Corporate Carbon Reduction Pledges

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1. Introduction

With the quest for rapid decarbonization gaining global momentum, a sizeable number of major corporations have recently begun to report more granular information regarding their own carbon emissions. For the most part, these disclosures have been voluntary and forward-looking, pertaining to both current and anticipated future emissions of carbon dioxide (CO₂) and other greenhouse gases into the atmosphere. The disclosing firms frequently “pledge” to achieve a carbon net-zero position by a particular date several decades into the future, most commonly the year 2050. The number of firms with net-zero targets more than doubled last year, increasing from 500 in 2019 to 1,000 in 2020. As such, individual corporate goals complement the carbon reduction targets set by national governments in the form of Nationally Determined Contributions (NDC) in international climate treaties, like the Paris 2015 agreement.

In this article we first summarize the specific plans articulated by seven major corporations for reducing their Corporate Carbon Footprints (abbreviated as CCF from hereon). Our sample is not intended to be representative of the broader population of firms that have become active in this regard. Instead, our selection aims to cover a range of industries, including energy companies, manufacturers and distributors of consumer products as well as internet technology firms. We then compare and discuss key features of the decarbonization plans put forth by these seven firms to highlight substantial differences regarding the specificity and measurement of the articulated goals. Our discussion points to considerable variation in the use of so-called carbon offsets. We also discuss what might make CCF disclosures more transparent and credible in the future, including the possibility of such disclosures becoming mandatory rather than voluntary.

Information on the carbon reduction plans disclosed by individual firms has been collected by multiple analysts, including Bloomberg New Energy Finance (BNEF), the Carbon Disclosure Project and Science-based Targets. Figure 1 below replicates a graph taken from BNEF, illustrating the CCF reduction plans of eight global oil and gas companies. A common feature of these projections is that the firm plans to achieve a “net-zero” position by a certain year, that is, their carbon footprint, measured as Scope 1 plus Scope 2 emissions, is projected to go to zero at some point in time within the next 30 years. As discussed below in detail, the net-zero goal frequently allows for credits to be subtracted from the firm’s emissions to obtain a measure of net emissions. Several of the companies shown in Figure 1, like Occidental, also set “milestones” that project their net carbon footprint at one or several intermediate points in time between the present and 2050. In drawing this graph, we note that BNEF apparently makes the
implicit, and ultimately critical, assumption that a firm’s carbon footprint decreases linearly between any two milestones.

CCF reduction plans have gained considerable attention in the recent public discussion about limiting the damaging effects of climate change. This interest reflects the growing concern that despite all protestations about the threat posed by climate change, the world economies have thus far failed to collectively bend the overall curve of annual CO₂ emissions, at least prior to the arrival of the COVID-19 pandemic in 2020. In the absence of effective policies, such as direct emission regulations and/or carbon pricing, corporate pledges to reduce emissions are seen as a potentially significant commitment and coordination mechanism for enabling the world to limit the overall global temperature increase on earth to a range of 1.5-2°C, relative to pre-industrial levels.

![Figure 1. Source: Bloomberg New Energy Finance (2021)](image)

The projected paths of direct (Scope 1) emissions of all economic entities, i.e., firms, households, governmental agencies, can, at least in principle, be aggregated to a forecast for the carbon emissions path for the global economy. Such aggregate carbon emissions trajectories have been forecast by numerous analysts and observers. Figure 2, for example, reproduces a graph from a recent McKinsey white paper. 

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Footnotes:


5 McKinsey white paper.
Climate scientists for the IPCC projected in 2018 that in order to have at least a two-thirds chance of limiting the temperature increase to 1.5°C, total cumulative anthropogenic emissions would have to stay within a 420 Gt carbon budget. That budget would increase to 570 (840) Gt in order to maintain at least a one-half (one-third) probability of keeping the temperature increase to 1.5°C. Aggregate carbon emissions paths, like the one shown in Figure 2, suggest the analogy of the atmosphere as a “bathtub” for anthropogenic carbon emissions. The carbon budget determines the size of this bathtub which will overflow if the cumulative future emissions i.e. the area under the curve, were to exceed the size of the tub.

The shape of the projected emissions curve is clearly crucial, with total cumulative emissions being vastly larger for a concave (delayed reductions) as opposed to a convex (accelerated reductions) shape, holding the endpoints of the curve fixed. This observation illustrates the elementary point that when individual corporations set goals for their own future carbon footprints, it is not only the endpoints between today and the projected net-zero date that matter, but equally so the projected path that connects the endpoints. Milestones trace out the shape of the anticipated individual firm-level trajectories and thereby effectively determine the total cumulative emissions projected by each firm.

Two central questions that are ultimately beyond the scope of this article are why firms are issuing voluntary decarbonization pledges and why the set of firms joining this bandwagon has
expanded rapidly in the last couple of years. Economists have long pointed to climate change as a prime illustration of the Tragedy of the Commons. Accordingly, the atmosphere is a public good (bathtub), yet economic agents only internalize a minor fraction of the social cost associated with their own activities that deteriorate this public good. The recent pace of global carbon emissions and the more frequent occurrence of extreme weather events have arguably accentuated the prospects of an impending public good crisis. In the face of this dynamic, the decarbonization goals articulated by many large, multi-national firms become a means of quantifying their intended contribution to the public good. While the stated goals are voluntary at this point in time, their achievement in the future may at least partly be driven by future carbon regulations.

There is increasing evidence that firms face pressure from multiple stakeholder groups to articulate their contribution toward the public good of an atmosphere in which the concentration of CO₂ remains within acceptable limits. These stakeholder groups potentially include the firm’s customers, managers, directors and, for publicly listed firms, the broader investment community. Some institutional investors, like the New York City Pension Fund and BlackRock, have become particularly vocal in this regard. For instance, BlackRock’s Larry Fink stated in his 2020 letter to CEOs that climate change will be a “defining factor in companies’ long-term prospects” and that BlackRock “will be increasingly disposed to vote against management and board directors when companies are not making sufficient progress on sustainability-related disclosures and the business practices and plans underlying them.”

The 2021 letter to CEOs becomes more explicit when it calls on all companies in BlackRock’s portfolio “to disclose a plan for how their business model will be compatible with the net-zero economy” and adds “We expect you to disclose how this plan is incorporated into your long-term strategy and reviewed by your board of directors.”

In the face of growing pressure from both internal and external stakeholders, there appear to be tangible benefits from joining the group of firms that have articulated net-zero pledges. At the same time, it is far from clear that such pledges entail substantial costs in the minds of either the firm’s management or its shareholders. Obviously, any commitment to a net-zero goal by the year 2050 is well beyond the personal planning horizon of current corporate officers. Furthermore, as argued below, currently stated net-zero pledges frequently offer considerable “wiggle room” in so far as there are no restrictions on the types of carbon offsets that are eligible for subtraction from the firm’s gross carbon emissions. A recent article in The Economist points out that the average price for carbon offsets in the voluntary carbon markets was a mere $3 per metric ton of CO₂ in 2018. At these rates, the oil majors represented in Figure 1 could
meet the net-zero target today by paying annually somewhere in the range of $60-90 million dollars each without any reduction in their Scope 1 and 2 emissions.

