Can Carbon Intensity Metrics Help Achieve Net Carbon Reductions?

By Miguel Jaller and Scott Matthews, June 2021

Abstract

Various global efforts have led to calls to reduce greenhouse gas (GHG) emissions to mitigate the effects of global warming. The most recent action, the Paris Agreement, seeks to reduce GHG emissions to limit warming to no more than 2 degrees Celsius by 2050.

As a result, different entities (e.g., countries, industries and companies) have been quantifying their GHG emissions and setting reduction targets to meet these goals. The measures used to track emissions and reduction performance vary, but include total emissions as well as intensity-based metrics such as carbon emissions per unit of GDP or revenue. Both approaches have value when trying to reduce emissions, though, there are key differences between them. While total emissions are important because of the need to reduce overall emissions, they do not speak about the efficiency of the entity in its use of resources, and whether changes in total emissions are due to positive or negative economic growth, for example. On the other hand, intensity-based measures provide an indication of such efficiency, and although having intensity improvements do not guarantee reductions in total emissions (at least in the short term), they indicate a trajectory (i.e., they show whether an entity is emitting less for a unit of output or not) or allow evaluating investments needed to decarbonize. Moreover, comparing intensity-based measures with economic growth helps to identify if entities are decoupling their economies to eventually drive absolute decarbonization.

In this paper, we analyze reporting by countries and the private sector to evaluate the role of carbon intensity as a metric for tracking emissions over time, to help entities determine progress towards emission reduction goals, and to identify approaches to evaluate fast growing countries' and companies' path to carbon reductions. The analyses show the benefits of intensity-based metrics, especially for entities experiencing rapid growth. These entities generally need to make significant capital investments (e.g., infrastructure, processes, equipment) that may not have a short-term payoff with respect to carbon reductions. Therefore, tracking intensity-based metrics can provide evidence of the effectiveness of such investments; the metrics could be used to set targets or as criteria during investment decisions; and they can help anticipate future carbon emissions.

Overall, the long-term focus needs to be on reducing total emissions. Concentrating only on reducing carbon intensity is insufficient. In the interim, net reduction targets can serve as the lever to identify the magnitude of intensity-reduction requirements needed, especially for fast-growth entities.

1 Introduction

As global awareness of the relevance and importance of greenhouse gases (GHGs) has increased in the last few decades, pressure has grown for entities to quantify their emissions. To effectively manage and reduce emissions, credible estimates need to be gathered that identify the GHGs emitted, as well as quantifying the volume of releases for those entities that cause them.

Previous general discussions about the need to reduce global carbon emissions in the future have become more focused in recent years, such as the Paris Agreement call to substantially reduce global emissions to keep average temperatures from increasing beyond 2 (preferably 1.5) degrees Celsius this century. Achieving such an outcome will require action by various entities such as individuals, companies, industries, cities and countries.

Entities generate emissions from a wide range of direct and indirect processes, including but not limited to the generation of electricity, physical or chemical processing, transportation, use of products or services, and waste disposal, among others. In addition to carbon dioxide (CO_2), various other chemicals are classified as GHGs when emitted. The Kyoto Protocol also considers methane, nitrous oxide, sulfur hexafluoride, and various forms of hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs) as GHGs. While the combustion of fossil fuels is the majority source of global GHGs, other non-combustion and natural activities also lead to emissions.

Generally, entities concerned about their GHG emissions need to quantify all of these substances, and many follow reporting protocols with set guidelines and also have third party verification of emissions. A number of these entities have been taking (unilaterally, voluntarily or mandated) action to reduce their GHG emissions, for example by participating in global treaties (i.e., the Paris Agreement goals of carbon reduction), industry target-setting, corporate-led initiatives, and compulsory programs, among others. Such activities typically commit an entity to a target to reduce its future 'total carbon emissions' or 'carbon footprint' against the emissions levels of a year in the past (i.e., a 20% reduction from 2000 GHG emissions levels by 2030), or to improve process efficiency to generate less (i.e., 25%) emissions per unit of output or "carbon intensity."

While some of these are laudable targets, it is important to recognize that the shapes and forms of these targets are rather different, as well as their outcomes. One of the main sticking points of global negotiations on carbon reduction is how to set goals for developing countries that are growing fast vs. developed countries that are established and growing much more slowly. The developing nations have argued convincingly that they should be judged on reducing their carbon intensity, rather than simply on reducing their total carbon.

This idea is also relevant for large entities in dynamic and fast-growing industries, for which evolving market conditions, complex corporate structures, and the very nature of their growth generate the need to develop appropriate measures that reflect such behaviors, and more importantly, allow them to incorporate technological innovation and economic transitions in their quest for decarbonization.

Consequently, the objective of this paper is to provide a general understanding of approaches to tracking carbon emissions, including a discussion of metrics and methods with examples, and pathways towards global decarbonization. The paper will provide discussions both general and specific to fast-growth companies, with examples and market trends, focusing on carbon intensity reductions.

2 Metrics and Methods Used to Track Carbon

Various metrics have been developed over time to help to measure GHG emissions for entities, and entities can choose which to use in their reports, or the data they provide.

Carbon Footprint (Total Emissions)

The most basic and common metric used to express GHG emissions by an entity is to quantify the **total GHG emissions, also known as the carbon footprint**, which is typically measured by adding up all of the carbon-equivalent GHGs emitted. The Intergovernmental Panel for Climate Change (IPCC) studies which chemicals act as GHGs (i.e., which when emitted to the atmosphere can lead to warming). IPCC has also promoted the use of a weighting function to convert all GHG emissions into equivalent emissions of carbon dioxide (CO_2), the most prevalent greenhouse gas. The weighting function prescribed by IPCC uses so-called global warming potential (GWP) values to convert emissions of all GHGs to equivalent emissions of CO_2, also called CO_2-equivalents or CO_2e. GWP refers to the ratio of radiative forcing resulting from the emission of one kilogram of a GHG compared to the emission of one kilogram of CO_2 over a period of years. While IPCC lists about 25 chemicals as GHGs, most global emissions come from CO_2 (~82%), methane (CH4) (~10%), and nitrous oxide (N2O) (~6%)[1,2]. The GWP values used when considering emissions of methane over a 100-year period are 28-36, and 265-298 for nitrous oxide for a 100-year timescale (IPCC 2013 - AR5). Overall, when entities measure and report their carbon footprint, they are reporting total emissions in units of CO2e.

