions reduction intensity by 15% by 2020 and absolute value chain emissions by 50% by 2030.

Agriculture pathway: company action planning

- [ ] How well do my *individual* corporate GHG-reduction **activities overlap with the key levers required for my sector** to hit Net Zero?
- [ ] Which of these key levers are ones that my company **can tackle on our own**?
- [ ] For levers where my company does not have direct control:
  - Which will require my company (and others) to **work with other companies within our sector** to develop and deploy solutions we can all leverage?
  - Where is a **change in another sector** required to deliver on our corporate targets?
- [ ] Where will companies like mine need to engage policy-makers to create the right incentives?

Does reviewing the sector-level pathway to Net Zero by 2050 change your thinking about the role of your individual company and its current GHG-reduction tactics?

Resources for net zero by 2050 in the agriculture sector

Supply Chain Solutions Center:

Sustainable Agriculture Resources

National Sustainable Agriculture Coalition:

Agriculture and Climate Change: Policy Imperatives and Opportunities to Help Producers Meet the Challenge

Parsons Brinckerhoff:

Industrial Decarbonization and Energy Efficiency Roadmaps to 2050

Energy Transitions Committee:

Accelerating the Low Carbon Transition: The Case for Stronger, More Targeted and Coordinated International Action

McKinsey & Company:

Agriculture and Climate Change

World Resources Institute:

Creating a Sustainable Food Future

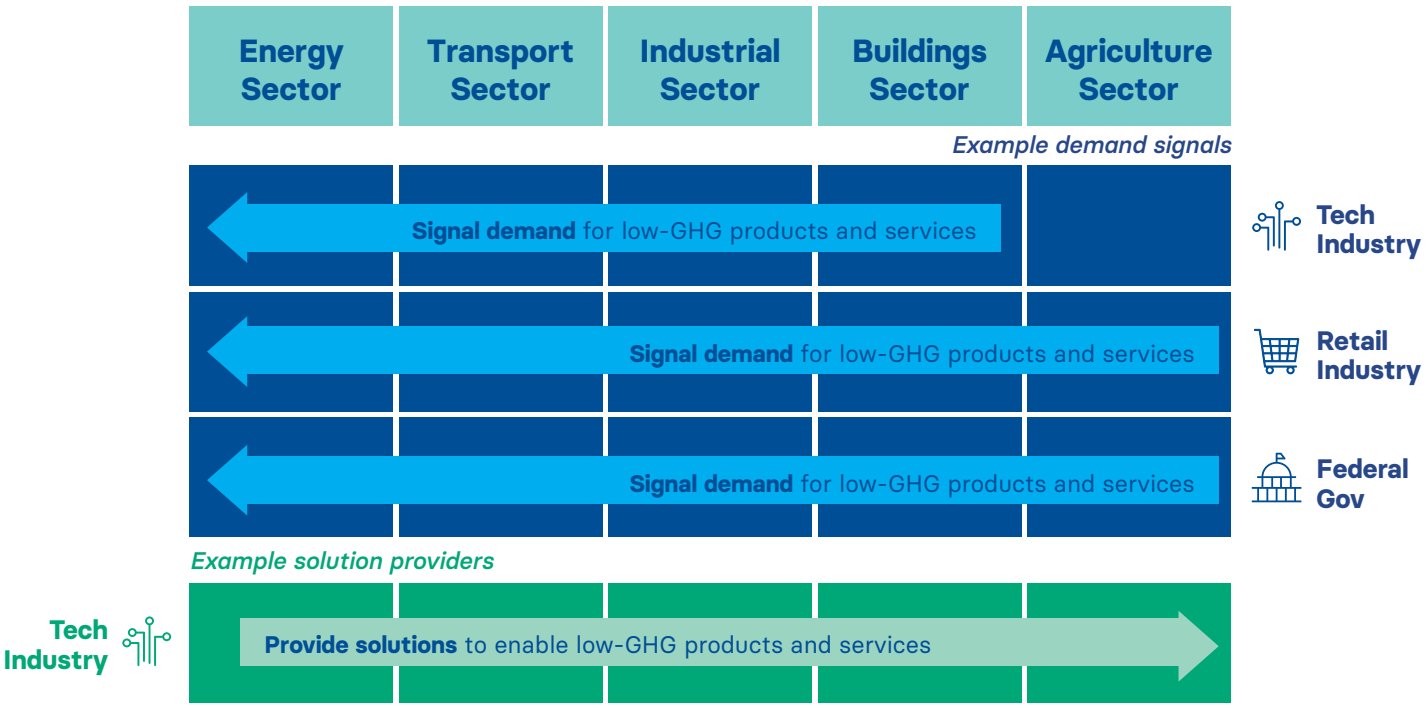
Food & Drink Federation:

