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Corporate Carbon Management and ESG Reporting

An insight into corporate investments by the technology industry for green growth and climate action



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Resilient India - Disaster Free India
National Institute of Disaster Management (NIDM)
(Ministry of Home Affairs, Government of India)

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2022

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Plot No.15, Pocket 3, Block-B, Sector-29, Rohini, Delhi-110042
Website: https://www.nidm.gov.in

Corporate Carbon Management and ESG Reporting: An Insight into Corporate Investments by the Technology Industry for Green Growth and Climate Action

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Authors:

Ms Mahak Agrawal
Dr Samuel Julio Friedmann
Dr Luisa Palacios
Prof Anil K Gupta

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Dr. Akhilesh Gupta
Secretary, SERB and Senior Advisor

Department of Science and Technology (DST)
Government of India
Technology Bhavan, New Mehrauli Road,
New Delhi-110016



MESSAGE

Greenhouse gas emissions' increase across the globe, and in India, plus changing land-use land cover, and environmental degradation, are amplifying the frequency and intensity of climate risks across space and time. For India, climate change and its inequitable and multifaceted impacts are key concerns at the national and regional levels. With the recent commitment by the Honourable Prime Minister of India at the Conference of Parties 2021 held in Glasgow, United Kingdom, green growth and carbon management have become policy priorities for India.

In this context, understanding the role of companies in unlocking new investments and amplifying actions for carbon management has gained momentum. Across the United States, United Kingdom and European Union, more and more companies are making voluntary commitments to carbon management and climate action. Corporate investments from these regions are flowing across the world, including in India. A comprehensive and quality study assessing the role of these corporate investments in carbon management and the role they can play in promoting green growth for India has been not been explored yet.

I compliment Ms. Mahak Agrawal and Dr Luisa Palacios from Columbia University's Center on Global Energy Policy, Dr Samuel Julio Friedmann from Carbon Direct as well as National Institute of Disaster Management (NIDM) for documenting key insights of the study while using case examples from the technology industry. I am sure that “Corporate carbon management and ESG reporting: an insight into corporate investments by the technology industry for green growth and climate action” being published by the NIDM, Ministry of Home Affairs, Government of India will be useful to all practitioners exploring, implementing or studying science and policy-based solutions for carbon management and climate change.

(Akhilesh Gupta)

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ताज हसन, भा. पु. से.
कार्यकारी निदेशक

Taj Hassan, IPS
Executive Director

सत्यमेव जयते
आज़ादी का अमृत महोत्सव

राष्ट्रीय आपदा प्रबंधन संस्थान
National Institute of Disaster Management
(गृह मंत्रालय, भारत सरकार)
Ministry of Home Affairs, Govt. of India
प्लॉट नं. 15, ब्लॉक बी, पॉकेट 3,
सेक्टर 29, रोहिणी, दिल्ली – 110042
Plot No. 15, Block B, Pocket 3,
Sector 29, Rohini, Delhi-110042



FOREWORD

Climate change, sustainable development, and ESG (environment, social, and governance) considerations are increasingly becoming a priority concern for policymakers and corporates across the world. From being a small part of corporate social responsibility, carbon management is becoming one of the key concerns in corporate boardrooms. Measurement, communication, and disclosure of corporate performance in terms of the environment, social, and governance efforts via ESG reports or sustainability reports are increasing across the world. Companies are taking a lead in these disclosures as they fear falling behind or choosing report or rating formats that open the door to greenwashing accusations.

While the global push on companies to commit to, measure, improve and disclose their ESG efforts is commendable, returns on corporate investments on this issue have been scarcely monitored. This study provides valuable insights into the world of corporate ESG reporting and corporate carbon management. It highlights the role companies are playing and can play in climate action and green growth using case examples of five of the world renowned companies in the technology industry.

I compliment the authors for leading this study and publishing key findings and ways forward in this direction. This publication is most relevant in the present time and I am confident it will be very useful for professionals and policymakers across multiple disciplines working on climate change and environment, social and governance reporting.

Tajhassan

(Taj Hassan)

Dr Julio Friedmann
Scientist and Chief Carbon Wrangler
Chief

Carbon Direct
Carbon Capture and Storag
Direct Air Capture



MESSAGE

We live in dynamic times. Human activity, including energy, agriculture, and deforestation, are almost certainly changing Earth's climate for the worse and causing unprecedented risks and damages to the economy and ecosystems. Energy markets are turning inside out due to a war of aggression between Russia and Ukraine and may prompt a global food crisis in its wake. Extraordinary inflation is creating chaos, uncertainty, and loss of capital around the globe and shaking markets. And all this on the back of a global pandemic that has killed millions, stranded millions, and sickened millions of people with terrible health, cultural and economic consequences in all nations.

So why, against this backdrop, write about accounting for climate and carbon commitments? The reason is simple: we cannot improve what we cannot measure.

As companies, investors, and governments begin to take action on all these fronts, numbers and facts matter. Numbers can, and should, provide foundational clarity where uncertainty might otherwise limit action. Leaders must understand if their decisions and investments deliver the outcomes they seek (in what the author Kim Stanley Robinson calls our “post-dithering” phase). If not, they're simply wasting money at a time when compounded crises demand money cannot be misspent. Companies must be true to their shareholders, customers, employees, partners, and homes. That starts with honest accounting and transparent reporting.

In a world where ESG reporting is gaining strength, investment, and purpose (and soon may be codified into statute and law), metrics are in short supply. In many cases, accurate carbon accounting is devilishly difficult. Nonetheless, as this report states early and often, carbon accounting is the easiest of the many ESG potential metrics to quantify, track and attribute. It's where the light is best, creating opportunities to learn by doing and make progress through fact-based understanding.

Finally, carbon is at the core of many of these challenges. Certainly, climate change has created a chronic crisis condition for governments and companies, but also in energy investment, supply chain reconfiguration, Keynesian response to

economic woes, and more. Energy is a foundational need. Climate is a multi-generational challenge. If we can't agree on what to count and how, the fights will be more vicious, the waste more pronounced, and the opportunity created by urgency squandered.

This excellent report prompts me to quote former U.S. Senator Patrick Moynahan from NY: “Everyone is entitled to his own opinion, but not his own facts.” His admonition underlies the point of this report – may it serve us all.