The U.S. EPA has maintained an inventory of U.S. GHG emissions since 1990 (i.e., the carbon footprint for the U.S.). In that time, emissions have increased from 5.1 billion metric tons (mt) of CO_2e (also referred to as 5 billion mt CO2e), to about 6.1 billion mt CO_2e in 2005, and then decreased to about 5.2 billion mt CO2e in 2019[3]. Emissions from most U.S. companies and industries have generally followed a similar path, with early awareness of emissions, and emissions increasing over time, but beginning to reduce in the past 5 years. However, CO2e emissions from transportation have not reduced over time, increasing from less than 1.5 billion mt in 1990 to more than 1.8 billion mt in 2019 (EPA, 2021).

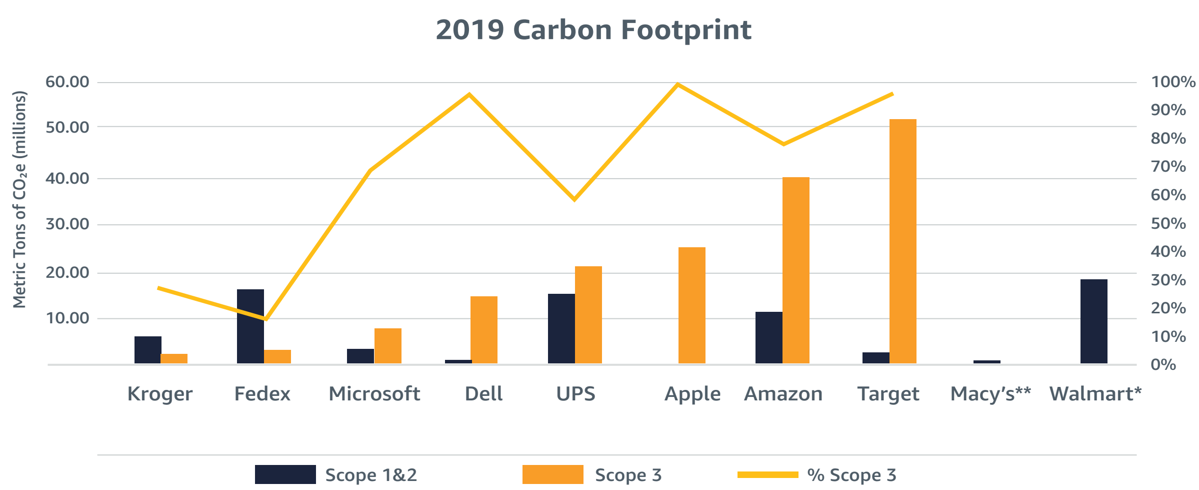
Total emissions can be detailed in various ways, and a variety of boundaries have been drawn to help emphasize the broad role that entities have in generating GHG emissions. A popular categorization used by companies and industries is the use of increasingly encompassing "Scopes," as developed by the World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD). The general definition of Scope 1 emissions is emissions that occur under the direct control of an entity. For example, a company that owns factories that burn fuels and generate carbon dioxide are releasing Scope 1 emissions. Scope 2 typically adds the emissions associated with the direct consumption of purchased energy (but where the generation of that energy does not happen at the site of the entity). For example, a company that uses electricity for their factories causes Scope 2 emissions to occur. Finally, Scope 3 relates to all other upstream and downstream emissions associated with an entity's activities, although entities reporting Scope 3 emissions do not generally include all possible up and downstream activities. Common upstream activities are other supply chain purchases such as the manufacture of materials and the subcomponents of inputs to a factory. Common downstream activities are the use and disposal of products

[1] Source: https://www.ssga.com/library-content/pdfs/insights/carbon-footprinting-an-anvestor-toolkit.pdf
[2] Source: https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks
[3] Source: https://www.epa.gov/sites/production/files/2021-04/documents/fastfacts-1990-2019.pdf.pdf

made by a company. So-called "Scope 3 inventories" track emissions across all 3 Scopes and are typically noted on a total mt CO_2e basis.

For companies that want to voluntarily disclose GHG emissions, the most popular global GHG registry currently is CDP. CDP manages data for more than 5,000 companies around the world that report Scope 1, Scope 2, and/or Scope 3 emissions. Practically, the data consist mostly of large companies who can more easily afford the expenses associated with the collection and reporting of emissions data and contract services for third-party verification. Smaller or medium-sized companies may not be spending the same amount of resources to track and report their emissions. To add to the multiplicity of reporting methods, there are also several carbon reporting verification standards[4].

As the Scope boundaries are expanded, more emissions are represented. To give context to this, the figure below compares estimated Scope 3 emissions versus Scope 1+2 emissions for selected companies in the tech, retail, and logistics industries. Scope 3 emissions are generally far higher for most companies across different industries, except for industries that are fossil-fuel intensive in their direct activities, such as materials and utilities.



Source: Company Websites and Reports

Emerging Carbon Metrics

Total carbon emissions (e.g., in mt CO2e as listed above) are not the only metric used to track GHG emissions, in part because reporting a total number gives little insight into other aspects of the entity, such as whether it is growing or becoming more efficient. The most common metrics are measures of **carbon intensity (CI)**, which generally track total carbon emissions divided by some activity. Commonly used activity measures include both physical like total units of production, or economic. As a physical activity example, in the electricity generation sector, a common intensity metric is CO2e emitted per kilowatt-hour of electricity generated (mt CO2e/kWh). The use of economic activities such as Gross Domestic Product (GDP) (for countries) or revenues (for firms) have been adopted and promoted by groups such as S&P Dow Jones in their CI indices. For financial services and investment analysis, a common intensity is GHG emissions per unit of revenue (e.g., mt CO2e/dollar of revenue). Financial metrics can be

[4] Source: https://www.cdp.net/en/guidance/verification

Note: *, ** No Scope 3 data available. Walmart reports that Scope 3 emissions represent about 90% of emissions (https://www.walmartsustainabilityhub.com/media-library/document/project-gigaton-accounting-methodology/_proxyDocument?id=00000165-159f-d0cc-ab77-95ff84350000).

generally used across many entities, while those that use physical units are most useful to aggregate or compare across businesses and industries with common products. Generally, these CI ratios normalize environmental impact data against business performance or activity (either for fast-growing or shrinking businesses) and allow for benchmarking and performance analyses. CI ratios, when reported in addition to total emissions, represent a valuable way to track carbon performance, and whether companies are "decoupling" their business growth from their carbon emissions.

The inverse of CI ratios, known as **productivity or efficiency ratios**, express the output as a function of the GHG impact (e.g., revenue per GHG). Other related metrics, include **percentage indicators**, which express the relationship between two similar outcomes, for example, the change in emissions from the current year compared with a reference year (e.g., 20% GHG reduction in 2020 compared to 1990).