The remainder of this article is organized as follows. The next section summarizes the voluntary carbon footprint reduction forecasts of seven major industrial and technology firms. Section 3 discusses systemic issues in connection with measuring corporate carbon footprints, in particular the practice of deducting so-called carbon offsets from firms’ gross CO2 emissions. Section 4 presents suggestions for making future voluntary carbon projections more transparent and consistent over time. We conclude in Section 5.

2. Corporate Carbon Reduction Goals: Select Examples

Google

Google LLC is a technology company that specializes in internet-related services and products, which include online advertising technologies, a leading internet search engine, cloud computing, software, and some hardware products. The firm’s 19 operational campuses across 21 data center locations in U.S., Europe, South America and Asia achieved $161B in sales revenue in 2019. The firm defines its operational emissions to include all Scope 1 and 2 emissions. For Scope 3, the company includes emissions related to business travel, candidate travel and employee commuting. Google has articulated its carbon neutrality commitment for these operational emissions and has pronounced itself carbon neutral since 2007 because its annual carbon footprint, measured according to its own methodology, has been less than or equal to zero.

Google’s primary approach to reducing emissions is through energy efficiency improvements (at its data centers), generating on-site solar power and investing in renewable power generation plants in various locations. For offsite renewable power plants (mostly wind and solar PV), Google will typically enter into long-term purchasing agreements with an offtaker, allowing Google to match 100% of its annual electricity consumption with renewable energy generation. By the end of 2019, Google had 5.5GW of renewable power generation capacity under contract, the majority of which was in the same grid locations as its data centers. Nonetheless, a significant share of the energy generated by Google’s renewable energy facilities is sold to third parties, such as utilities. To bring its remaining carbon footprint (CCF) to zero, Google purchases carbon offsets that it deems to be of “high-quality”. Typical carbon offset projects include landfill gas capture, agricultural methane capture and deforestation avoidance credits.

In September 2020, Google announced new decarbonization targets, the primary one being carbon-free energy on a “24-by-7” basis for its direct operations by 2030. To calibrate the size
of this goal, in 2020 only 61% of all electricity used by the firm was matched with regional, carbon-free resources on an hourly basis, with high/low examples being Oklahoma and Singapore, at 96% and 3% respectively. The firm has acknowledged the challenge of achieving its 24/7 goal, and has outlined potential enabling technologies. These include demand response/demand matching for its data centers and the use of clean dispatchable power generation, e.g., advanced nuclear, enhanced geothermal, low-impact hydro, long-duration storage, green hydrogen and carbon capture and sequestration.

An additional major goal – which the company pronounced to be achieved on the day of the announcement in September 2020 – was to eliminate all legacy carbon emissions via purchased carbon offsets, effectively making the sum of Google’s past CCFs zero.

**Xcel**

Xcel Energy, Inc. (Xcel) is an investor-owned electricity and natural gas company that operates through four regulated utility subsidiaries in eight states across the Midwest and Western U.S. The firm serves 3.7M electricity and 2.1M natural gas customers and in 2019 achieved revenues of $11.5B. In December 2018, Xcel set the goal of providing its retail and wholesale customers with 100% carbon-free electricity by 2050, with an intermediate goal of an 80% CO₂ reduction carbon emissions for all electrical energy delivered by the year 2030, compared to 2005 baseline levels. This pledge pertains to emissions from Xcel-owned generating plants (Scope 1) and electricity purchased from others producers that is ultimately supplied to the firm’s customers (Scope 3).

Xcel follows the common practice of reporting CO₂ equivalents to aggregate the emissions of all greenhouse gases, such as methane, nitrous oxide and several fluorocarbons in a composite emissions measure usually termed CO₂e. For Xcel, the combustion of fossil fuels comprises 99% of generated electricity CO₂e emissions, while the remaining 1% is attributable to methane emissions. By the end of 2020, Xcel had already achieved a 50% emissions reduction from its 2005 baseline, which in absolute terms amounted to ~40 MTCO₂e.

The company has outlined investment and operational changes that are intended to underpin its net-zero approach. Primarily, this entails investing in solar and wind generation with a projected 2030 energy mix of 60% renewables, 10% nuclear, with the remaining quantity equally divided across natural gas and coal fired facilities. Xcel’s strategy broadly entails a mix of natural gas, wind, solar and “advanced technologies”, while maintaining existing nuclear generation facilities and reducing the operation of existing coal plants. From an electricity demand perspective, the firm plans to undertake end-customer energy efficiency programs and
strategic electrification including the build-out of electric vehicle infrastructure. Notably, carbon offsets are not considered as a lever for achieving Xcel’s carbon commitments. To meet its 2050 goals beyond 2030, the company advocates for research and development to enable the final 20% emissions reductions, as the current suite of technology options are not viewed as commercially viable for “providing customers reliable, affordable clean energy.”

**REI**

Recreational Equipment, Inc. (REI) is an American retail and outdoor recreation services corporation with 168 locations, 13,000 employees and ~$3B net sales in 2019. REI has declared that it will become “carbon neutral” with respect to its operations and products sold under its own brand, beginning in 2020 emissions. The supply chain tied to products sold under the REI brand account for approximately one quarter of the company’s ~1MtCO$_2$e total CCF. In addition, the firm has committed to reduce its total CCF (Scope 1-3) by 55% by 2030 relative to a 2019 baseline. This will entail reducing the emissions associated with the nearly 1,000 product items carried by the retailer, constituting approximately at least 42% of REI’s total footprint.

REI first achieved carbon neutrality in its direct operations in September 2020, through a combination of ongoing capital investments in buildings, energy purchase changes and carbon offsets. Since 2006, the firm has embarked on upgrades to retail, distribution and administrative buildings including HVAC replacements eliminating the use of freon and the installation of energy efficiency measures such as LED lighting at new and existing stores. Since 2014, REI operations have been powered by 100% renewable energy achieved through a combination of onsite generation, utility green tariffs and renewable energy credits. Finally, to eliminate the remaining CO$_2$ from direct operations, REI joined Climate Neutral in late 2020, an organization that measures corporate CO$_2$ footprint of brands and then facilitates the purchase of carbon offsets through its project pool.

**Unilever**

Unilever plc is a multinational consumer goods company, organized into three main divisions – foods & refreshments, home care, and beauty and personal care. Its 400 products are available in 190 countries and the firm achieved ~$60B revenue in 2019. Unilever has publicized its Sustainable Living Plan (USLP) since 2010, which sets time-bound goals for achieving, among other things, reductions in carbon emissions. In 2019, Unilever reported a GHG footprint of ~60 MtCO$_2$e, 98% of which was attributable to Scope 3 emissions. The USLP sets two
marquee commitments, the first being to have no carbon emissions from Unilever’s operations (Scope 1 and 2) by 2030. The second goal, set relative to a 2010 baseline, is to reduce by 50% the GHG footprint across the entire value chain of the firm’s products by 2030 on a per consumer use basis.\textsuperscript{28} This intensity measure is based on the quantity of CO\textsubscript{2e} allocated per single portion, use or serving of a Unilever product to one person.\textsuperscript{29} It is based on the amount of product sold to the consumer in combination with the recommended dose/use or habits data.\textsuperscript{30} In 2019, this intensity measure was determined to be 45.5 grams of CO\textsubscript{2} per use. Importantly, this component includes the emissions attributed to the consumer use of products sold by Unilever (one of the categories among the Scope 3 emissions), accounting for \~66\% of Unilever’s CCF in 2019.