(Samuel Julio Friedmann)

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डॉ. अनिल कुमार गुप्त
आचार्य एवं अध्यक्ष

ANIL K. GUPTA (Prof./Dr.)
Head of Division, I/c. International Cooperation & Advisory Services
Head-Online Training & Continuous Learning
Director of Projects & Centre of Excellence
Professor of Policy & Strategies

सत्यमेव जयते



राष्ट्रीय आपदा प्रबंधन संस्थान
National Institute of Disaster Management
(गृह मंत्रालय, भारत सरकार)
Ministry of Home Affairs, Govt. of India
प्लॉट नं. 15, ब्लॉक बी, पॉकेट 3,
सेक्टर 29, रोहिणी, दिल्ली
Plot No. 15, Block B, Pocket 3,
Sector 29, Rohini, Delhi-110042

PREFACE

Climate Crisis and carbon management are increasingly becoming a material sustainability concern for companies around the world. On one hand, where public companies are increasingly taking up many reporting frameworks for disclosing their social, environmental and governance (ESG) targets, concerns, commitments and corresponding progress. Similarly on the other hand, these reporting frameworks lack or have limited scope for representation of corporate carbon management.

Catering to this, there is a need for significant expansion of the scale and scope of corporate investments towards carbon reduction and removal as Carbon Management can provide a broad spectrum of opportunities to amplify and initiate global impacts.

This publication is developed under the "Climate Adaptive Planning for Resilience and Sustainability in Multi-Hazard Environment (CAP-RES)" supported by DST, GoI, including green growth as one of the major focus areas along with climate proofing disaster relief and recovery. CAP-RES aims to address the gap areas in capacity building to curb the challenges of climate change. This publication contributed to the project by trying to analyse corporate carbon performance as a component of ESG reporting with special focus on the technology sector.

(Anil K. Gupta)

ACKNOWLEDGEMENT

On November 1, 2021, the Prime Minister of India Sh. Narendra Modi delivered India's national statement at the Conference of Parties (CoP 26) held in Glasgow, United Kingdom. Globally, India is the third-largest greenhouse gas emitting country and its emissions are not expected to peak in the next three decades. Up until COP 26, India was one of the last few G20 countries that had not committed to a net-zero emission target. But the landscape changed with Prime Minister of India's speech at COP26 announcing India's vision to achieve net-zero emissions by 2070.

While India has yet to formally publish the new intended nationally determined contribution (NDC) and details of the commitments announced at COP26, carbon management became a national priority post-COP 26. For companies, there is a significant push to commit to ESG and carbon management efforts. However, ESG reporting in India began in 2009 with the issuance of the National Voluntary Guidelines on Corporate Social Responsibility by the Ministry of Corporate Affairs, Government of India. Since 2009, guidelines and frameworks for ESG reporting have diversified and are closely monitored by the Securities and Exchange Board of India (SEBI). However, how these ESG efforts and associated investments can help green growth and carbon management is not fully understood. We hope and believe that this study and its insights are critically important in the context of India's 2070 commitment to net-zero emissions — as it clarifies the role corporate investments are playing for carbon management and can play in green growth.

This publication has been supported by the Department of Science and Technology (DST), Government of India, through the Climate Adaptive Planning for Resilience and Sustainability (CAP-RES) in multi-hazard environments. Our most sincere thanks to Mr Taj Hassan, Executive Director of NIDM, Dr Nisha Mendiratta, Advisor and Head of Climate Change at the Department of Science and Technology, Dr Susheela Negi, Principal Scientist, and Dr Rabindra Panigrahi, Senior Scientist of Department of Science and Technology, Government of India for their support to this study.

Our special thanks to Ms Pritha Acharya, Research Associate of CAP-RES for coordinating the printing and publication of this study. Mr S.K. Tiwari, Librarian, Mr Surendra Thakur, Consultant, I/C (HR and Admin.) and the entire publication cell including Ms Karanpreet Kaur Sodhi, Junior Consultant for facilitating the study's printing and publication. We sincerely hope that the findings and recommendations of this study are useful for further research and policy action on carbon management and the role companies can play in unlocking new investments and ideas for green growth and climate action.



Prof. Anil K. Gupta
Project Director, CAP-RES

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ABBREVIATIONS

AUM	Assets Under Management
CSR	Corporate Social Responsibility
CDSB	Climate Disclosure Standards Board
DAC	Direct Air Capture
EHS	Environment, health and safety
EPFI	Equator Principles Financial Institutions
ESG	Environmental, Social and Governance
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GRI	Global Reporting Initiative
GNI	Global Network Initiative
IIRC	International Integrated Reporting Council
ILO	International Labour Organization
ISO	International Organization for Standardization
LBC	Living Building Challenge
LEED	Leadership in Energy and Environmental Design
MMT CO_2e	Million metric tonnes of carbon dioxide equivalent
MSCI	Morgan Stanley Capital International
NBS	Nature-based solution
NFRD	Non-financial reporting directive
SA8000 Standard	Social Accountability 8000 Standard
SAF	Sustainable Aviation Fuel
SASB	Sustainability Accounting Standards Board
SDGs	Sustainable Development Goals
SRI	Socially Responsible Investments
TCFD	Task Force on Climate-Related Financial Disclosures
UNEP- FI	United Nations Environment Programme Finance Initiative
UNGC	United Nations Global Compact
UNGP	United Nations Guiding Principles on Business and Human Rights
UN PRI	United Nations Principles for Responsible Investment

Executive Summary

Climate crisis and carbon management are increasingly becoming a material sustainability concern for companies around the world. Public companies are increasingly adopting one or more reporting frameworks to disclose their environmental, social and governance (ESG) concerns, targets, commitments, and corresponding progress. These frameworks are a good starting point to hold companies accountable for their broad sustainability efforts, but the scope of corporate carbon management reported via these frameworks is limited. Companies can reap many benefits from ESG reporting, including improved investor relations, market competitiveness, and accurate, automated, and comprehensive measurement of their carbon footprint across the world and geographic regions. However, the reality is that progress in corporate carbon management, such as carbon neutrality, may not equate to a company neutralizing its total reported emissions to zero or reducing its emissions to the extent disclosed.