The potential concern with efficiency-based metrics and targets is that while they may provide indications of a trajectory, they do not guarantee eventual reductions in net emissions, which will be required globally. However, they are a valuable tool that provides an indication of current intensity trajectories; the bottom line is that they do show whether an entity is emitting less for a unit of output or not. It is hard to imagine the case in which an entity could sustain or increase economic growth and achieve total carbon reductions without a clear path of CI reductions. Likewise, as mentioned above, decoupling means that a decreasing carbon footprint for a company or industry in decline is not a significant achievement.

Whether total carbon footprint or CI, these metrics are used by entities for various purposes such as reporting and verification for programs such as the U.S. EPA Climate Leaders, WWF Climate Savers, the World Economic Forum's Global GHG Register, the EU GHG Emissions Allowance Trading Scheme, the European Pollutant Emission Registry and Respect Europe, among others. Additionally, they are key for setting improvement targets.

Using Metrics to Set Targets

While many entities are pursuing carbon reduction targets, the most common targets are being set based on total carbon emissions (also referred to as reducing "absolute" emissions). However, various entities are pursuing reductions in CI as opposed to exclusively pursuing absolute carbon emission reductions. An example of this is the carbon reduction targets of those developing countries that are experiencing large growth; for instance, instead of committing to total emission reductions in the short term, China committed to reducing CI, and then more recently transitioned to total emission reductions. What this means practically is that while their overall emissions may continue to increase, given the continuing growth of the economy, they are trying to reduce emissions per unit of GDP. Consequently, their country will trend to being more carbon efficient, but meanwhile emissions may continue to increase, albeit at a lower rate. The argument is that if they had to commit to trying to reduce emissions while still growing the economy at a much higher rate than other economies, it would be not only a highly difficult task, but an inequitable one.

Overall, targets based on total carbon emissions seek to reduce a specified quantity of GHGs, which can generate net reductions of emissions to the atmosphere. These targets can be perceived as environmentally robust, generating trust from multiple stakeholders as the target outcomes are absolute targets, not relative ones. However, total carbon emission-based targets do not provide information about the efficiency and intensity of the operations involved with respect to their carbon emissions. That is, even under very inefficient systems (i.e., higher emissions per unit of output), total carbon emissions can decline if production and output declines (i.e., it could exemplify less business or less growth), rather than carbon reduction. This is of particular concern to fast-growth companies and sectors for which production and output are expected to increase. Without a way to decouple its emissions trajectory from its projected growth, setting net reduction targets can be seen as hampering growth, especially if the CI improvements are not sufficient to compensate for the net increase resulting from growth.

3 Carbon Data and Trends

Data

Inventory data from entities interested in disclosing their GHG emissions may be directly released to the public periodically (e.g., through annual environmental, social and corporate governance-ESG-reports), and may also be submitted to GHG disclosure registries. Such registries have existed for more than a decade and provide online access to inventories submitted by an entity over time. Submission of this data may be mandatory or voluntary. There are several guidelines and standards for reporting, such as those set forward by the GHG Protocol[5], Global Reporting Initiative[6], the Sustainability Accounting Standards Board (SASB)[7], and the Task Force on Climate-Related Financial Disclosures[8], among others.

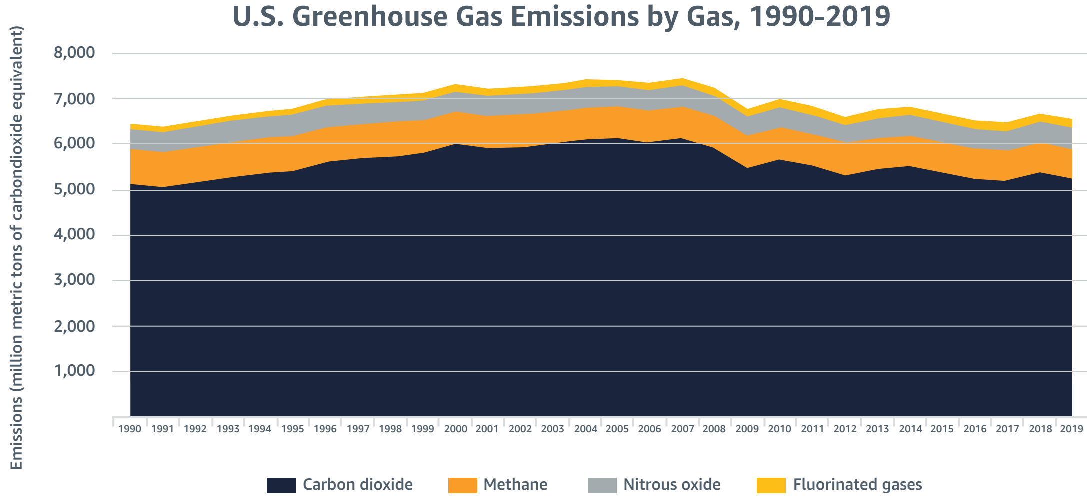
For U.S. companies, the GHG Reporting Program (GHGRP) registry[9] is managed by the EPA and requires only facility emitters from specific industries to annually report their GHG emissions. The GHGRP predominantly includes facilities related to power plants, petroleum and natural gas companies, refineries, chemicals, waste, metals, minerals, pulp and paper, miscellaneous combustion, electronic manufacturing, suppliers of natural gas and natural gas liquids, and electrical equipment production and use. Retailers and wholesalers are mostly not included. Since it is a facility-level program, GHGRP cannot serve as a registry of total emissions from companies, as companies may have activities in other areas that do not have submission requirements.

For countries, there are various online data sources for country-level inventories, which may be based on direct reports from countries or on estimates from NGOs. The prime example is the United Nations Framework Convention on Climate Change (UNFCCC), which has information on GHG emissions of all countries from 1990 to 2018 (the most recent consistent inventory year available). While not for whole countries, CDP manages data submitted by more than 800 cities and more than 100 regions around the world that are pursuing climate reduction targets. It is important to recognize that the various GHG registries mentioned above do not always include Scope 3 emissions.

Global Trends

Resulting from the various reporting efforts and registries, aggregate data is accessible to identify some trends in overall carbon footprints. The figure below shows total GHG emissions emitted in the US in the past 30 years.