To meet its climate goals, Unilever intends to use 100\% renewable energy to power all firm-controlled operations. The company also plans to rely increasingly on sustainable sourcing of commodities such as palm oil, soy, paper/pulp and reformulating products with the objective of using fewer input ingredients.\textsuperscript{31}

In June 2020, the firm released an additional statement to “fight climate change and protect nature as part of a new integrated business strategy.” Specifically, Unilever additionally forecasts to achieve net-zero emissions from all products by 2039, covering all associate emission from the sourcing of the materials to the point of sale.\textsuperscript{32} Importantly, this new goal does not include the consumer use phase. One key pillar to achieving the 2039 goal is for the firm to attain a “deforestation-free” supply chain by 2023, through investment a combination of strict supplier contracting and investing in satellite imagining and data processes for monitoring and verification. Finally, Unilever has stated that it intends to balance any residual emissions in the supply chain by 2039 through purchased or self-generated carbon offsets.

**United Airlines**

United Airlines, Inc. operates \~1,400 aircraft, with 4,900 daily flights to 361 airports across the world. Total operating revenue in 2019 was \~$43B. In December 2020, United pledged to reduce its CO\textsubscript{2e} emissions by 100\% by 2050 on an absolute basis.\textsuperscript{33} The firm’s climate strategy is focused primarily on mitigating its aircraft emissions related to fuel combustion, as \~81\% United’s annual CCF (42 MtCO\textsubscript{2e}) results from jet fuel consumed by its own aircraft (Scope 1). United also provides regional transportations service under the brand United Express, within which six separately owned airlines operate short-and-medium feeder flights.\textsuperscript{34} The jet fuel emissions from these flights (Scope 3) accounts for \~17\% of United’s CCF. Accordingly, a total of \~98\% of the firm’s corporate emissions stem from jet fuel combustion.\textsuperscript{35}
United has announced essentially three broad approaches to achieve its climate pledge: increasing fuel efficiency, reducing carbon intensity of fuels, and removing carbon dioxide from the atmosphere. Aircraft body upgrades support fuel efficiency. For example, United reported that the implementation of Boeing’s split scimitar winglets reduces fuel consumption by 2%. Regarding carbon intensity of fuel, the firm has entered into long term contracts to purchase sustainable aviation fuel, which can reduce lifecycle emissions by 60%. In particular, United has made a $30 million equity investment in Fulcrum BioEnergy and entered into a long-term supply agreement for 90 million gallons per year for 10 years. United is also bound by the International Civil Aviation Organization, the UN agency for aviation Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). Starting in 2027 for U.S. domiciled air carriers, CORSIA calls for international aviation to offset part of its CO₂ emissions through the reduction of emissions outside of the international aviation sector, essentially through carbon offsets. Examples of offset projects mentioned there include those that reduce emissions from electricity generation, industrial processes and agriculture. CORSIA’s goal is to keep global net CO₂ emissions from international aviation at 2019 levels going forward (i.e. carbon neutral growth from 2019). United Airlines has indicated that the CORSIA offsets will ultimately be insufficient and therefore the company will seek to remove all of its carbon permanently using direct-air-capture technology. In late 2020, United made a multi-million-dollar investment in 1point5, a development company formed by Oxy Low Carbon Ventures and Rusheen Capital Management to finance and deploy Carbon Engineering’s large-scale direct air capture technology. As a first demonstration 1point5 is to deliver a facility located in the Texas Permian Basin that will capture and permanently sequester 1 MtCO₂/year when operational, expected sometime in 2022 or 2023.

BP
The British multinational oil and gas company BP plc operates in all segments of the oil and gas industry with increasing investments in renewable energy. In 2019 BP achieved ~$277 B in revenue based on operations in over 80 countries. The company produces 2.6 million barrels of oil per day. Due to the sheer volume of its fossil fuel production, the firm reports a large carbon footprint of ~55 MtCO₂e from direct operations in 2019. An additional 360 MtCO₂e in Scope 3 emissions account for the combustion of oil and gas sold by the company. This number reflects BP’s equity share in joint ventures. In February 2020, BP articulated a net-zero goal to
be achieved no later than 2050. This goal is seen as part of a new strategy to transform BP from an International Oil Company to Integrated Energy Company.

Known as the “Net Zero Ambition,” the 2020 targets can be divided into direct operations, upstream production activities and downstream product use. BP seeks to achieve net-zero emissions for its direct operations (Scope 1 and 2), and net-zero emissions from its upstream production of oil and gas (Scope 3) on an absolute basis by 2050, with a 20% reduction by 2025. Regarding its other Scope 3 emissions, BP has pledged to reduce the carbon intensity of the products it sells by 50% by 2050, with a 5% reduction by 2025. The intensity measures are based on the estimated lifecycle emissions associated with the production, processing, transportation and use of the portfolio of all marketed products on a per unit energy basis (i.e. tCO₂ per MJ of energy). Products include fuels, gas, and electric power supplied to customers.

The general expectation expressed by BP is that absolute the level of emissions associated with marketed products will grow up to 2030, even as the carbon intensity falls. Beyond 2030, the firm projects that absolute emissions will fall as well, in part because of plans to reduce overall oil and gas production.

To meet its targets, BP aims to increase the number and cumulative capacity of its renewable energy projects. For instance, by the end of 2020, it had instantiated 3.3GW of renewable energy projects and amassed a ~11 GW development pipeline (20% solar, 80% offshore wind). The firm has also stated that it will increase low-carbon investments to $5 B per year by 2030, up from current levels of $0.5B. These funds will be used to scale up deployment in mobility electrification, sustainable fuels, hydrogen energy and carbon capture, utilization and sequestration technologies. BP will seek divestments to lower its CCF and develop technology to reduce its carbon footprint from refining operations specifically. To meet its shorter-term targets BP intends to not rely on carbon offsets. However, to achieve its aims beyond 2030, natural climate solution carbon offsets may be included.

Through its Target Neutral activities, BP already purchases carbon offsets for its own operations and on behalf of its customers to help them achieve their carbon targets. Regarding its own operations, some of these offsets are used to comply with obligations under mandatory emissions schemes, such as the California Cap-and-Trade Program. For example, a BP subsidiary with operations in California purchased 1.7 MtCO₂e of offsets as part of its requirement to meet the state’s Cap-and-Trade emissions trading scheme 2015-2017 compliance period. Beyond compliance markets, BP sees carbon offsets as a growing industry. In December 2020, the firm expanded its carbon offset project development
capabilities by acquiring Finite Carbon, at the time the largest developer of forest carbon offsets in the United States (70MtCO2e registered offsets).\textsuperscript{52}

**Microsoft**

The integrated technology company Microsoft Corporation had $143B in sales revenue in 2020. Microsoft’s cloud operations were distributed across more than 100 data centers in 54 regions delivering computing services in 140 countries. In 2020, the firm accounted for a CCF of \(~11\text{MtCO}_2\text{e}\), including Scope 1-3 emissions.\textsuperscript{53} In January 2020, the firm announced it would be carbon negative by 2030 and remove all the CO\(_2\) it has cumulatively emitted since its founding in 2050.\textsuperscript{54} Broadly, the firm has identified four levers to achieve this goal: i) an internal carbon fee, ii) data center energy efficiency and exclusive reliance on renewable energy, iii) supply chain partnering and coordination, and iv) the use of CO\(_2\) removal technologies.