This report analyses corporate carbon performance, as a component of ESG reporting, for the technology industry — with a case study of five technology companies of Google, Amazon.com, Apple, Samsung Electronics, and Microsoft. It focuses on carbon for two key reasons: one, carbon is one of the most pressing global challenges; and, two, it is tough but relatively easier than other global challenges to measure and monitor. In essence, carbon management provides a broad spectrum of opportunities to initiate and amplify global impact. Focusing on five of the largest technology companies in terms of revenue—including Google, Amazon.com, Apple, Samsung Electronics, and Microsoft—the study examines the role of ESG reporting in managing carbon across corporate value chains and supply chains. A comprehensive analysis of every ESG report of these five companies reveals a significant expansion of scope and scale of corporate investments towards carbon reduction and removal. This analysis is possible because of the voluntary transparency of these companies as part of the overall set of corporate policies to lead in environmental reporting and stewardship—to prompt other companies and governments to higher ambition.

The analysis also highlights that four of the five companies with bold net-zero targets are neutralizing a very small fraction—ranging from 2% to 12% in 2020—of total reported emissions. This gap presents

diverse challenges to technology companies that have publicly announced targets for decarbonization and are unable to neutralize 100% of their reported emissions. There are several strategies and solutions to get closer to net-zero carbon emissions.

Diversifying low-carbon energy source options and expanding their storage capacity is one area of action. Expanding nature-based solutions to sequester carbon in another. But these only reduce the emissions to a certain extent. Nature-based forestry solutions face risks of releasing carbon into the atmosphere due to pests, land use-land cover change, fires and droughts.

The authors recommend technology companies can take the following actions to effectively manage carbon linked to their internal operations, value chain and supply chains:

1. Comprehensively measure, monitor and report carbon emissions, including scope 3 emissions.
2. Move beyond carbon neutralization efforts focusing on purchasing offsets and procuring renewable energy to a diverse portfolio of low-carbon energy resources and long-term, durable solutions for deep decarbonisation
3. Monitor quantum and quality of multifaceted returns on investments geared towards carbon reduction and removal

Technology companies that reflect these recommendations would be better equipped to align business decisions with the global carbon budget. It would also help them avoid accusations of greenwashing whilst improving their performance, accruing cost savings from emission reduction, and advancing the market readiness and scalability of engineering or technological solutions that are needed to achieve deep decarbonization of the company's internal operations, value chain and supply chains.

Introduction

The origin of environmental, social and governance (ESG) reporting can be traced back to year 2000 when a few non-governmental organizations started tracking carbon emissions for corporations.[1] In the same year, the Global Reporting Initiative (GRI) was launched and argued that if companies measured, monitored, and periodically reported their ESG performance, a sustainable form of capitalism would emerge through business transformation and strategic reinvention.[2] In 2004, former UN Secretary-General Kofi Annan invited over 50 CEOs of major financial institutions to a joint initiative led by the UN Global Compact, International Finance Corporation (IFC) and the Swiss Government. In 2005, this initiative produced the *Who Cares, Wins* report and advocated for embedding ESG factors in capital markets.

A few months later, UNEP-FI published a report outlining a legal framework for the integration of ESG issues into institutional investment.[3] These two reports contributed to the launch of Principles for Responsible Investment (PRI) in 2006. Consequently, 63 investment companies with $6.5 trillion in assets under management (AUM) signed and committed to incorporating ESG issues into investment decisions. A big push for ESG came in 2013 with evidentiary support linking good ESG- aligned corporate governance with good financial outcomes. It underscored the importance of ESG information for assessing corporate risks, strategies, and operational performance.[4]

By 2018, the number of signatories expanded to 1,715 with $81.7 trillion in AUM.[5] In March 2021, over 15% of all listed companies were disclosing their carbon emissions—with variable ESG maturity levels across companies. Investors and lenders are now proactively seeking information and are better informed on the risks of climate change and other environmental risks their investments and assets are susceptible to. Partnerships to solve pressing ESG challenges are increasing too.[6] In May 2021, six big banks started working together to develop an agreement supporting the decarbonization of the steel industry.[7] However, the adoption of ESG has not been smooth. The utility of ESG reporting in measuring carbon performance—across a company's internal operations, value chain and supply chains—is still not fully understood.

This study analyses corporate carbon performance, as a component of ESG reporting, for the technology industry — with a case study of five technology companies of Google, Amazon.com, Apple, Samsung Electronics, and Microsoft. It focuses on carbon for two key reasons: one, carbon is one of the most pressing global challenges; and, two, it is easier to measure than other ESG metrics — such as metrics on biodiversity and habitat loss. A single numeric value of carbon, in the form of CO_2 equivalent emissions, captures and conveys the impact created by a variety of greenhouse gases and can be compared across companies, activities or even monetized in the form of a carbon price.[8]

Conceptual Background

ESG reporting by companies is increasingly becoming a norm — irrespective of industry, the scale of operations, and portfolio of products and services. Different reporting frameworks provide a different set of standards and indicators to measure and report a company's performance along environmental, social and governance dimensions.

In an ESG reporting framework, environmental metrics include activities, attributes and disclosures related to carbon accounting, GHG emissions, waste management, and other environmental impacts. Social metrics focus on how an organization manages the relationships between and among stakeholders, including activities, attributes and disclosures on workplace health and safety, employee diversity and inclusion, labour standards, human rights, and other societal impacts. Governance metrics highlight a company's ownership structure, decision-making process, corporate policies, other practices and operations that balance the rights, responsibilities and identities of stakeholders and shareholders while improving fairness and transparency.[9]

ESG reporting frameworks have evolved to consider the specific ESG elements that are most relevant to each industry. Apart from the various ESG reporting frameworks, there exist sustainability reporting frameworks that may or may not focus on ESG in their entirety. Much like ESG reporting, these sustainability reporting frameworks allow companies to define goals, improve transparency to stakeholders and shareholders, support the transition towards a low-carbon economy, and communicate insights on performance beyond the bottom line to stakeholders.[10]

Some of the earliest sustainability reports were published in the 1980s by select chemical and mining companies to counter the negative image associated with the company's impact on the environment and local communities in which they operated.[11] Since the 1980s, several sustainability frameworks have been

formulated and used by companies around the world to measure and analyse these sustainability considerations in the annual financial reporting process. Reviewing key frameworks and the scope of carbon metrics measured by these frameworks (as summarized in Appendix 1), it is evident that all ESG reporting frameworks are sustainability frameworks but not all sustainability reporting frameworks are ESG frameworks.