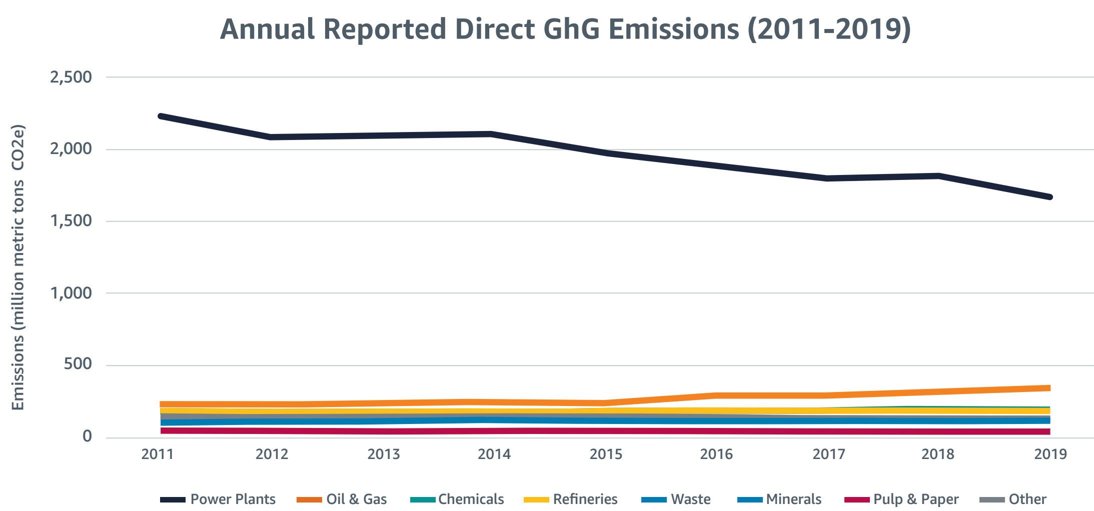
[5] Source: https://ghgprotocol.org
[6] Source: https://www.globalreporting.org/standards
[7] Source: https://www.sasb.org
[8] Source: https://www.fsb-tcfd.org
[9] Source: https://www.epa.gov/ghgreporting/ghg-reporting-program-data-sets



Source: U.S. Environmental Protection Agency[10]

Emissions were generally increasing by about 1 to 2% per year until about 2004 (with a slight declining trend in growth after 1997), when they flattened, and subsequently have generally declined since the great recession. The latter is important, as it evidences the direct connection between emissions and economic activity, which is relevant to the discussion in this paper about emissions and the CI of industries and companies experiencing fast growth. Economic contraction during the great recession impacted manufacturing, industrial, and commercial activities, thus significantly decreasing emissions. After 2010, there seems to be a lack of convergence in the rate of change of U.S. emissions, showing the initial decoupling of the U.S. economy from its GHG emissions.

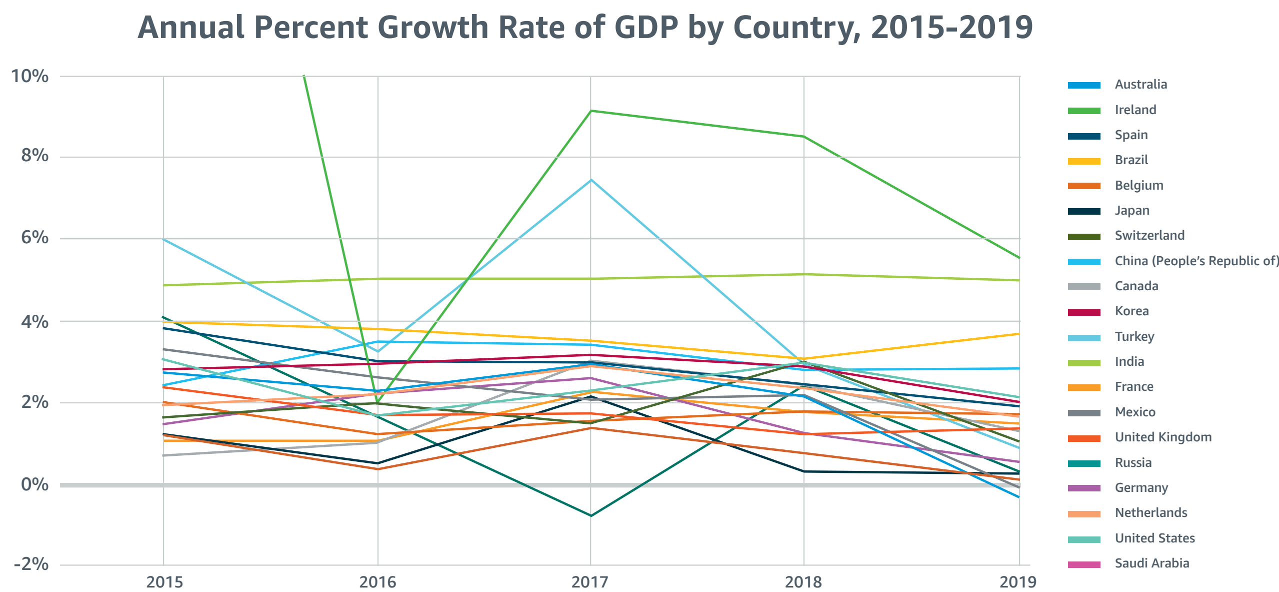
During this period, various industries in the U.S. have experienced diverse growth, which could be one of the reasons for such variance, in addition to reductions in CI and emissions from energy sources. For example, the following graph shows a high-level comparison of carbon-intensive industry GHG emissions in the past decade. All of these sectors were experiencing economic (and output) growth over this time. The decarbonization of the electric power industry is apparent, and while less apparent, most other carbon-intensive industries in the U.S. are decarbonizing as well.



Source: U.S. Environmental Protection Agency, GHGRP Program[11]

[10] Source: https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks
[11] Source: https://www.epa.gov/ghgreporting/ghgrp-emissions-trends