Microsoft has been charging an internal carbon fee since 2012 on Scope 1 and 2 emissions and business air travel (Scope 3). In 2020, the fee was increased to $15/tCO\(_2\) for all business groups and now also applies to all Scope 3 emissions, though initially at a lower rate.\textsuperscript{55} The company has provided the following quantitative reduction goals for the coming decades:\textsuperscript{56} reduce Scope 1 and 2 emissions by 2025 through energy efficiency and 100% renewable energy, eliminate diesel generators as a backup power source for data centers by 2030 and replace them with batteries or hydrogen fuel cells, and electrify the 1,800+ campus operations vehicle fleet. By 2030, the firm also aims to reduce its Scope 3 emissions (which account for \(~65\%\) of) by 55% through an updated supplier code of conduct, requiring GHG emissions disclosure, and implementation of an audit management system to track progress in the emissions by its suppliers. Starting in 2021, supplier emissions will become an evaluation criterion for the purchasing departments at Microsoft.

To zero out residual emissions and become carbon negative on an annual basis by 2030, Microsoft is investing in carbon removal solutions rather than so-called avoidance offsets. On this shift, the company commented: “As we shifted our focus from carbon offsets to carbon removals, we entered a relatively new landscape. We could no longer rely as heavily on carbon registries to validate project quality, because their standards were designed almost exclusively to measure and verify the claims of projects that avoid or reduce emissions, and we experienced a lack of consistency in how the standards address key criteria. We are eager for standards to address these issues in their crediting systems. For now, although we did look to existing standards for some guidance, we largely needed to set our own course.”\textsuperscript{57} In July 2020, Microsoft issued a request for proposals to source carbon removal projects, with an initial focus
on “nature-based climate solutions due to pricing and availability.” Microsoft secured 1.3 MtCO2e removal for 2021 from 15 projects, with 99% of earmarked CO2 to be removed via natural solutions with a durability (permanence) of up to 100 years.

3. Measurement Issues

A common feature of the corporate decarbonization plans discussed in the preceding section is that firms operationalize their CO2 reduction goals in terms of an annual flow variable:

\[ CCF_t = E_t - O_t , \]

where \( E_t \) represents “gross emissions” in year \( t \) and \( O_t \) represents “offsets” in that year. We refer to \( CCF_t \) interchangeably as the firm’s corporate carbon footprint or its net-emissions in year \( t \). Firms with “net-zero” pledges project that their adopted measure of \( CCF_t \) will go to zero by a target date, frequently the year 2050. As argued in Section 2, Microsoft and Google have articulated far more ambitious goals to the extent that they seek to eliminate all legacy emissions from the firm’s past. For Microsoft, this will require the sum of all \( CCF_t \) starting in 1985 and ending in 2050 not to exceed zero. This more demanding criterion, also put forth by Google, is sometimes referred to as “climate neutrality”.

There is a host of measurement issues pertaining to both gross emissions and offsets.58 As illustrated in the conceptual framework shown in Figure 3, the purchase of offsets frequently relies on a marketplace in which suppliers make projects available that corporate emitters then claim as offsets. In the current environment, buyers of these offsets have wide latitude in determining the eligibility of particular offset projects.

Figure 3. Conceptual Framework for the Calculation of \( CCF_t \).
3.1 Gross Emissions

There appears to be general agreement that all direct (Scope 1) CO2 emissions from flue gases and tailpipes emanating from a firm’s production and transportation activities are to be included in $E_t$. Our summaries in Section 2 also suggest that it is common practice to include Scope 2 (indirect) emissions based on the production of energy i.e., electricity, heating and cooling, that is consumed by the firm. For firms in service industries, like internet technology or financial services, this second component of $E_t$ is frequently the dominant part of their CCFs. The main argument for including these indirect emissions in the measure of $E_t$ is that, depending on the jurisdiction, businesses have partial control over their energy supplier and the energy mix they buy. At the same time, though, there is the obvious issue of double-counting in the overall economy: a firm’s Scope 2 emissions are also included in the Scope 1 emissions of its energy suppliers. As a consequence, any year-over-year reduction in the direct emissions by the energy supplier will also be counted as an improvement in $E_t$ by the party buying the energy.

Issues of double-counting become even more prevalent in connection with Scope 3 emissions.59 Not surprisingly, the supply chain report of the Carbon Disclosure Project estimates that the ratio of indirect supply chain emissions relative to direct emissions is 10.9 for firms in the retail industry, yet this ratio is only .4 for firms in the fossil fuel industry.

For the sample of firms covered in Section 2, we note that there was considerable variation as to which of the many categories among the Scope 3 emissions firms are willing to include in their measure of $E_t$. While Excel, BP or Unilever include multiple Scope 3 emission categories, companies like Google only recognize employee travel and commuting.60 Similarly, as noted in Section 2, the utility Xcel excludes from its CCF the emissions associated with the combustion of the natural gas that the firm supplies to its customers.

For manufacturing industries in which firms assemble multiple complex components in their products, the boundaries of the Scope 3 emissions become inherently “fuzzy” as one moves up the value chain across the different tiers of suppliers, who in turn supply multiple customers. The issues associated with the inclusion of Scope 3 emissions are well illustrated in connection with an automotive company like Toyota.61 According to the GHG Protocol (Corporate Value Chain, Scope 3, Accounting and Reporting Standard), Toyota should estimate the carbon content of all components going into their vehicles including an “appropriate allocation” for the use of capital goods, upstream transportation and distribution.62 Clearly, this is a task of daunting complexity for an automobile consisting of approximately 30,000 individual parts. Consistent with these concerns, a recent white paper by the Rocky Mountain Institute concludes that “Scope 3 emissions are not well defined for individual industries.”
On the product use side, the GHG protocol suggests for Toyota to estimate the CO$_2$ emissions from combusting the fuel used by the vehicles sold over their lifetime and to recognize these lifetime emissions in the year of sale. On this last prescription the GHG protocol appears to conflate stock- and flow variables. To witness, when the company acquires a car for use in its own operations, it would presumably recognize the attendant (Scope 1) tailpipe emissions on an ongoing annual basis rather than in the year of acquisition.

As noted in the Introduction, some firms not only set net-zero targets but also specify milestones for partial reductions at intermediate points in time. To account for growth (or contraction) of the business over multiple decades, a meaningful criterion for achieving the milestone goal must put the $CCF$ measure in relation to a suitable activity measure, such as output or sales. The absolute $CCF_t$ metric is then replaced by a carbon intensity ratio with the activity variable in the denominator to be chosen. For companies with a relatively homogeneous product line, physical measures of output may be suitable, but even then the reporting entity will retain considerable flexibility in choosing a favorable measure for the denominator of its carbon intensity metric. As described in Section 2, Unilever addresses this issue by imputing a standard quantity of CO$_{2e}$ per individual portion (use). This quantity is the same for Unilever’s entire spectrum of consumer products. To measure reductions in the carbon intensity of diversified industrial conglomerates, it seems that only a financial aggregator, like sales or cost of goods sold, will be practical as the activity measure in the denominator.