Decarbonization of Heat across the Food and Drink Manufacturing Sector

Role of Influential Industries

Industries are a critical group within the net zero by 2050 story. These groups of similar companies source and/or provide products and services from a range of economic sectors and can be part of accelerating progress on low-GHG activities through those roles.

For example, in order to hit their own net zero by 2050 targets, retailers will need low-GHG inputs from the energy, transportation, industrial, building and agricultural sectors. As retailers make commitments to source climate-friendly products and services, they can shift the companies that "win the future" in each of those sectors.



Downstream industries can **signal long-term demand** for low-carbon products and services through their procurement function, other industries can **provide solutions**, and all can **advocate for climate policy.**

Technology

The technology industry is ahead of the curve when it comes to net zero by 2050 commitments. This can largely be attributed to the fact that the sector's emissions are heavily attributable to electricity use. There are many ways to offset emissions from electricity including onsite or offsite renewable energy sources.

As the technology industry drives toward net zero — and even climate positive — futures, much of the conversation will shift from decarbonizing their own operations to how technological solutions can decarbonize other industries and sectors. **This industry has a unique role to play in both signaling demand for low-GHG products and solutions as well as enabling those solutions for others.**

Technology: net zero by 2050 pathway

	Near-term actions (2020-2025)	Mid-term actions (2025-2030)	Long-term actions (2030-2050)
Scope 1	• Retrofit existing buildings • Upgrade equipment to more efficient versions • Adjust temperature, ventilation and lighting (e.g., movement or network-connected sensors)	• Switch to renewable energy wherever possible • Retrofit existing buildings • Reduce demand for new buildings	• Centralize data centers and facilities to optimize operations • Incentivize sustainable behaviors to mitigate remaining emissions in operations
Scope 2	• Increase purchase of renewable energy and consider opportunities for onsite • Pursue low-carbon heating and cooling • Decommission legacy networks	• Switch all purchased energy to renewable sources	• Operate all data centers and facilities using renewable energy • Support the increased adoption of renewable energy
Scope 3	• Establish business models to decarbonize end-user device electricity consumption • Purchase high-quality carbon credits for remaining emissions	• Encourage suppliers to set science-based targets of their own	• Partner with suppliers with proven low-carbon construction capabilities
Invest	• Data center efficiency measures • Innovation in technologies and platforms that support carbon reduction across sectors	• Circular materials, products and processes • Full-scale implementation of building automation for reduced energy use • New low-carbon construction materials	• Technology for buildings to produce their own energy
Advocate	• Renewable energy incentives • Policies that support building retrofits and onsite renewable energy • Ensure technology is not enabling production and sales of fossil fuels	• Ongoing grid decarbonization • Incentives for efficient technology as new solutions are scaled and available	• Zero emissions construction support and incentives

Sources: Exponential Roadmap

Technology: examples

SBTi-approved science-based goals: Lead Invest Advocate

Microsoft

Microsoft's path to being carbon negative by 2030 and to removing all of its historic carbon by 2050 includes a $1B climate innovation fund, an internal carbon tax for Scope 1, 2 and 3 emissions to drive decision making, and investment in negative emissions technologies.

stripe

In 2019, Stripe committed to spending at least $1M/yr on permanent carbon removal, making its first purchases in May 2020, following a transparent application and review process. In 2020, it began allowing its own customers to contribute to the portfolio of permanent carbon removal with a new product, Stripe Climate.