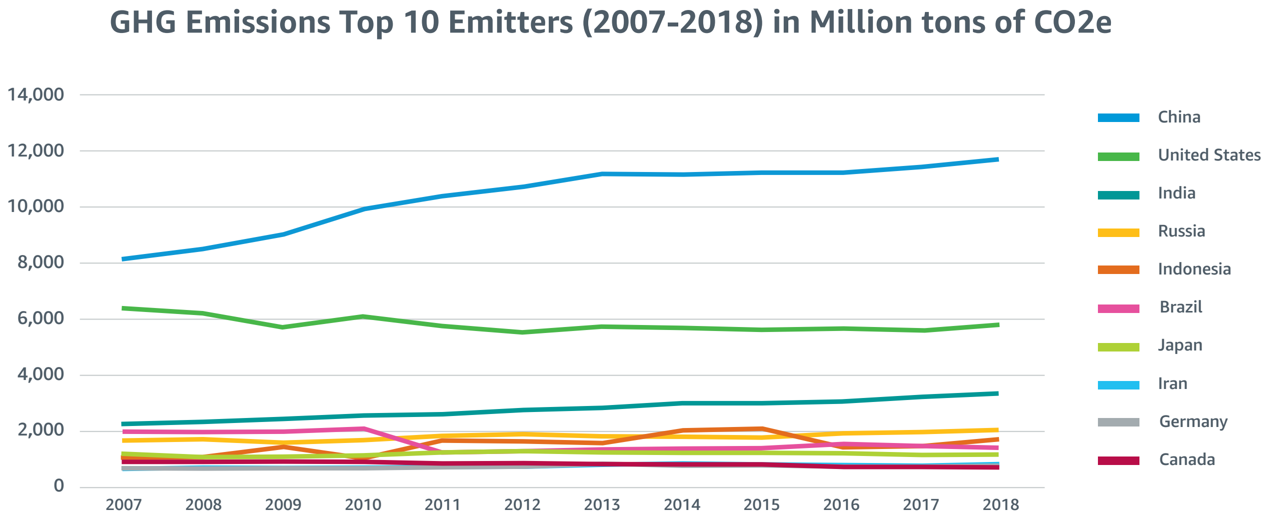
What can be seen at the global level is that GHG emissions have generally been increasing, and in aggregate, were almost 40 GT CO2e in 2019[12]. According to data from the World Bank and OECD[13], over the last 60 years, global average population growth has been about 2% (and is decreasing), and global economic growth has been about 3%. For many developed countries, a 3% growth rate is considered a typical and reasonable goal for an economy. However, developing countries are generally growing at rates higher than 3%. India and China have had economic growth of double or even triple the global rate for almost two decades. It is difficult to consider keeping emissions flat, let alone making progress on reductions (or at least at the same rate as the economic growth), when a country is still growing at a higher than average rate and making significant investments in physical infrastructure (e.g., buildings, highways, rail systems, etc.) to support higher standards of living for their people. While physical infrastructure is inherently carbon intensive, there are opportunities to "build better" in terms of infrastructure with lower carbon emissions (e.g., using low-carbon concrete). The figure below shows the growth in GDP for a sample of countries between 2014 and 2019. As shown, most countries are growing around the same (low) rate (with a slight declining trend in growth), with some outliers.



Source: OECD. Stat, GDP (Expenditure approach), Constant U.S. dollars[14]

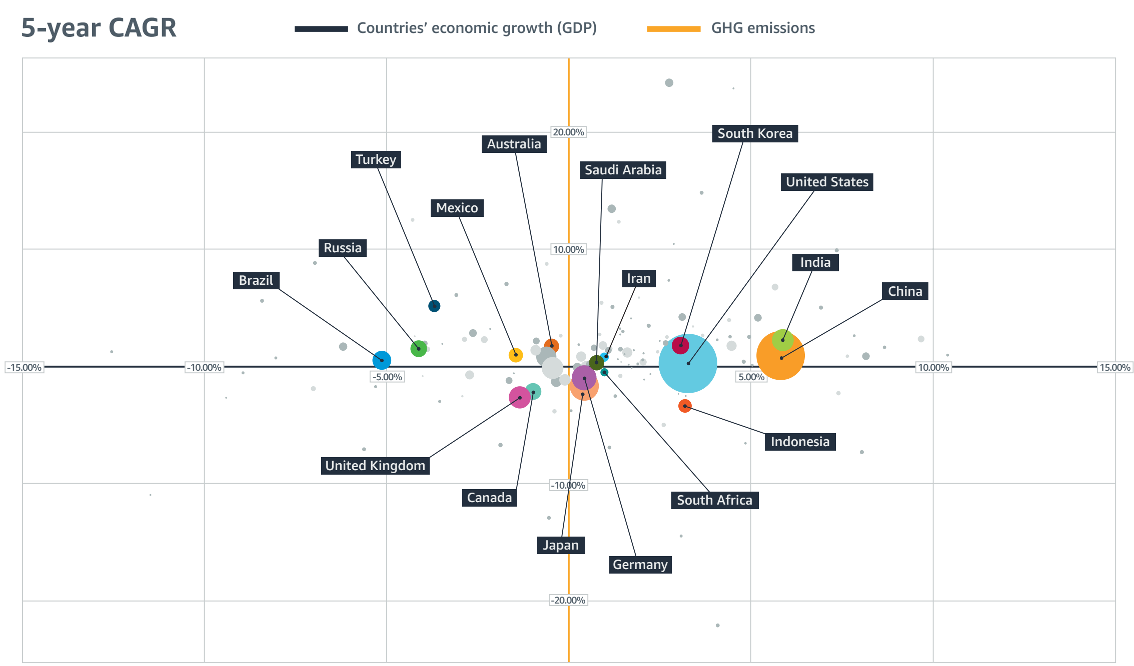
Many developed countries (including the U.S.) have had modest GHG reductions in recent years, but developing economies, most notably China, have seen continued increases in emissions along with its economic growth. The figure below shows absolute GHG emissions from 2007-2018 for selected countries. Most had relatively flat emissions, however, India and China showed noticeable, substantial increases (with the caveat that getting reliable data is easier from some countries than from others). These historical increases require context; specifically, that both countries serve as "factories to the world," and are making significant investments in infrastructure to support increases in their levels of production, and the associated ancillary systems (e.g., energy, transportation). In addition, part of their economic and carbon growth was fueled by taking production from other countries such as Japan and the U.S.

[12] Source: https://www.ipcc.ch/site/assets/uploads/sites/2/2019/06/SR15_Full_Report_High_Res.pdf
[13] Source: https://data.worldbank.org/indicator/NY.GDP.MKTP.CD
[14] Source: https://stats.oecd.org



Source: Climate Watch[15]

Overall, total (absolute) emissions do not consider how an economy is growing. The following graph compares the 5-year compound annual growth rate (CAGR) of countries' economic growth (GDP in the x-axis), and the countries' 5-year CAGR with respect to total GHG emissions (y-axis). The size of the circle is based on the relative value of the GDP in 2018. The graph shows a larger concentration of countries that have not decoupled their economies (top right), though, the closeness to the x-axis indicates that their economic growth is slightly larger than emissions patterns. There are also a handful of countries (lower right) that have managed to increase their economy over the last 5 years, while at the same time decreasing emissions. On the contrary, there are countries in the left half of the graph which have exhibited a negative economic growth, with worrisome countries in the top left quadrant as they have experienced an increase in emissions under a negative economic growth.