3.2 Carbon Offsets

We refer to a carbon offset as one metric ton of CO$_2$ either not emitted into or removed from the atmosphere in that year. Somewhat like indulgences sold by the Catholic Church over the course of multiple centuries, offsets can effectively lower a firm’s reported carbon footprint (its environmental “sin registry”). It is widely acknowledged that there are significant differences in the types of offsets currently traded in voluntary carbon markets. These differences are reflected in the wide range of transaction prices – ranging from $0.10 to $780 per metric ton, with an average of $3. The carbon offset supplier SilviaTerra, for instance, works with timber farmers who are paid to delay cutting down trees for one year. In contrast, some buyers of carbon offsets contract with a third party to capture CO$_2$ from the ambient air (direct air capture) and then sequester the CO$_2$ captured in geological formations for long periods of time, say 1,000 years.

The offsets traded in current voluntary credit markets can be grouped into avoidance and removal offsets. Avoidance offsets are generated from projects that lead to a reduction in
emissions from current emissions sources. They account for tons of CO₂ that would have been emitted (relative to a projected baseline), but were avoided in that year due to an intervention. Avoidance offsets typically involve contractual agreements with another party. These offsets can originate in nature or through reliance on a technology-based intervention. Nature-based avoidance offsets can be generated, for instance, if a forest, which from a carbon storage perspective is in a steady state, is preserved rather than logged. Large-scale project developers such as the Nature Conservancy and GreenTrees pay landowners who have a stated intention, and plausible economic motive, of cutting down forests to not do so – thus avoiding the emissions of deforestation. Technology-based avoidance offsets hinge on the use of a production process which reduces the amount of emissions in comparison to the status quo. Applicable examples here include renewable energy projects, green cement, or clean cook stoves.

Section 2 touched upon Google’s approach of leveraging technology-based avoidance offsets, for instance by financing renewable power plants that supply clean energy to the grid. As a consequence, the emissions from fossil fuel energy in that location are displaced by a renewable power plant owned or financed by Google. To the extent that Google only consumes a share of the clean energy generated by the plant, the company performs an effective “electron swap” for accounting purposes and recognizes offsets from clean power production based on the carbon intensity of the grid in the location of the renewable power facility. Issues of double counting across the economy will again arise in this context if the company that buys the energy from Google’s renewable plant, say a utility like Xcel, also takes credit for the clean electrons sold to its customers in its own CCF.

In contrast, removal offsets are generated by projects that actively remove carbon dioxide from the atmosphere, and then store the gas for a period of time. Removal offsets also comprise nature- and technology-based solutions. Nature-based removal offsets sequester additional carbon in the biosphere, for instance, through reforestation, afforestation, biochar, ocean fertilization, and soil carbon sequestration. Locus Agriculture provides an example in this context, offering a microbial stimulant product that farmers spray to both increase yields and sequester 2-3 additional tons of CO₂ per acre. Locus is the first company offering such payments to farmers in the U.S., with the offsets bought by Shopify. Technology-based removal offsets involve the capture of CO₂ followed by storage outside of the biosphere. Here the Swiss company Climeworks is a prime example as it captures CO₂ directly from the ambient air and then permanently sequesters it underground in basaltic rock formations. Figure 4 illustrates
both nature-based (storage inside the biosphere) and technology-based (storage outside the biosphere) carbon removal mechanisms.

![Figure 4. Source: CDR Primer](https://example.com/figure4)

In voluntary carbon markets, buyers who seek to offset their emissions are matched with suppliers who have projects that entail either avoided emissions or CO₂ removal. A growing ecosystem is developing to facilitate trades on these voluntary carbon markets - consisting of brokers, exchanges, registries, and verification bodies. Brokers are frequently boutique firms that buy offsets and bundle them to the specific needs of buyers. Exchanges, in contrast, are marketplaces that list a wide range of offsets available for sale. Brokers such as South Pole and BlueSource have built reputations for listing high quality offsets of all types, while a firm like Puro.Earth offers only removal offsets.

Brokers work with end-suppliers to scope out price/quantity agreements, bring in registries and third-party certifiers. Buyers can also purchase offsets directly from suppliers (“over the counter” purchases). Recently there has been an increased trend towards over-the-counter purchases, especially from larger firms like Stripe and United Airlines that seek direct interactions with specific suppliers deemed to be of high quality. Once an offset is purchased, it is retired to avoid multiple crediting.

Carbon markets first came to prominence in 1997 under the Kyoto Protocol, which established carbon credits as a mechanism for countries and firms to offset their emissions. The volume of offsets supplied (issued) and bought (retired) has seen significant growth over the past few years. As shown in Figure 5, volume supply doubled between 2018 and 2019 (138M), and then again growing by a third from 2019 to 2020 (181M). Currently, the vast majority of these
offsets are avoidance offsets, which tend to be cheaper than removal offsets; just over half of all offsets (53%) were nature-based in 2019.\textsuperscript{69}

The voluntary carbon market has grown significantly in recent years.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{voluntary_carbon_market.png}
\caption{Voluntary carbon market, millions of metric tons of carbon dioxide equivalent}
\end{figure}

\textbf{Figure 5.} \textit{Source: McKinsey}\textsuperscript{70}

The average price of an offset has been declining, from an average of $7 per metric ton of CO$_2$ in 2008 to around $3 in 2019.\textsuperscript{71} Overall, transaction prices vary dramatically based on the degree of verification and the geographic location of the offset project. The graphic in Figure 6 illustrates the wide range of offset prices observed in the voluntary carbon markets. As noted above, the prices of offsets can approach $800 per ton for select over-the-counter transactions.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{offset_prices.png}
\caption{Voluntary carbon offset prices, by sector}
\end{figure}

\textbf{Figure 6.} \textit{Source: BloombergNEF, CBL}

In light of Figure 6 it is instructive to estimate the cost of the technology-based avoidance offsets that a company like Google incurs when it builds (finances) a renewable power plant in
some offsite location. As described above, the renewable energy is frequently sold to third parties and Google claims the carbon offsets by effectively swapping the carbon-free energy produced for “grey” grid power consumed by its data centers. The unit economics of a renewable power plant is proportional to the difference between the price per MWh under the Power Purchasing Agreement (PPA) (negotiated between the investor and the offtaker) and the lifecycle cost of generating 1 MWh of electricity, the so-called Levelized Cost of Electricity (LCOE).  

For a solar photovoltaic facility in California, for example, reasonable values in the current environment would be a PPA = 30 dollars per MWh and an LCOE = 32 dollars per MWh. The facility would then be unprofitable (negative NPV) at the rate of $2/MWh for the investor (Google), but each MWh of clean electricity generates carbon offsets. The magnitude and cost of the resulting offsets depends on the carbon intensity of the grid in which the solar facility operates. For the California grid, the average amount of CO₂ emitted is 0.2 t/MWh. The cost of offsetting one metric ton of CO₂ for the investor therefore is $10 (i.e., 2/0.2 = 10). This cost would shrink to one third, that is, $3.33 per ton of CO₂, if the solar facility were to operate in the state of Colorado where the grid emits on average 0.6 t/MWh. In effect, these types of avoidance offsets become cheaper for the investor if the same “clean” electrons are counted as displacing “grey” electrons with higher CO₂ origin.