As the number of companies issuing ESG reports has surged so has the need to analyse these ESG disclosures and evaluate corporate performance. The need for investors to differentiate companies in terms of their improvement or worsening of ESG metrics and measure non-financial risks has led to a whole industry of ESG rating agencies — which measure a company's resilience to long-term ESG concerns by processing ESG metrics.[12]

ESG ratings have many criticisms, including that they highlight the potential impact of the world on a company and its shareholders — instead of measuring a company's impact on Earth and society. This is because both ESG disclosures and ratings are emulating standard financial practices in measuring risks while focusing on the concept of materiality to assess why and how an ESG risk has the potential to impact the company's economic performance — as not all ESG issues matter equally and to every company. In essence, the methodology of many ESG ratings might potentially only consider ESG issues that impact a company's performance.[13]

By and large, ESG rating agencies do not consider carbon emissions to be part of the materiality considerations for technology companies. For example, the materiality map of MSCI or SASB for technology companies, two of the most important ESG rating providers, does not include carbon emissions — even though technology sector is responsible for 2% to 3% of global greenhouse emissions.[14] For MSCI, ESG Industry Materiality Map reflects the average key issue weight for companies in an industry. This weightage is determined via two key factors: one, how much does each industry contribute to the main externality connected to the issue as compared to other industries, such as how carbon-intensive industry is relative to other industries; two, the time horizon within which the externality may materialise.[15]

Similarly, the SASB materiality map identifies financially material concerns that are likely to impact the financial or operating performance of a company, and are thus most relevant to investors. For 5 of the 6 industries identified under the technology and communications industry, SASB does not identify GHG emissions as relevant issue affecting enterprise value. For the semiconductors industry,

however, GHG emissions are identified as a relevant issue but only focus on the scope 1 direct emissions that the company generates through its operations.[16]

Carbon Performance as a Component of ESG Reporting

There are no universally adopted standards for companies to measure and report their ESG performance. Instead, a large number of non-governmental organizations and agencies are independently developing standards for ESG reporting, and since this ESG reporting is largely voluntary and loosely regulated at the present, companies can choose ESG metrics from one framework or blend of frameworks to report their performance. In 2018, 78% of the S&P 500 published an ESG report, of which nearly 97% c[hos]e to customize their reporting models instead of opting for any one framework.[17]

The voluntary nature of ESG reporting is may soon change as regulators across different parts of the world are developing proposals and rules mandating such disclosures. For instance, in March 2022, the Securities and Exchange Commission (SEC) of the United States proposed a rule that requires all publicly traded companies to disclose their GHG emissions and risks they face from climate change in a standardised fact sheet from the Commission.[18]

Six key ESG standards and frameworks for a company to assess, measure, and communicate its ESG performance are GRI Standards, International Integrated Reporting Framework (IIRF), Sustainability (SASB) Standards, CDP, Task Force on Climate-Related Financial Disclosures (TCFD) Framework, and Climate Disclosures Standards Board (CDSB) Framework. A comparative overview of these six ESG reporting frameworks (summarized in Appendix 2) highlights that the scope of ESG reporting and carbon metrics monitored differ — in line with the purpose of reporting, who the reporting agency or company is, and the target audience (summarized in Table 1).

Table 1: Scope of carbon metrics monitored by key ESG reporting frameworks

ESG Frameworks Scope of carbon management#	Carbon metrics
GRI Standards (Universal, Sector, Topic Standards) **Implicit** for Universal Standards; **Explicit** for GRI 305: Emissions	1. Universal standards focus on the environmental impacts of a company and its strategy to manage the negative impacts 2. Topic Standard on Emission is applicable for all reports published on or after July 1, 2018, and focuses on disclosures for Scope 1, 2, and 3 emissions; GHG emissions intensity and reduction; emissions of ozone-depleting substances; NOx, SOx, and other air emissions

ESG Frameworks Scope of carbon management#	Carbon metrics
CDP **Explicit** in Climate Change Questionnaire; **Implicit** in Forest and Water Security Questionnaires	1. In the CDP Climate Change questionnaire, there are 4 out of 14 modules that have carbon man agement in their scope, including Emissions methodology, emissions data, energy, and carbon pricing 2. Other metrics: science-based emission reduction target, GHG emissions inventory, corporate climate change strategy 3. Requested data point: Magnitude of intended carbon removal
IIRF **Explicit**	1. Emissions caused by product manufacturing may be disclosed as part of business model disclosures, based on materiality 2. Performance KPIs such as the ratio of greenhouse gas emissions to sales, and the monetary value of carbon emissions, may be reported
CDSB Framework **Explicit**	1. Calls for informing readers of the organization's material environmental risks and opportunities 2. REQ-03: reporting regulatory risks and opportunities linked to GHG and non -GHG emissi ons limits, plus emission trading schemes 3. REQ-04 reporting on absolute and normalized GHG emissions and non -GHG emissions (Scope 1 & 2 focus, Scope 3 not necessary) as sources of the organization's environmental impact.
SASB Standards **Explicit** for Scope 1; **Implicit** for Scope 2 and 3	1. Direct Scope 1 emissions in 22 of 77 industry standards, including Semiconductors for technology industry 2. Energy management as a proxy indicator for indirect scope 2 emissions in 35 of 77 industry standards. For the t ech industry, it is applicable for Semiconductors, Software & IT services, and Telecommunication services 3. Scope 3 emissions are disclosed for 30 out of 77 industry standards via product design & lifecycle management, supply chain management, material sourcing & efficiency.
TCFD Framework **Explicit**	1. Scope 1 and 2 emissions and related risks. 2. If appropriate, report Scope 3 emissions and related risks 3. Report historic emissions to examine trends and methodologies used to assess GHG emissions

Developed by authors (2022)

Scope of carbon management is:

- Explicit when standards of the framework reflect on monitoring and reporting of carbon emissions, and/or carbon reduction, and/or carbon removal.
- Implicit when climate change or environmental footprint is the focus, and not carbon.

In terms of carbon reporting, these frameworks focus on GHG emissions — particularly scope 1 and 2 emissions; scope 3 emissions are recommended disclosures, but not necessary. Out of the six frameworks assessed as part of this study, only GRI Topic Standards on emissions (GRI 305: Emissions 2016) specify standards for emission reduction disclosure. For CDP, it is the Climate Change Questionnaire that calls reporting organizations, companies and cities to measure and report their science-based reduction target and corporate climate strategy. The scope of reporting on outcomes and impact of initiatives for carbon removal, reduction and sequestration remain flexible.