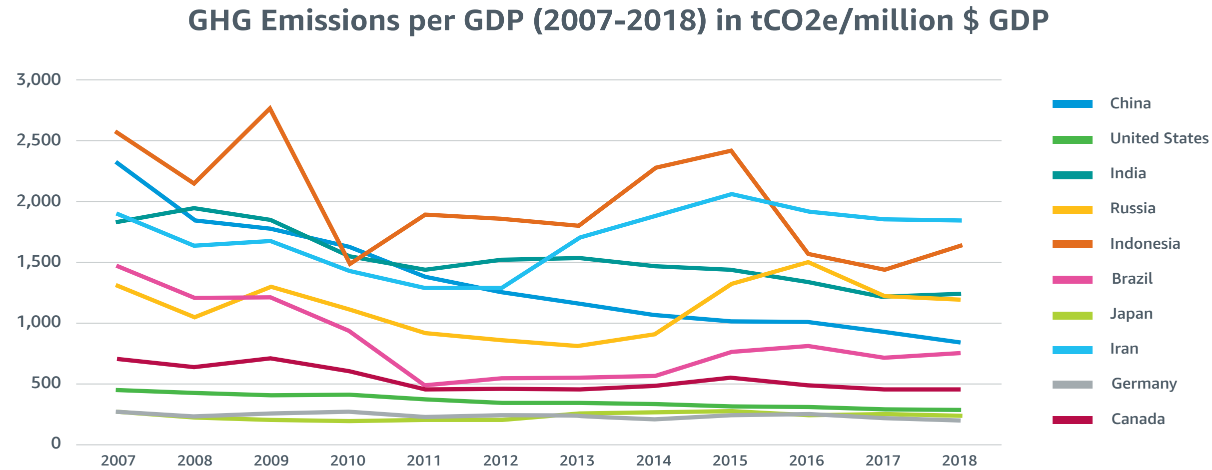


Source: Climate Watch[16]

[15] Source: https://www.climatewatchdata.org/ghg-emissions?end_year=2018&gases=all-ghg&regions=TOP&sectors=total-including-lucf&-source=-CAIT&start_year=1990

[16] Source: Authors' estimate using GPD and GHG data from https://www.climatewatchdata.org/ghg-emissions?end_year=2018&start_year=2014

The following chart shows U.S. dollar GDP-adjusted emissions for the same "top emitting" countries (meaning that the CI was found in the home currency of each country and then converted to U.S. dollars in each year). In short, most countries' GHG emissions per-GDP are exhibiting a decreasing CI over time. Whether these intensity reductions are lower or greater than the rate of economic growth varies by country.



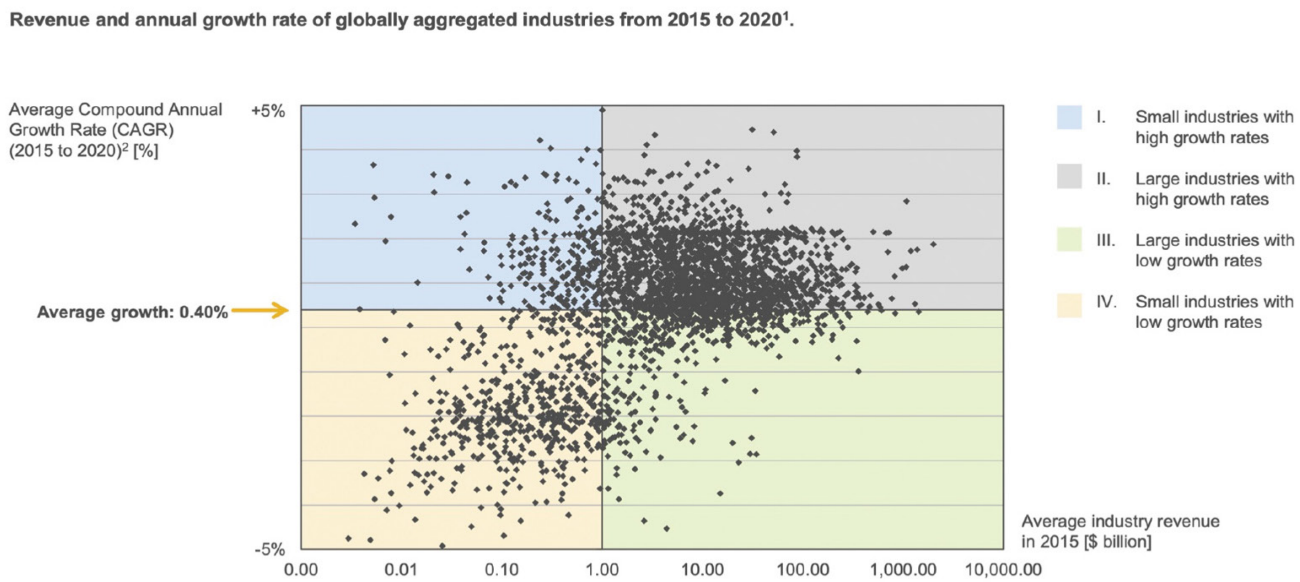
Source: Climate Watch[17]

Additionally, intensity improvements do not guarantee lower total emissions; intensity improvements are, however, a necessary, though insufficient, condition to achieving climate change reductions, as they only point towards an improvement trajectory.

Corporate Trends

At the corporate level, many long-established global companies have been reporting GHG emissions, including Scope 3 emissions, for many years. Consistent with the global and country level growth-related discussion, the same argument can be made for high-growth companies and industries. Across many industries globally, the average industrial growth has a historical 5-year (2015-2020) CAGR of less than 1% per year (see figure below). On the high end of the growth rates are industries with 5% growth per year, with larger (in revenue) industries having relatively higher growth rates. Companies or industries growing significantly more than 5% per year could be considered high-growth companies (a 5% per year growth rate would see revenue doubling in 14 years). Companies with low or flat revenue growth could likely see carbon emission reductions without much additional effort, compared to high-growth companies that have to decouple their emissions from growth.