The wide range of carbon offset prices observed in voluntary carbon markets suggests significant quality variances. While the Taskforce on Scaling Voluntary Carbon Markets (TSVCM) reports that 90% of credits do adhere to verification through certification bodies such as Verified Carbon Standard or American Carbon Registry, such verification arguably represents only a minimum standard. In contrast, there does not appear to be a bright line standard for what constitutes a “high quality” carbon offset. Certain qualitative criteria mentioned repeatedly can be summarized under the acronym PLAN: Permanence, Leakage, Additionality and Negativity.

Permanence or durability of an offset refers to the amount of time that the CO₂ is expected to be stored rather than released into the atmosphere. A company like SilviaTerra deliberately focuses on short-term durability when it offers one-year contracts to landowners – paying them to delay cutting down a tree for at least one year. Such contracts can obviously be renewed and have the advantage of avoiding the long lead times required to verify and accrue credits in connection with some nature-based offsets. Typically, technology-based removal offsets have longer permanence, as carbon is stored outside of the biosphere with relatively low risk of being released in the foreseeable future. Some buyers, such as Stripe, have set permanence thresholds
of at least 1,000 years for the offsets they purchase. CarbonPlan, a non-profit focused on improving the functioning of voluntary carbon markets, seeks to quantify the tradeoff between permanence and the cost of different types of carbon removal offsets; see for instance Figure 7.74

![Figure 7](source: CarbonPlan)

**Figure 7. Source: CarbonPlan**75

Leakage in connection with avoidance offsets would occur if credits are issued because the supplier agrees to preserve a particular forest or natural habitat, including the carbon stored there, yet the supplier releases the same amount of CO₂ by taking down another natural habitat in another location. Leakage is closely related to the criterion of Additionality. The requirement here is that the carbon reduction would not have happened without the intervention generating the offset. Additionality is harder to establish with avoidance offsets, as, by definition, the offset hinges on a counterfactual claim: without the intervention a specific amount of carbon dioxide would have been emitted at this location. There has been increased press on the additionality issues with nature-based solutions. Bloomberg Green reported that a number of nature-based avoidance credits were issued by GreenTrees and The Nature Conservancy on forests that were never under threat of being cut down76. For removal credits, especially technology-driven ones, additionality will frequently be easier to establish. It appears implausible that the suppliers of these offsets would mine the air or flue gases from an industrial facility for CO₂ and then sequester it geologically without the monetary incentive of selling the corresponding offsets. Microsoft announced in 2020 a shift from buying avoidance nature-based offsets to only buying removal offsets, specifically because additionally was hard to prove for the avoidance offsets the company had historically purchased.
Finally, the *Negativity* criterion postulates that the emissions generated by implementing an offset project are properly subtracted from the total emissions claimed by the offset. In connection with a direct air capture plant, this would require that the project generates credits in the amount of CO$_2$ directly removed from the atmosphere minus the CO$_2$ that was emitted to generate the electricity that is required by the capture plant.

Carbon offset buyers like Stripe and Microsoft have formulated their own criteria for what constitutes a high-quality offset. Stripe has committed to spending $1M annually on removal offsets. The company led a transparent procurement process to buy offsets directly from suppliers. Furthermore, the company restricted attention to projects that can remove and store carbon outside of the biosphere for at least one thousand years. The first year of purchases went to just four projects, with Stripe paying between $75-775 per ton of carbon removed (up to 258x the current average price of offsets). Beyond the immediate offsets generated, Stripe’s impact concept emphasizes the idea to bring the price of removal technologies down the cost curve. As mentioned above, Microsoft, will for now only acquire removal offsets, but does not exclude nature-based removal offsets with shorter durability. Numerous other firms with net-zero commitments are taking a similar path, shunning avoidance credits in the short-run and investing instead directly in removal technologies for the long run.\textsuperscript{77} Our earlier discussion indicates that United Airlines is a company in that group.

Not everyone agrees that the best way forward is to focus exclusively on removal offsets. The TSVCM calls for reliance on avoidance credits in the short term, as they are currently the most cost-efficient way to reduce overall emissions subject to appropriate verification. Only once innovation and deployment experience have brought down the cost of removal offset technology - and there has been sufficient focus on abatement of new emissions - does the TSVCM call for a shift towards removal technologies that would offset the remaining “hard to abate” emissions. The TSVCM also estimates demand for carbon credits would need to increase by a factor of 15x by 2030, and a factor of 100x by 2050 to achieve the $1.5^\circ$C global warming limit.

It remains an open question at this stage to what extent voluntary carbon markets will also grow because of firms’ obligations under the mandatory carbon compliance markets such as the EU Emission Trading Scheme (ETS) or the California Cap-and-Trade system. Under both of these regulatory schemes, the obligated firms must generally obtain allowances for their local, Scope 1 emissions. The California Cap-and-Trade system allows for firms to substitute allowances for carbon offsets obtained from approved supply sources, up to an 8% ceiling of the emissions regulated by the state of California. Companies like BP are taking advantage of this alternative
compliance route. The recent acquisition of a majority stake in Finite Carbon, a nature-based offset project developer, presumably enables BP to secure offsets at favorable spot- and future prices.\textsuperscript{78} The offsets purchased in this manner therefore satisfy both BP’s regulatory requirement and the achievement of its voluntary \textit{CCF} reductions.

\section*{4. Improving the Transparency and Accountability of CCF Disclosures}

Recent years have witnessed a surge of firms making the kinds of carbon reduction pledges summarized in Section 2 above. Since these voluntary disclosures thus far exhibit wide variation in terms of specificity and scope, the immediate question going forward is what type of reporting format would make the disclosures more credible and allow the general public to hold firms accountable for their earlier projections. Put differently, if firms do not anticipate having to issue progress reports in the foreseeable future,\textsuperscript{79} there seems to be very little downside to joining “net-zero by 2050 club”.

It is well established that the internal management control systems of major corporations evolve around a comprehensive system of standard setting combined with subsequent comparisons of the standards with actual results achieved.\textsuperscript{80} The initial disclosure, say in the year 2019, regarding a firm’s carbon footprint trajectory can be viewed as the initial standard. The credibility of this initial disclosure would be enhanced considerably if there was also a commitment to provide, at regular time intervals, updated trajectories that relate to the earlier projections. Figure 8 illustrates the idea of \textit{time-consistent emission trajectories} for a setting in which updates on actual emissions are provided annually and updated forecast trajectories are issued every five years. Another assumption maintained in this illustration is that the initial and the updated trajectories all have a 2050 net-zero goal as well as milestones that are 10 years apart.\textsuperscript{81} The dashed lines between the milestones reflect the default scenario of linear interpolation.
In the hypothetical scenario considered in Figure 8, the firm committed initially to issue a total of six carbon footprint trajectories every five years over the next thirty years. With the year 20230 having arrived now in this hypothetical scenario, each trajectory splices together the actual results since 2020 with a forecast segment (dashed line), each one five years shorter than the previous one. Thus, subsequent disclosures would take the actual carbon footprint in that year as the initial baseline value, allowing for dynamic performance assessments that compare multiple standard values, issued at five-year intervals in the past, to the actual result achieved in a given year. As illustrated in Figure 8, the trajectory forecast every five years is likely to change in the intervening years and actual values need not be consistent with any of the previous forecasts for that particular year.