To sum it up, the scope, scale, and impact of ESG frameworks in monitoring and managing carbon is limited. These frameworks largely focus on building and communicating ESG inventory, and less on the solutions and strategies that follow—to reduce or remove reported emissions.

Discussion

Corporate ESG reporting is on the rise, and often equated as a proxy for progress; the reality however differs. The voluntary nature of ESG reporting, limited regulation on disclosures, and lack of standardization across different reporting frameworks allow selective communication of ESG metrics and communication of a tale favourable to the reporting agency or company. If a company misses its voluntary target or continually increases its emissions, it may face backlash from stakeholders and shareholders, and it may suffer temporary valuation loss, but it will not be held liable or penalized — as these frameworks come up with little to no liability clause.

The majority of these ESG frameworks report on GHG emissions — especially scope 1 and 2 emissions. While guidelines for scope 3 measurement are available and several frameworks support its disclosure, corporate reporting of scope 3 is challenging. It requires a company to measure, monitor, and report the full extent of emissions across value and supply chains. These frameworks focus on the final emission value and not on breaking down emissions across sources. The latter can help identify hotspot areas and activities where emissions reduction needs to be focused on and use this information to identify risks and opportunities.

Moreover, these frameworks often focus on measurement, particularly metrics that can be monetized. For instance, GHG emissions are easy to measure and a numeric value helps convey a company's impact on the environment. While emission is one metric quantifying a company's impact on the environment, it is not the only metric to evaluate complex and multidimensional cause-and-effect relationships a company has on the environment at local, regional, and global scales.

Despite several limitations, ESG frameworks are a good starting point to hold companies accountable for their carbon management and broader ESG efforts. Efforts to harmonize standards of different frameworks are underway. Partnerships for solving pressing ESG challenges are expanding and are expected to further expand in scale and scope.

ESG Reporting and Corporate Carbon Management

Several businesses, cities and countries are increasingly announcing big-bold commitments, particularly for carbon management — and in the lead up to a major global climate conference. Commitments and targets — such as net-zero, carbon negative, and carbon neutrality — signal good intentions but often lack ambition and strategic actions aligned with the 2015 Paris Agreement.

Climate neutrality is a conceptual state wherein human activities result in no net effect on the climate system. This state requires balancing residual emissions with emission removal as well as accounting for regional and local bio-geophysical effects of human activities that affect local climate.

Net-negative emissions are achieved when anthropogenic activities lead to more removal of GHGs from the atmosphere than are emitted into it.

Net-zero emissions are achieved when anthropogenic GHG emissions to the atmosphere are balanced by anthropogenic removals over a specific time. When several GHGs are involved, the quantification of net-zero emissions is guided by the climate metric—such as global warming potential, global temperature change, etc.—selected to compare emissions of different GHGs.[19]

In terms of corporate carbon management, three categories of emissions — scope 1, scope 2, and scope 3 — are measured, monitored and managed via carbon reduction and removal solutions. Scope 1 emissions are direct GHG emissions produced by a company's facilities and fleet, i.e. resources that the company owns or controls. Scope 2 emissions are indirect emissions associated with its purchased electricity, i.e., the emissions from power plants generating electricity that the company uses for its diverse operations. Scope 1 and 2 are largely within a company's control as a company and can act as a great starting point to deliver carbon pledges and commitments for a net-zero or carbon-negative future.[20]

Scope 3 emissions are indirect emissions embedded in the materials and services that a company uses across the value chain, including emissions from upstream and downstream activities, suppliers and distributors, employees' business travel, and use of sold products and services. Businesses have limited control on scope 3 emissions, even though it accounts for a significant proportion of a company's total emissions. Companies can opt for solutions to reduce emissions and remove carbon in

the supply chain by collaborating with suppliers and/or changing the product design; the real influence, however, is linked to the procurement or purchasing decisions of suppliers.[21]

This study has been undertaken with case examples of five of the biggest technology companies in terms of annual revenue, including Apple Inc., Google LLC, Amazon.com, Microsoft Corporation, and Samsung Electronics. While all of these companies are technology companies, each company offers a different set of products and services and has a different portfolio of assets, operations, and markets for its products and services. This analysis is possible now in large part from the voluntary transparency of these companies, which is part of the overall set of corporate policies to lead in ESG reporting and stewardship and prompt other companies and governments to higher ambition.

Case One: Apple Inc.

Apple Inc. is a U.S. technology company that designs, manufactures and sells personal computers, computing, and mobile communication devices as well as diverse software, services, peripherals and networking solutions. Founded in 1976 and incorporated in 1977, Apple was one of the earliest manufacturers of personal computing devices equipped with graphic user interfaces.[22] Known for its innovations, Apple gradually expanded and diversified its portfolio of products and services, and thence its geographic influence beyond the United States to Europe and Asia — in terms of corporate operations, manufacturing of products and product parts, markets and customer base, supply chains, and distribution network comprising of online and retail stores, direct sales force, third-party wholesalers, and resellers.

Corporate ESG strategy

In 2021, Apple published its first ESG report highlighting existing and new disclosures in line with metrics outlined in the GRI, SASB, and TCFD frameworks. The company's ESG strategy is built on the belief that businesses can and should act as a force for good. It aims to achieve this via innovation, collaboration, and serving others to leave the world in a better state while creating tools that empower others to do the same.