Its path to being carbon neutral for its supply chain and products by 2030 is bucketed into a 5-step program featuring low-carbon product design and recycling, energy efficiency, renewable energy, carbon removal, and process and material innovation such as low-carbon aluminium. By 2030, Apple will reduce emissions by 75% and is developing innovative carbon removal solutions for the remaining 25% of its comprehensive footprint.

Google

In September 2020, Google claimed a lifetime carbon footprint of zero through the use of high-quality carbon credits. Google is planning to operate on 24/7 carbon free energy in all data centers and campuses worldwide by 2030. Near-term targets include 100% carbon neutral device orders to and from Google customers in 2020.

SAP

SAP has committed to becoming carbon neutral by 2025 and achieve 85% reduction in total emissions by 2050. Since 2014, SAP's data centers have been drawing from 100% renewable energy sources. Beginning in 2018, SAP's Executive Board members' compensation package have been tied in part to carbon reduction efforts. In 2020, SAP adopted carbon emissions as a non-financial KPI to reinforce its commitment ambitions.

salesforce

Salesforce achieved its net zero 2050 commitment in 2017 through its funding of high-quality carbon credit projects. Salesforce is furthering its commitment by updating offices to achieve net-zero carbon certifications by 2020, transitioning to 100% renewable energy sources by 2022, and working with its suppliers to set their own emissions targets. Salesforce has also invested in Salesforce Sustainability Cloud for tracking, analyzing and reporting climate change metrics across sectors.

Retail

Retailers have complex supply chains with vast networks of suppliers across sectors and geographies. In order to make the most efficient and effective steps toward net zero by 2050, all retailers should start by assessing their own Scope 1 and 2 emissions to know their climate impact, and then assess or estimate their Scope 3 emissions from across their value chain to get the full picture. Creating a holistic, multi-year GHG reduction pathway to net zero GHG impacts by 2050 based on those assessments will give these companies the best shot at meeting their commitments and staying on track.

If there are emissions that will take more time to abate through new technologies or solutions that aren't technologically or economically viable today, our recommendation is to invest now in high-quality carbon credits to offset that impact with a focus on the most urgent climate actions such as preventing tropical deforestation and reducing near-term methane.

Retailers must also develop a clear policy approach to match and accelerate their 2050 strategies, as many of the solutions they will need to implement — from zero-emissions transportation to green buildings — require broader incentives and investment to make them widely available and affordable to implement. **The AAA framework for climate policy leadership provides guidance on advocating for policies consistent with net zero, aligning the work of your trade association's climate policy with those same goals, and allocating spending accordingly.**

Retail: prioritized five-year action plan on pathway to net zero

SBTi-approved science-based goals: Lead | Invest | Advocate

Now

- Assess your Scope 1 and 2 emissions to know your annualized climate impact
- Assess or estimate your Scope 3 value chain emissions to get the full picture
- Create holistic multi-year GHG reductions pathway to net zero emissions impacts by 2050 (or earlier!)
- Invest in high-quality carbon credits to negate emissions that you cannot currently mitigate, with focus on the most urgent climate actions such as preventing tropical deforestation and near-term methane reduction
- Develop clear policy approach to match and accelerate your net zero by 2050 Strategy using AAA Policy Framework for Climate Leadership

By 2023

- Incorporate net zero goals into all supplier/ sourcing protocols
- Embed green freight practices on pathway to all zero emissions vehicle fleets
- Incentivize sustainable behaviors for employees and customers
- Develop circular product and packaging solutions
- Retrofit buildings and upgrade equipment, as necessary
- Support climate and circular economy policies
- Champion broad retail industry support of climate-friendly policies and practices

By 2025

- Require all major suppliers to develop pathway to net zero by 2050 and encourage all suppliers to follow suit
- Automate product detail transparency for customers
- Invest in innovations required to cut CO_2 emissions in half by 2030
- Eliminate single-use products and packaging in favor of recyclable, renewable and reusable options
- Re-evaluate and refine your AAA Policy Framework for Climate Leadership to support critical policies that activate and incentivize climate-friendly practices from your supply chain partners

Sources: EDF Green Freight Handbook; EDF Roadmap to Sustainable E-Commerce; Exponential Roadmap