As discussed in Section 3.1, any measure of $CCF_t$ that includes indirect emissions (Scope 2 and 3) as part of gross emissions is subject to economy-wide double-counting issues. Such a measure will also be afflicted by the subjective choice individual companies make in including different categories of their Scope 3 emissions. Similarly, as argued in Section 3.2, there is currently considerable variation in the quality of offsets, in particular avoidance offsets, that companies are willing to include in their measure of $O_t$. The general public would therefore receive more detailed information if, beyond their current carbon footprint disclosures, firms were to report their Scope 1 net-emissions which we denote by $CCF^1_t = E^1_t - O^1_t$. This “core” carbon footprint measure takes a firm’s direct emissions and subtracts only removal offsets with a certified high sequestration duration, e.g., carbon capture combined with geological sequestration. As such, the two components of the metric allow for an apples-to-apples comparison.
comparison of tons of CO₂ “permanently” released into and removed from the atmosphere in a particular year. Our advocacy for this core carbon footprint measure derives from the observation that it is ultimately the sum of all $CCF^t$, added up across all economic entities and years to some horizon date $T$, that determines the concentration of greenhouse gases in the atmosphere at some horizon date $T$. Put differently, the concentration of carbon dioxide in the atmosphere and therefore the global temperature increase relative to pre-industrial levels, hinges on the cumulative value of all $CCF^t$, when added up across all economic entities and years up to the planning horizon.

The measurement of carbon footprints would, of course, have to be standardized if reporting were to become mandatory. To that end, U.S. companies have an obligation to report their Scope 1 emissions to the U.S. Environmental Protection Agency. For a wide range of industrial sectors, European installations are obligated to report their annual Scope 1 emissions to the European Union Transaction Log under the EU Emissions Trading Scheme (ETS).

In addition, publicly listed firms in Britain have, beginning in 2013, also been mandated to disclose their annual direct (Scope 1) and indirect (Scope 2) GHG emissions as part of their annual financial reports. Corporate GHG emissions are to be reported in tCO₂e, with the conversion factors for gases other than CO₂ published annually by the British government. The disclosure mandate does not prescribe a specific method for calculating GHG emissions, but it requires the use of “robust and accepted methods” and recommends a “widely recognized independent standard” (DEFR 2013).

Several recent academic studies have examined whether the UK reporting mandate had a real effect insofar as the reporting obligation induced firms to reduce their emissions in comparison to other firms not subject to the regulation. Downar et al. (2020) hypothesize the emergence of such real effects due to stakeholder pressure. Essentially, these authors conjecture that the carbon footprint figures publicized in a firm’s annual report will create a “pillory” and managerial pressure to achieve improvements over time. At the same time, the UK mandate may actually not have entailed the reporting of substantial additional public information because many of the treated firms were already engaged in voluntary carbon reporting to the CDP (see Grewal, 2021). Furthermore, as noted above, all European installations covered by the EU-ETS scheme already had to report their Scope 1 emissions to the European Union Transaction Log, and that information has always been in the public domain.

Using a difference-in-differences empirical design, Downar et al. (2020) estimate that UK firms subject to the carbon reporting mandate under the 2013 Act, subsequently decreased their Scope 1 emissions by an additional 8% relative to a control group of European firms not subject to the
British regulation. The authors interpret their finding as evidence that reporting on current emission leads to additional transparency beyond the information are already available through other channels. In anticipation of having to disclose their carbon footprint in subsequent years, firms apparently did feel pressure to show ongoing improvements.90

5. **CONCLUDING REMARKS**

In the public discussion about mitigating the damaging effects of climate change, companies have recently begun to issue voluntary forecasts regarding their intended contributions towards driving overall global CO2 emissions to zero. While for some companies, like REI, these efforts have always been part of their mission (even their corporate DNA), many global players in carbon intensive industries have joined this group only recently, resulting in the recent surge of pledges illustrated in Figure 9 below. Increased stakeholder pressure appears to be a major motivation for making these emission reduction pledges. At the same time, our assessment is that the various existing corporate carbon pledges leave substantial “wiggle room”, largely because of scope, horizon and measurement issues. This may allow some firms to wear the “green mantle” without having to make significant efforts beyond those that will emerge anyhow from more stringent carbon regulations in the future.

![Largest U.S. companies with unmet net-zero CO2 targets](image)

**Figure 9.** Source: Bloomberg New Energy Finance91

Our analysis has focused on how corporate carbon footprints are measured. In that context, the selective inclusion of indirect emissions that fall into the bucket of Scope 3 emissions under the international GHG protocol create the most significant variation in corporate CO2 reporting
and anticipated future emission reductions. Further latitude with these pledges arises because firms in different industries will adopt different metrics for the carbon intensity of their product and operations. Yet carbon intensity measures are essential in order to quantify decarbonization progress at intermediate milestones, prior to firms arriving at their net-zero goal points several decades into the future.

Carbon offsets, in particular avoidance offsets, are another variable that create substantial variation and latitude in comparing the carbon footprint reductions actually achieved. As the set of firms embracing the “net-zero by 2050” goal has rapidly expanded, the supply of avoidance offset providers appears to have grown correspondingly, leading to a situation where avoidance offsets trade on average at extremely low prices per metric ton of CO₂. Unless firms either declare that avoidance offsets are excluded from their CCF measures or restrict attention to removal offsets, subject to carefully defined durability standards, carbon reduction pledges will likely be achievable at negligible expense. In that sense, we second Microsoft’s Brad Smith in stating “... we need to get real on carbon math. The current methods used for carbon accounting are ambiguous and too discretionary. We need clear protocols to ensure that progress reported on an accounting statement is truly progress in the real world.”

Aside from discussing issues with the current approaches to determining a firm’s carbon footprint, we argue that the informativeness and accountability of corporate carbon pledges would be enhanced if companies were to update these projections at regular time intervals. The resulting collection of emission reduction curves would allow the public to examine not only how forecasts of future emissions have changed over time, but also to what extent intermediate goals at milestones have been met or missed. Firms could self-commit to such time-consistent carbon emission projections. The existing mandate to report concurrent Scope 1 and 2 emissions for listed firms in the UK also suggests that extended reporting on time-consistent emission trajectories could be required in the foreseeable future as mandatory information items in firms’ annual reports.
Endnotes