Table 2: Evolving focus and key elements of Apple Inc.'s ESG strategy, 2008-21

Year of reporting *ESG reports* **Reporting frameworks**	**Environment**	**Social/ People**	**Governance**
2021 *1. ESG Report* *2. Environmental Progress Report* *3. People and Environment in Our Supply Chain* **GRI, TCFD, SASB**	- **Supply chain:** carbon-neutral supply chain, energy efficiency, water stewardship, eliminating waste - **Environmental strategy:** smarter chemistry (assessment, innovation, mapping, and engagement); resources (sourcing, efficiency, material progress, packaging, product longevity, product end -of-life, water stewardship, zero waste); climate change (low carbon design, energy efficiency, renewables, carbon removal)	- **Supplier responsibility:** standards, accountability - **Labour and human rights:** policy, recruitment, materials sourcing - **Health, safety, and wellness:** culture, COVID response - **Supplier performance:** assessment and improvement	- **Corporate leadership:** diversity & compensation - **Commitment to human rights:** policy, progress - **Ethics and compliance:** business conduct - **Tax payments** - **Stakeholder engagement**
2008 *1. Facilities report* *2. Supplier responsibility* **GRI**	- **Environmental impact:** energy use, renewable energy, transportation, water use, waste, and recycling - EHS policy statement and guiding principles	- Supplier training	- **Supply chain audit:** KPIs, core violations

Developed by the authors (2022)

The environmental component of this strategy focuses on measuring the environmental impact, carbon-neutral corporate operations and products, and partnering with communities for just implementation of environmental efforts. The social component focuses on empowering people with technology, establishing an inclusive and diverse work environment, and respecting the human rights of internal and external stakeholders. The governance dimension focuses on embedding transparency and accountability across all levels of the company.[23]

From 2008 to 2013, Apple reported its environmental performance via annual Facilities Report and Supplier Responsibility Progress report. The Facilities Report highlights environment, health and safety (EHS) policy and its guiding principles, as well as environmental progress—on energy use at Apple facilities, water use and waste management. In 2014, metrics and scope of reporting

expanded and until 2018, the annual report was published as the Environmental Responsibility Report. In the last 14 years, ESG metrics measured and reported by Apple have expanded unevenly with the expansion inclined more towards the environment or social dimension (indicated in Table 2. For a detailed overview, refer to Appendix 3).

Emissions Profile

Apple Inc. annually measures and reports its scope 1,2, and 3 emissions using a blend of different emission calculation tools and standards. For its scope 1 calculations, Apple uses emission factors developed by EPA Center for Corporate Climate Leadership.[24] The boundary of scope 1 emissions includes emissions emanating from natural gas use in buildings, and fuel use for fleet vehicles and since 2016 it also calculates emissions from the use of diesel in emergency backup generators and propane gas used in its corporate offices. In 2017, it started calculating process emissions—as part of scope 1—to reflect emissions from research and development processes (refer Appendix 4).

Focusing on post-2016 trend—with more common data points and methodology for emission accounting—the emission profile indicates a dominance of scope 3 emissions whereby a total of scope 1 and 2 account for less than 0.5% of total reported emissions (indicated in Figure 1). From 2016 to 2018, scope 1 emissions increased by over 23,000 tCO_2e, but from 2018 to 2020, these emissions decreased by 10,000 tCO_2e—witnessing a net increase of 38% (~13,000 tCO_2e) from 2016 to 2020. This five-year growth in scope 1 emissions is dominated by emissions from the use of natural gas, diesel and propane.

Scope 2 emissions witnessed a dramatic decrease from 2016 to 2018 and became zero in 2019 and 2020, wherein Apple claims to have matched its total electricity use with renewable electricity—procured through power purchase agreements, renewable energy certificates, direct ownership, and equity investments. The breakdown of these renewable energy sources is not publicly reported.

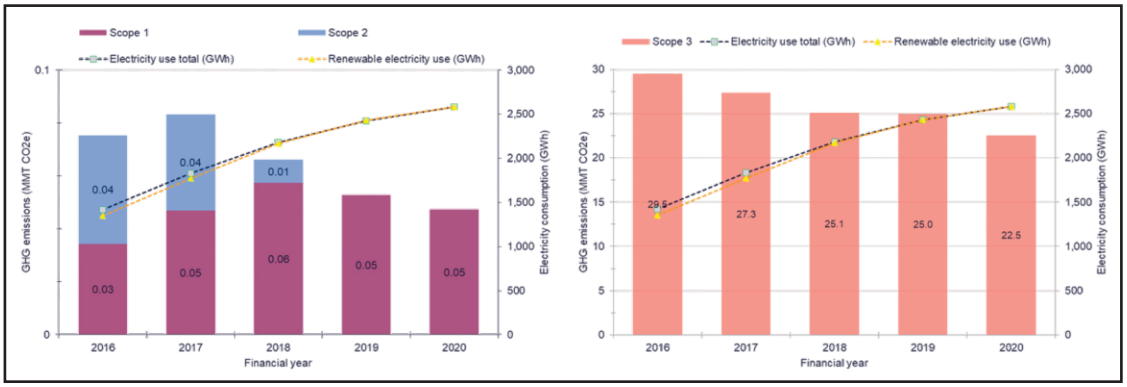


Figure 1: Scope 1, 2 (left) and 3 (right) emissions (in MMT CO_2e) of Apple Inc. and corresponding use of energy and renewable energy (in GWh), 2016-20[22,24]

Scope 3 emissions—accounting for 99.7% to 99.8% of total emissions reported during 2016-20—are dominated by manufacturing emissions (as indicated in Figure 2). The latter accounts for over 70% of total scope 3 emissions in any year. Emissions from end-of-life treatment of products witnessed a sharp decline post-2016 as the company revised its methodology in 2017 to highlight disposal and recycling practices. In essence, Apple has an immense opportunity to exercise control over its manufacturing processes and better manage the bulk of emissions linked to its global manufacturing.

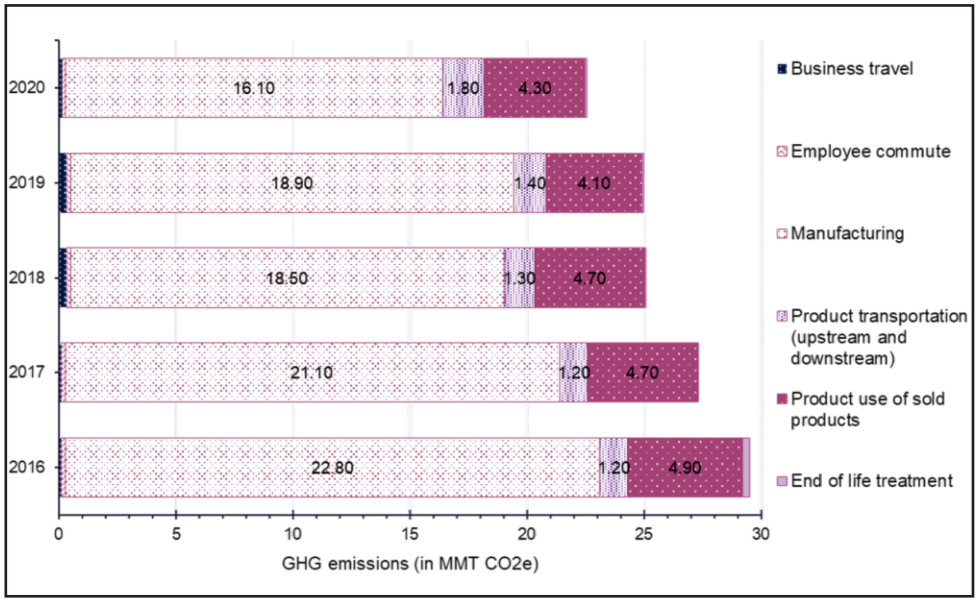


Figure 2: Breakdown of scope 3 emissions of Apple, Inc., 2016-2020
Developed by the authors (2022)[22, 24]