[17] Source: https://www.climatewatchdata.org/ghg-emissions?calculation=PER_GDP&end_year=2018&gases=all-ghg&regions=TOP&sectors=-total-including-lucf&source=CAIT&start_year=2007



Source: Statista[18]

Large (in terms of market capitalization or revenue) companies in the U.S. are listed by the Fortune 500, which lists both large public and private companies, and the Standard & Poor's 500 Index (S&P 500), which includes the largest publicly-traded companies. Over the last 5-years, CAGR has been between 9% and 12%. Fortune also tracks the 100 "fast growth" companies, and these companies had a 3-year annual revenue growth rate of about 19%[19]. Companies like this are hard-pressed (either from internal decarbonization commitments or from potential external market or regulatory forces) to make substantial absolute reductions in GHGs while still maintaining such high growth. Similar to the example of China above, these fast-growth companies could benefit from having a parallel CI reduction strategy in the short term, while pursuing overall carbon emissions reductions in the longer term. The CI reduction strategy can help show and track progress, and as mentioned before, provide an indication of the trajectory towards absolute GHG reductions. This could also be a useful way of demonstrating the efficiency benefits of a low-intensity company taking market share from a higher-intensity company. That said, a company, whether in positive, negative or no growth, may or may not have low-intensity processes or sub-industries, thus affecting net emissions based on the type of market substitution.

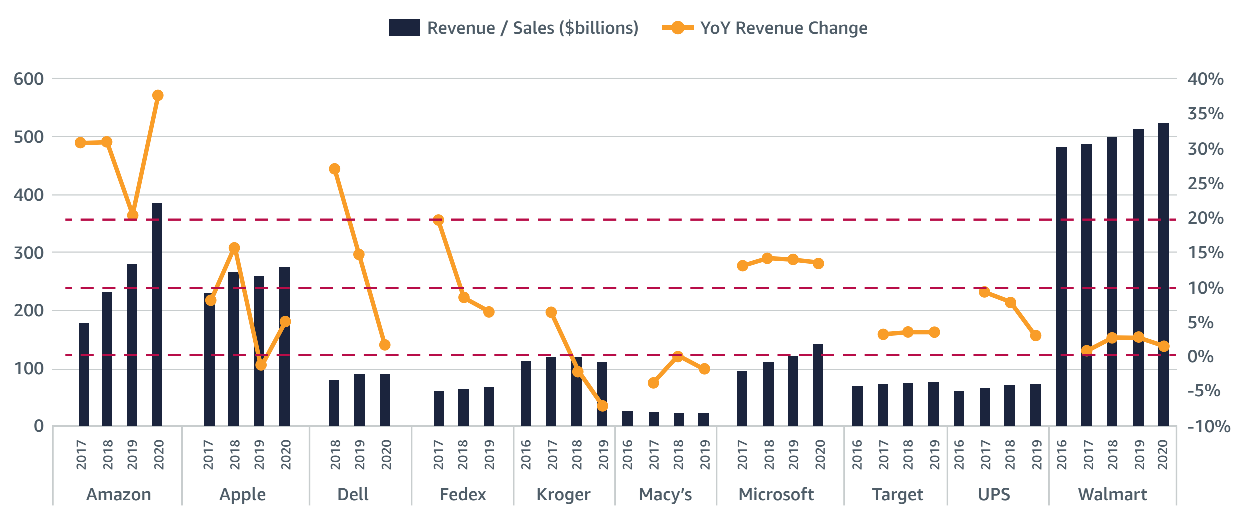
Recalling the discussion in the previous section, as various countries are experiencing higher than average growth, it motivates the thought that global companies may be generally reducing emissions except for operations in high-growth countries where they do business. On the other hand, companies regardless of growth could be implementing reduced carbon-intensity strategies and investments, even in countries that do not show a clear carbon reduction path. Further work is needed to assess the performance of companies of varying growth rates of doing business in countries with varying growth rates. Their relative performance in the different countries could be studied to see whether there were leading indicators of performance in reducing total emissions, or from an intensity perspective.

[18] Source: https://cdn.statcdn.com/static/promo/Statista_Global_Industry_Forecast_Summary_2016.pdf
[19] Source: https://fortune.com/100-fastest-growing-companies/

Measures and Investments

The use of absolute and carbon-intensity metrics has also been gaining significant interest from companies, investors, and financial institutions as a way of evaluating their exposure to carbon change risk, specifically, assessing the efficiency of investments, holdings, and processes with respect to climate risk[20]. In the financial sector for example, the Montreal Pledge[21] and the Financial Stability Board (FSB) have been promoting the use of climate-related risks and emissions reporting for risk management and to improve strategic planning. FSB established the Task Force on Climate-related Financial Disclosures (TCFD)[22] and has been providing financial disclosure recommendations that provide adequate information, and ultimately help inform capital allocation and investments, especially towards more sustainable and resilient business and operational models. Further, the TFCD defines four widely-adopted metrics, including: i) Weighted Average Carbon Intensity; ii) Total Carbon Emissions; iii) Carbon Emissions to Value Invested; and iv) Carbon Emissions to Revenue Intensity. Although developed to assess portfolios and investments from financial institutions, these metrics could also be used by companies in other sectors to assess and evaluate their internal projects and capital investments considering their total carbon or intensity outcomes.

CDP data of voluntarily reported GHG emissions from companies are not included in this white paper. Instead, we manually collected publicly available data from companies' sustainability reports and websites, financial reports to the U.S. Securities and Exchange Commission (SEC), and other secondary sources. We chose companies that: (1) are relevant to our discussion (i.e., have large, continuous growth), and from industrial sectors such as technology, retail and logistics; and (2) have been publicly reporting their Scope 1-3 GHG emissions for the past few years (e.g., via annual ESG reports). Overall, various companies have reported flattening or even decreasing GHG emissions. The chart below shows revenue history (annual, in the black bars) for selected comparable companies in the past four years.



Source: Company Websites and Reports

[20] Source: https://www.ssga.com/library-content/pdfs/insights/carbon-footprinting-an-anvestor-toolkit.pdf
[21] Source: https://montrealpledge.org/
[22] Source: https://www.fsb-tcfd.org/

Most companies are growing based on a revenue metric (orange lines, year on year revenue growth), with most having annual growth rates of less than 10%, or at most, 15% (as shown by the horizontal dashed lines). Likewise, based only on total (absolute) emissions, more than half of the companies' Scope 1 and 2 emissions are increasing. It is important to recognize that while most of these companies are still growing (in terms of revenue), their growth rates are, for the most part, declining or remaining flat, and only a few have growth rates above 10%. However, most of the companies have a positive growth rate, thus their corresponding decline in total emissions may be attributed to CI improvements, such as: Walmart's Project Gigaton[21] working along the supply chain to reduce emissions; Apple's[22] investments in 100% renewable energy use in its offices, retail stores and data centers (already achieved in 43 countries); Amazon's[23] commitment to The Climate Pledge to decarbonize its business with investments in cleaner energy, zero emission vehicles, and other developments; or UPS's'[24] developments in smart logistics, and the decarbonization of its fleet and fuels. Some of the companies in the sample are more established, whereas others are operating in emerging markets, and in some cases disrupting or leading new markets (e.g., on-demand economies). Consequently, they may be at different stages of their emission reduction trajectories.