Retail: net zero by 2050 pathway

	Near-term actions (2020-2025)	Mid-term actions (2025-2030)	Long-term actions (2030-2050)
Scope 1	• Retrofit existing buildings (e.g., lighting) • Upgrade equipment to more efficient appliances (e.g. refrigeration, kitchen equipment) • Purchase low-carbon fuel alternatives (e.g., biofuels, ZEV, low-carbon refrigerants) and pursue green freight practices (see EDF Handbook)	• Implement waste-to-energy solutions • Increase use of zero emission vehicles in owned fleets • Continue to purchase low-carbon fuel alternatives for existing vehicles	• Achieve fully zero emission vehicle fleets • Incentivize sustainable behaviors to offset remaining emissions in operations
Scope 2	• Increase purchase of renewable energy and consider opportunities for onsite, as appropriate • Pursue low-carbon heating and cooling	• Switch to all renewable energy (mix of onsite and offsite)	• Support the increased adoption of renewable energy for suppliers and customers
Scope 3	• Conduct Scope 3 assessment and set targets • Support circular economy commitments to drive down GHG impacts • Develop systems to support supply chain transparency and signal importance of GHG reduction • Collaborate with, encourage or support suppliers to set science-based targets • Purchase high-quality carbon credits for remaining emissions (for Scope 1, 2 and/or 3) • Engage consumers to purchase more sustainable products.	• Refine and add clear requirements around supplier transparency • Collaborate across industry to set supplier standards	• Partner with suppliers with proven low- or zero-emission capabilities and pathways to net zero

Retail: net zero by 2050 pathway

	Near-term actions (2020-2025)	Mid-term actions (2025-2030)	Long-term actions (2030-2050)
Invest	• Pursue greater digitization across activities to increase material and energy efficiencies • Sustainable aviation fuel projects to drive down emissions associated with air transport of goods	• Invest in circular products and packaging • Invest in low-carbon construction materials • Push toward full-scale implementation of building automation for reduced energy use	• Invest in fully zero emission vehicle fleets • Invest in technologies for buildings to produce their own energy
Advocate	• Establish climate policy advocacy plan in line with AAA Framework for Policy Leadership	• Advocate for grid decarbonization policies and near-term ag methane reduction (food retail) • Support incentives for circular economy solutions	• Support and incentives for zero-emissions construction and transportation • Support and incentives for circular economy

Retail: examples

SBTi-approved science-based goals: Lead Invest Advocate

amazon

Amazon is taking a multi-faceted approach to achieving its net zero carbon emissions by 2040 target. Amazon is electrifying their delivery fleets and deploying 100,000 electric vehicles by 2030, powering its global infrastructure with 100% renewable energy by 2025, and investing in credible carbon offsets. Moving beyond its own walls, Amazon has committed $2B in founding the Climate Pledge fund to invest in companies developing products or services that reduce carbon emissions.

IKEA

IKEA aims to become climate positive by 2030, reducing more GHG than it emits, without purchasing carbon offset credits. IKEA will systematically tackle GHG emissions reduction across its value chain, including reductions in GHG emissions by 2030 in retail and operations (80%), food (25%) and production (80%). IKEA is also funding and engaging in global projects to establish global standards for measuring carbon removal and storage.

P&G

P&G committed to achieve carbon neutrality in its operations by 2030. In addition to purchasing carbon credits, the consumer goods company is transitioning to 100% renewable electricity. P&G is also advocating for carbon pricing policies in the U.S. and engaging with trade groups to increase awareness of climate change impacts.

Walmart

Walmart targets zero emissions by 2040 without the use of carbon credits across its global operations through renewable energy, a zero-emissions transportation fleet, low-impact refrigerants for cooling and electrified heating equipment. The company is also working with suppliers through its Project Gigaton initiative to avoid one gigaton of greenhouse gas emissions across the global value chain by 2030.

TESCO

The British retailer has a goal to achieve net zero carbon emissions in their operations in 2050. Tesco will continue to invest in energy and refrigeration efficiency, which has already achieved 40% reduction in emissions per square foot in stores and distribution centers. Tesco is also aiming for a 25% and 15% decrease in manufacturing and agriculture suppliers, respectively, by 2030.