Carbon Management Strategy

Apple is not new to corporate carbon management. To phase out lead in batteries, the company started embedding environmental stewardship into its operations in 1991 and has come a long way since.

Presently, Apple's environmental strategy—in line with its commitment to become carbon neutral across its entire business, manufacturing supply chain, and product life cycle by 2030—is built on three pillars of climate change, resources and smarter chemistry (indicated in Table 3). Guided by its carbon footprint, Apple's work on climate change focuses on reducing emissions by 75% compared to 2015 levels and investing in carbon removal solutions for the remainder of the emissions (indicated in Figure 3). The resources pillar seeks to eliminate plastics in packaging by 2025, develop products and packaging with recycled or renewable materials only, steward water resourcing and send zero waste to landfills. Through smarter chemistry, Apple aims to design products that are better for the environment and safer for everyone assembling, recycling and using them.[25]

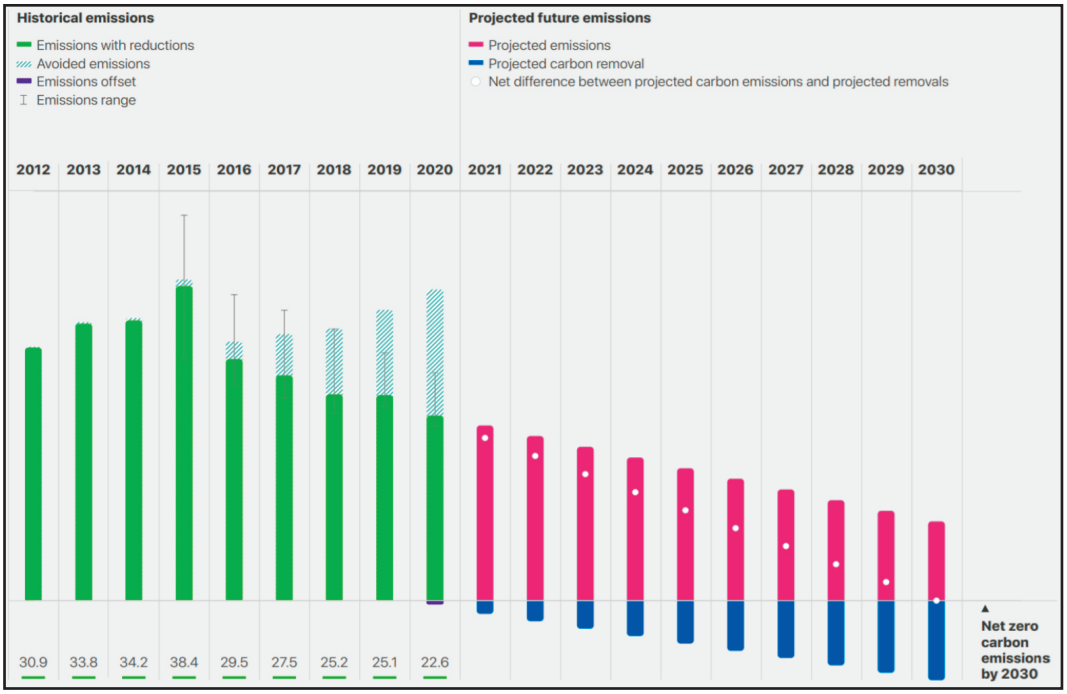


Figure 3: Apple's historical carbon footprint and proposed pathway for net-zero emissions by 2030
Source: Apple Inc., 2021

To amplify its impact, Apple established an Impact Accelerator, Restore Fund and First Movers Coalition in 2021. The Coalition was launched at COP26 with 34 other global companies to amplify demand for scalable and accessible decarbonization technologies.[26] In 2021, it launched a $200 million Restore Fund with Goldman Sachs and Conservation International—amplifying responsible packaging innovations and carbon removal via nature-based forestry projects to remove at least 1 MMT of CO_2e annually from the atmosphere.[27] Impact Accelerator invests in minority-owned businesses driving positive outcomes in its supply chain and communities disproportionately affected by environmental hazards.[28]

Across the three key action areas, the general focus is on carbon reduction via fuel switch to renewables, energy efficiency and conservation. The company is expanding its focus and investments in carbon removal via nature-based solutions. For most of these carbon reductions and removal projects and initiatives, the geographic scope of impact and implementation is global. But a few initiatives on carbon removal—such as the micro-forestry project in Kenya, and mangrove restoration in Colombia—and renewable energy are concentrated in select countries.

Table 3: Action areas, initiatives and outcomes of Apple's carbon management strategy

Key action areas *Carbon management focus* *Geographic focus*	Initiatives	Key outcome and achievements
A. Climate Change *Carbon reduction, Carbon removal* ***Low-carbon design:*** *Global* ***Energy efficiency:*** *Global*	1. **Low-carbon design:** via efficient use of materials, low-carbon alternatives, product energy efficiency **2. Energy efficiency:** for Apple facilities' operat ions, working with suppliers towards a more energy-efficient supply chain, expanding access to energy efficiency	1. Compared to 2015, 34% reduction in product carbon footprint via the use of the M1 chip for Mac mini and; a 72% reduction in emissions associated with aluminium via the use of recycled and hydro - smelted aluminium.