Based on the data provided by these companies in their annual reports, we identified the following key observations. First, not all companies of interest have consistent reported data in the past 5 years that allow for a trend analysis. Several issues include, the historic length of detailed reporting, the timing and consideration of scope 3 (and when considered it may only include corporate travel, for example), or the fact that values may only be reported in figures. Second, for the most part, most companies are showing decreasing absolute and carbon-intensity trends. And Third, generally, the companies whose absolute emissions were increasing showed decreases in CI. As mentioned before, reducing CI is important because it may be evidence of continuous improvements in which companies innovate and implement efficient processes (e.g., transport and energy). Although it cannot guarantee absolute emission reductions, especially for fast growing companies, it could provide a directional expectation of absolute emission reductions in the mid- to long-term. Science-based targets (SBTs) have been used in this way to help entities link their reduction targets with available climate science. This is done by providing evidence of, for example, how a target will help meet the expectations of the Paris Agreement and the ways in which an absolute or intensity-based target would be achieved.

[21] Source: https://www.walmartsustainabilityhub.com/climate/project-gigaton
[22] Source: https://unfccc.int/climate-action/momentum-for-change/climate-neutral-now/apple
[23] Source: https://sustainability.aboutamazon.com/
[24] Source: https://sustainability.ups.com/sustainability-strategy/environmental-responsibility

4 Discussion and Synthesis

Any comparison of countries, industries, or companies will generally comprise a mix of entities having average, above average, and below-average growth. These entities may also be setting carbon reduction targets. While comparing these entities can be challenging in economic terms, making climate-relevant comparisons is even harder, as both total emissions and intensity-based metrics can be used.

Total emissions trajectories can show how an entity is performing at a high level, but may mask the effects of short-term capital investments (e.g., buildings, vehicle fleets, etc.) made that enable longer term emissions reductions needed to get to targets like net zero. Infrastructure investments are investments in the future. When done in a climate-friendly way, investments made today in order to ensure a Net Zero 2040 represent a socially valuable investment strategy. Investments can generate double dividends, enabling growth AND helping to meet carbon reduction or intensity reduction goals. For example, a fast-growing company that invests in renewable electricity for its facilities, or replaces fossil-fueled vehicles with zero emission vehicles (e.g., battery electric, fuel cell), will enable additional revenues and also reduce the company's CI even if the investments are insufficient to reduce their total footprint due to growing emissions from other activities.

For high growth entities, tracking CI of overall activity, or for key components, may be a critical part of analyzing progress towards meeting reduction goals. During periods of fast growth and innovation-driven market disruption, CI improvements may be expected to catch up to or outpace economic growth, and result in net total emissions reductions. In most cases, fast growing companies are not tied to legacy systems and infrastructure. This offers the opportunity to focus investments in new processes, assets, systems, and infrastructure that can achieve substantial intensity reductions at lower costs, with minimal disruptions to day-to-day operations.

These new technologies and business models help achieve direct and internal improvements, and may provide system-level benefits as they allow substituting entire processes (e.g., traditional shopping) with more efficient ones (e.g., online shopping). They may also enable behavioral changes that further help decarbonization efforts.

Developing parallel metrics for total and CI-based targets can play an important role in transitioning to more efficient processes, and could be adopted by more entities. CI-based targets can also enable innovative improvement pathways, as efforts can be spent identifying efficient processes or making the necessary changes and upgrades to existing processes to reduce their intensity. For example, replacing grid electricity with renewable electricity in a building will reduce its carbon footprint. This is a great outcome, but if the building can also be redesigned through the use of innovative technologies to increase revenue in a subsequent year, the footprint would remain unchanged, but the intensity would continue to decrease. The same is true for the use of fleet vehicles, which can be decarbonized to reduce the overall footprint, but can also have delivery routes better optimized to reduce intensity. If packaging volume can be reduced, total emissions decrease, and if more packages can fit in a vehicle, then intensity is further reduced. Making such systems more efficient can have further overall benefits to financial and carbon performance, but those efficiency gains might only be recognized with intensity-based metrics. Total carbon reduction targets, on the contrary, can potentially eliminate the flexibility of a gradual improvement, and make it more difficult for companies to meet those goals while remaining competitive or growing. Such targets when viewed in the larger market context can also be inequitable.

The planet depends on investments and growth that lead to absolute decarbonization by decoupling growth and emissions over the next few decades. In some cases, investments may not instantly (or in the short-term) materialize but potentially set the foundation for net carbon reductions. Currently, reporting is mostly optional (except for some specific high emitting industries) and there are no established or set timelines to evaluate improvement trajectories for companies or countries, therefore, establishing interim targets (at specified time periods), based on total emissions and carbon intensity, is a logical way to help entities achieve net zero. Those targets will also allow identifying if the collective improvements will realistically achieve decarbonization by the time we need it. Equally important would be to have, in addition to these targets, mechanisms and transparency about the investments made by different entities in this transition to a low-carbon future. This will not only help comparing carbon (or intensity) trajectories, but also provide common knowledge for different stakeholders' benefit about the effective strategies to maximize resources and move faster to decoupling and decarbonization.

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Biographies of Authors

Miguel Jaller, Ph.D., has been studying the economic, environmental, and social impacts of supply chains, logistics systems, and freight transport for the last 15 years. Through a multi-disciplinary approach, he has developed tools and knowledge to help improve planning and operations, and to achieve a sustainable transportation system. He is a member of various practice and research communities and committees. He is currently an Associate Professor, and Co-Director of the Sustainable Freight Research Program at the University of California, Davis, and has a BS in Industrial Engineering, Master's degrees in Industrial and Transportation Engineering, and Applied Mathematics, and a Ph.D. in Transportation Engineering.

H. Scott Matthews, Ph.D., has been studying the energy and environmental impacts of information and communication technology-enabled systems in the retail and transportation sectors for 20 years, and has also tracked how those impacts have been changing over time. He has been a member of Steering Committee activities for the development of carbon footprinting standards for companies (e.g., the GHG Protocol's Product and Scope 3 Standards). He was formerly a Professor at Carnegie Mellon University, and has a BS in Computer Engineering and an MS and Ph.D. in Economics, all from Carnegie Mellon University.