Sainsbury's

Sainsbury's, a UK grocery retailer, has committed to achieving net zero carbon emissions by 2040. Sainsbury's will continue its journey to Net Zero through increasing its use of renewable energy, improving the efficiency of its refrigeration, and switching 20% of its fleet to alternative fuels by 2025. Sainsbury's also plans to invest £1B ($1.3B) in sustainability programs with a focus on carbon emissions reduction and other initiatives.

Conclusion

Reaching net zero by 2050 and building a sustainable, more equitable and more prosperous future will require **unprecedented leadership from the private sector**. This report focuses on the essential step of championing net zero in your own business by setting and meeting science-based targets and signaling demand to suppliers for products and services that align with net zero goals. But reaching net zero by 2050 will also require:

1. Collaborating across industries and sectors. Engaging with outside stakeholders (e.g., nonprofit organizations, policymakers or investors) can scale solutions, drive down implementation costs, and reduce barriers such as technical requirements.

2. Investing in short- and long-term solutions as an individual company and as an industry, where pre-competitive coalition building with other industry players can scale solutions more quickly. Most pathways to net zero by 2050 require investment in new technologies and innovations.

3. Setting a science-based policy agenda that aligns with the **AAA Framework for Climate Policy Leadership**. Advocating for policies consistent with achieving net zero emissions by 2050, aligning your trade associations' climate policy advocacy with this same goal and allocating advocacy spending can advance climate policies, not obstruct them.

Appendix:

Methodology, scope and approach

The EDF Net Zero Industry Pathways project, prepared with support from Deloitte, is a meta-analysis of what is required to achieve net zero emissions by 2050 across four sectors in the U.S. For the purpose of this project, we are defining meta-analysis as a study that takes into account a range of other work done in the area and combines it into one report.

The goal of the study is to review the most comprehensive work completed to date on net zero pathways and provide directional pathways to net zero emissions by 2050. The focus of the analysis will be one of the most meaningful and actionable levers that companies can pull to move the needle towards a net zero future for their company and sector.

Geographic parameters

Global elements

The study will include global context on how the two in-scope sectors (transportation and agriculture) and two in-scope industries (retail and technology) contribute to global GHG emissions and the high-level requirements for each sector to chart a path toward net zero. Additional global insights will be included, as available and differentiating, in the sector pathways to net zero.

Some of the most robust studies on country-level and industry-level pathways to net zero have been developed in the European context (e.g., the U.K. Government's Report on "Industrial Decarbonization and Energy Efficiency Roadmaps to 2050: Food and Drink"). These will be used to identify key levers and translated to the U.S. context as part of the meta-analysis.

U.S. elements

The forward-looking net zero pathways will be focused on how to achieve net zero while operating within the context of the United States. This will allow for more specificity in the discussions on costs and policies, which can vary widely across geographies. Individual corporate case studies will be taken from the United States, where available. Case studies from other geographies will be included, as needed, to provide additional insights.

Sector definitions and parameters

Transportation

The transportation sector will be defined inclusive of air, intermodal transportation and logistics, road, rail and marine movement for passengers and cargo, as well as the support services of those modes of transport. The sector aligns with industry NAICS codes 48-49, covering Transportation and Warehousing.

Retail

The retail sector will be defined as the final step in the distribution of merchandise and includes retailers operating brick-and-mortar locations and non-store retailers operating via mail order, door-to-door, kiosks and the internet. Merchandise sold by retailers is purchased from suppliers and is then sold to end consumers (individuals or businesses) though the retailer's store or other mediums.

The sector aligns with industry NAICS codes 44-45, covering Retail Trade. There are times when we will also refer to the CDP retail categories, including convenience and discretionary. Convenience retail includes hypermarkets, superstores, supermarkets, food and drug stores, while discretionary retail includes apparel, department, discretionary retail and specialist retail.

We will focus on retail to individual end consumers as compared to business-to-business wholesaling, outside of the food and technology wholesaling referenced below. We will note where studies that we use are inclusive of business-to-business (B2B) interactions.