1 Angel Hsu et al., “Accelerating net zero: Exploring cities, regions, and companies’ pledges to decarbonize”, Data-Driven EnviroLab & NewClimate Institute, September 2020. datadrivenlab.org.
2 We note in passing that the U.S. oil majors ExxonMobil and Chevron are not represented on this chart.
3 According to the International Greenhouse Gas Protocol, Scope 1 emissions are direct greenhouse gas emissions from flue gases and tailpipes, while Scope 2 includes the emissions associated with electric power, heat and cooling produced by external suppliers. Finally, Scope 3 captures the indirect emissions in connection with the use of a firm’s products as well as the emissions associated with the production of inputs supplied to the firm by its supply chain. The GHG protocol classifies these emissions into multiple categories on both the firm’s upstream and downstream side. https://ghgprotocol.org/sites/default/files/standards/Corporate-Value-Chain-Accounting-Reporing-Standard_041613_2.pdf.
8 A survey published by Barclays Private Bank found that 87 per cent of the world’s wealthiest individuals, families, family offices and foundations reported that the effects of climate change played a part in their investment choices. “The Problem with Zero Carbon Pledges”, Financial Times, December 2, 2020.
15 The IPCC has issued guidelines for setting the relative weights attached to greenhouse gases other than CO₂ in order to reflect their potency and longevity in the atmosphere.
16 Methane is being addressed through voluntary programs like U.S. Environmental Protection Agency’s Natural Gas STAR program, which provides a framework to implement methane reducing technologies and practices and document voluntary emission reduction activities.
18 Base year emissions ~80 MTCO₂e
20 Ibid
23“Climate Change & Our Environmental Impact,” REI Co-op.
https://www.rei.com/stewardship/climate-change


25Unilever includes upstream ingredients and packaging use and downstream distribution, retail and consumer use. Consumer use accounts for nearly 66% of the firm’s total CCF.


27Based on projections for changes in the number of consumer uses of products, this equates to a 5% decrease in absolute emissions by the 2030 target. Also, the target does not include production for which Unilever does not have direct influence of the finished product namely; “products developed and manufactured through our joint venture operations, products distributed to professional markets via Food Solutions, bulk items and export items that are sold to third parties as unfinished products, promotional items and complex packs, and tools and devices”


29Unilever CDP Climate Change Questionnaire 2020.

30For reference, United consumed 4.3 billion gallons in 2019; United Airlines Fourth-Quarter and Full-Year 2020 Results

31“While they may offer customers some peace of mind, traditional carbon offsets do almost nothing to tackle the emissions from flying,” Scott Kirby, chief executive of United Airlines, said in an interview. “And, more importantly, they simply don’t meet the scale of this global challenge.”

https://www.oxylowcarbon.com/news/1pointfive-selects-worley-for-feed-on-milestone-direct-air-capture-facility/


34BP Sustainability Report 2019.


Craig Marshall et al., “BP Fourth Quarter and Full Year 2020 Financial Results Presentation,”

46Energy with Purpose: BP Sustainability Report 2019; all targets are relative to a 2015 baseline
47This goal is set on an equity share basis based on the company’s net share of production, thus excluding production by its partner Rosneft. Further, this aim includes the emissions from the combustion of upstream production of crude oil, natural gas and natural gas liquids. See Energy with Purpose: BP Sustainability Report 2019, page 24, for further details.


53Scope 3 emissions include 6 upstream categories (purchased goods and services, capital goods, fuel and energy related activities, upstream transportation, waste, employee commuting) and 4 downstream categories (downstream transportation, use of sold products, end of life of sold products, downstream leased assets).

542020 Microsoft Environmental Sustainability Report – A Year of Action.

55 Ibid. This fee will increase over time so that there is a single fee across the entire emissions portfolio
56This is only a sample from the most recent updates. For other targets, see Microsoft Corporation CDP Climate Change Questionnaire 2020 (Microsoft, 2020).

57Microsoft Corporation CDP Climate Change Questionnaire 2020 (Microsoft, 2020),
https://query.prod.cms.rt.microsoft.com/cms/api/am/binary/RE2EWBx

58We shall use the terms “credit” and “offset” interchangeably.

59Milloy (2020) reports that Exxon Mobil will be reporting Scope 3 emissions related to the sale of oil. Milloy (2020) argues that such reporting not only leads to undesirable double-counting but is also redundant because it is known that every barrel of oil ultimately results in about .42 tons of CO2 emissions. Steve Milloy, “Scope 3 Emissions: A Climate Accounting Absurdity,” Real Clear Energy, December 16, 2020.
https://www.realclearenergy.org/articles/2020/12/16/scope_3_emissions_a_climate_accounting_absurdity_653453.html.

60Similarly, the aircraft manufacturer Boeing currently only recognizes emissions from business travel in its Scope 3 calculations. See “Global Environment Report 2020 Companion Summary” (Boeing, 2021).

61 Scope 3 accounted for >98% of emissions associated with vehicle production in 2020. See “Scope 3 Emissions,” Toyota Industries Corporation.

62GHG Protocol: Corporate Value Chain (Scope 3) Accounting and Reporting Standard, Supplement to the GHG Protocol Corporate Accounting and Reporting Standard

63According to its CEO, the German chemical company BASF intends to measure its carbon intensity by using “ton of chemical product” as the denominator. See https://www.youtube.com/watch?v=umVk2cKwTM8. BASF produces a wide range of chemical products that differ significantly in terms of their individual carbon content. Thus a mere change in the product mix could result in a substantial reduction in the firm’s carbon intensity metric, even though the emissions per ton of each individual product remains unchanged.


65Andrew Bergman and Anatoly Rinberg, “Harms and co-benefits of large-scale CDR deployment,” in Carbon Dioxide Primer (CDR Primer, 2021).
https://cdrprimer.org/read/chapter-1#sec-1-6-https://cdrprimer.org/read/chapter-1#sec-1-6


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TSVCM Final Report


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In the literature on voluntary disclosure such an outcome is referred to as a pooling equilibrium. The literature has also established conditions when such pooling equilibria will either be impossible or at least improbable because some players will be able to credibly differentiate themselves from the pool.


Forthcoming measurement, reporting and verification guidelines from the Science Based Targets Initiative will likely suggest the ongoing communication of annual and historic results as part of a firm’s climate disclosures. See: From Ambition to Impact: How companies are reducing emissions at scale with science-based targets, SBTi Progress Report 2020

This consideration is precisely the basis for the IPCC when it calculates (probabilistic) carbon budgets for keeping the global temperature increase below specific ceiling values.

The GHG Protocol observes that compliance regimes like the Kyoto Protocol focus on direct emissions as part of top-down country-level inventory development. These calculations would be complemented by an aggregation of bottom-up company data, so long as the metric is unambiguous, verifiable and avoids double counting. The core carbon footprint metric CCFI meets these criteria.


The 2013 Regulations of the Companies Act 2006 makes “listed companies” obligated parties in this regard. Section 385 (2) of the Act defines a listed company as a UK-incorporated company whose equity shares are either listed on the Main Market of the London Stock Exchange, an exchange in a European Economic Area state, the New York Stock Exchange or Nasdaq. The Act applies to all fiscal years ending on or after the 30th of September 2013.


The 2013 UK mandate also requires firms to disclose a carbon intensity variable. Downar et al. (2020) estimate the effect of the disclosure mandate on firms’ carbon intensity by considering both Sales and Cost of Goods Sold
(COGS) as the activity variable in the denominator. They find that the firms in the treatment group exhibited a significant incremental reduction in carbon intensity of approximately 13% (10%) when the denominator in the carbon intensity ratio is Cost of Goods Sold (Sales).