GHGs associated with transportation is a significant part of the retail emissions story, and any pathway to net zero will need to take the movement of goods into account. While the emissions associated with that part of the value chain will overlap with our study of the transportation sector, we believe it is important to keep it in the retail pathway as well so that the retail pathway findings can stand on their own. Retailers that review the materials should be able to see how critical the transportation lever is to achieving net zero relative to the other elements of their operations and value chain.

Technology

The technology sector includes actors across a range of hardware and software industries, including manufacturing and wholesaling activities. Hardware sub-sectors includes computer, semiconductor, circuit, circuit board and electronic manufacturing as well as computer wholesaling. Software sub-sectors include software publishing and wholesale.

The sector aligns with industry NAICS codes 33411a/b, 33441a/b, 42343, 51121, which sit underneath the broader manufacturing, wholesaling and information industry groupings, respectively.

Agriculture

The agricultural sector will be defined inclusive of the agricultural sector (including farming, fishing, hunting and agricultural support services) as well as food production and processing. Those activities most closely align with US NAICS codes 11, 311XX, 42441 through 42452, and 72, respectively. The food analysis will exclude food retail locations since those will be included in the retail sector analysis.

While forestry is often grouped into US NAICS code 11, our study will be exclusive of forestry products. We also plan to exclude lodging and rubber taping and tobacco from the study, though they fall under the CDP food, beverage and agriculture industry grouping.

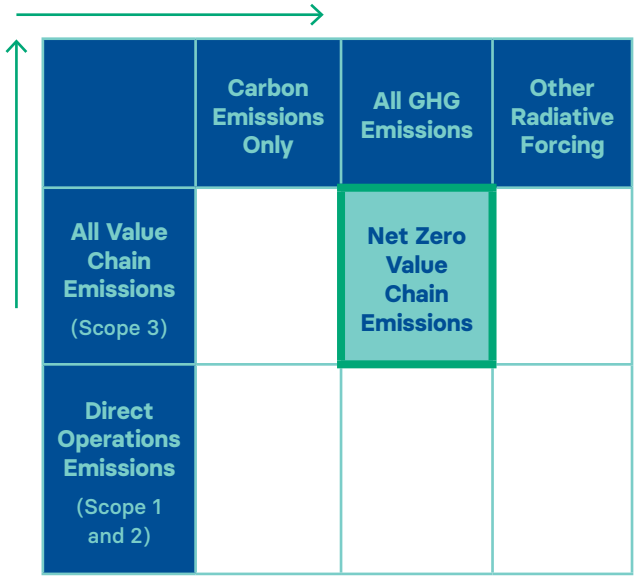
More detailed work on the net zero pathway for animal proteins (farming and processing) is covered in a separate EDF and Deloitte 2020 study. Our industry-level analysis will sit above that detailed analysis.

Emissions parameters

Scope of Activities Covered

For each of the sectors, we will be studying the direct emissions created by those sectors as well as the emissions created by their upstream value chains.
Using a framework adopted from the Science-Based Targets Initiative (SBTI), we would like the analysis of current state emissions and pathways to net zero to be inclusive of the following elements wherever possible:

- Direct Operations (i.e., Scope 1 and 2)
- Value Chain Emissions (i.e., Scope 3)



This study will exclude product lifecycle analysis, or the study of embedded emissions within products and services in these sectors. While this type of analysis is critical in understanding the relative environmental impact of similar products and services, it will remain outside of this project's scope other than referencing where those type of emissions fit into the relative impacts of a given sector.

Scope of Climate Forcers Covered

The study will focus on all GHGs, inclusive of carbon dioxide, methane and other GHGs. The analysis will not cover other radiative forcing, which, per the framework adopted from the SBTI, is required to make claims of "climate neutral" companies or value chains as compared to achieving "net zero" companies or value chains.

Climate scenarios

This study is anchored on industry-specific pathways to net zero emissions by 2050. While not directly linked to the Intergovernmental Panel on Climate Change (IPCC) recommendation to limit global warming to no more than 1.5° by 2050 to stave off the worst impacts of climate change, we will be referencing and overlaying many of the mitigation pathways compatible with this IPCC recommendation.

Some of the key climate and emissions scenarios referenced will be from the **Intergovernmental Panel on Climate Change (IPCC)** and **International Energy Agency (IEA)**.

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