Key action areas *Carbon management focus* *Geographic focus*	Initiatives	Key outcome and achievements
Renewable electricity: *Global (active projects in Australia, Brazil, U.S., China, Denmark, France, India, Israel, Japan, Taiwan, South Africa, Mexico, Turkey)* ***Emission abatement:*** *Global* ***Carbon removal:*** *in Kenya, China, U.S., Colombia, China*	**3. Renewable electricity:** for Apple facilities & suppliers, developing energy storage, supporting supplier capacity, advocating for policy change **4. Direct emission abatement:** via fuel switch to low-carbon options, innovating aluminium manufacturing, addressing fluorinated GHG emissions, less-carbon intensive transportation of products, improving employee travel and commute **5. Carbon removal:** via nature-based solutions	2. Reduction in energy use by 13.9M KWh in FY20. 3. 87% of renewable projects are long -term renewable energy contracts, 3% are equity investments, and 10% are directly owned. 4. Installation of emission mitigation technologies for display suppliers to reduce F -GHG em issions by over 90% 5. Set up a $200 million Restore Fund in 2021 to remove more than 1 MMT CO_2e per year
B. Resources Carbon reduction ***Materials:*** *Global* ***Water stewardship:*** *U.S., China* ***Zero waste to landfill:*** *Global*	**1. Materials:** efficiency and sourcing of recycled and renewable materials, product longevity, product end-of-life **2. Water stewardship:** improving efficiency across operations, alternatives to fresh water, water savings **3. Zero waste to landfill:** reduce waste from corporate facilities & manufacturing	1. 10.4 million devices refurbished for new users in FY20. 65% less single -use plastic in packaging in FY20 as compared to FY15. 2. 172 suppliers of the Clean Water Program saved 10.8 billion gallons of water in FY20 3. Diverted 1.65 MMT of waste from manufacturing between 2015-20
C. Smarter Chemistry Carbon reduction ***Mapping/engagement:*** *Global* ***Assessment:*** *Global* ***Innovation:*** *Global*	**1. Mapping and engagement:** creating an inventory of chemicals used in products **2. Assessment:** setting high standards for chemical safety, standards-based assessment of chemicals in the environmental testing lab **3. Innovation:** to design and manufacture with safer chemicals, safer alternatives	1. 40K materials included in comprehensive material library 2. 600+ manufacturing partner facilities share use and management of chemicals 3. 100% of supplier final assembly sites use safer chemicals

Developed by authors (2022)

Summary: Corporate Carbon Review

Reviewing the company's emission profile and carbon performance, it is noted that:

One, the company's scope 1 and 2 reporting does not account for 100% of emissions. It doesn't disclose whether the scope 1 emission calculations include the entire range of fuel options it uses, including natural gas, biogas, propane liquid, gasoline, and diesel for mobile combustion and other uses. This fuel consumption for corporate facilities alone accounts for roughly 15% of total energy use in FY20. Also, the scope 2 emissions do not include emissions from building operations and cooling of data facilities, as the company notes these emissions are beyond its operational control.

Two, Apple reports net-zero emissions from purchased electricity from 2019-onwards as it claims to have matched its electricity consumption for data centres, retail stores, and offices around the world with renewable energy. This electricity consumption accounts for 81-85% of the total energy consumed by Apple. In its 100% renewable energy sourcing, 10% of the projects are directly owned by Apple, another 3% of Apple-create projects are equity investments, and the remaining 87% of projects are long-term renewable energy contracts. It does not account for the fact that even when companies contract renewable supply, on an hourly basis only a fraction of electricity use is matched with carbon-free or low-carbon sources.[29]

Three, the company has expanded its carbon-neutral boundary. From April 2020 onwards, the company reports its global corporate operations as carbon neutral. But this carbon-neutral boundary accounted for less than 1.5% of total reported emissions in 2020 — as it only included scope 1, market-based scope 2, and scope 3 emissions from business travel and employee commute. In 2020, the company expanded this boundary to include the entire emissions inventory reported which also includes scope 3 emissions from manufacturing, product transportation, product use and end-of-life treatment. However, the company makes no such commitment to neutralizing its historic footprint.

Four, Apple does not disclose the true extent of the impact of some of its key carbon efforts. For instance, the company expanded its trade-in program to 25 countries in FY20 and sent 10.4 million devices for refurbishment. However, it does not disclose its plans for expansion of the trade-in program and the scale of impact it envisions from it. Moreover, 10.4 million is a big number, but it accounted for roughly 5% of 200 million new devices Apple added to the market

in 2020.[30] How and if it plans to reduce the demand for new devices, extraction of materials from Earth, and life cycle emissions with this trade-in and refurbishment program, is left unanswered.

Five, Apple is ramping up its efforts to decarbonize the supply chain. In 2020, 70 suppliers committed to using 100% renewable energy for production. It's a mammoth undertaking for Apple as the company has a significant portion of its supply chain in China and Southeast Asia, where the grid is predominantly powered by fossil fuels. The company, however, does not disclose how it plans to monitor the use of renewables by suppliers. How big a dent will 70 suppliers opting for renewable make to the company's 2030 goal — remains unclear. For effective alignment of business decisions, investments and decarbonization efforts, it is important that the company measure, monitor and report the scale of the impact these cross-cutting initiatives will make in line with the 2030 goal.

To sum it up, Apple has been making some bold commitments in the past two decades and deploying a cocktail of carbon management solutions. It has an immense opportunity to accelerate the transition toward a more sustainable future and expand the scope and scale of investments toward carbon reduction and removal efforts. It could map out plans for deep decarbonization rather than perpetuating its reliance on purchasing offsets and short-term nature-based carbon removal solutions.

Case Two: Samsung Electronics Co. Ltd.

Samsung Electronics Co. Ltd., headquartered in South Korea, is a multinational electronics and information technology company of the Samsung Group. It was founded in 1969 as a small manufacturer of black-and-white TVs and quickly became a major manufacturer of home electronics and semiconductors for the Korean market.[31] By the early 1980s, the core business of Samsung Electronics diversified and expanded globally. With the merger of Samsung Electronics and Samsung Semiconductors in 1980, the company's reach expanded further into electronics, semiconductors, optical telecommunications, and new fields of technological innovation. In 2021, Samsung Electronics was the world's second-largest technology company by revenue, and had a sales network and assembly plants spanning over 74 countries and employing nearly 300,000 people worldwide.[32]

Corporate ESG Strategy

The ESG strategy of Samsung Electronics is built on the premise that environmental sustainability and economic development can co-exist and align with the co-prosperity of communities. Acknowledging that a company is not evaluated solely based on business performance, the company's ESG strategy focuses on using human resources and technology to create products and services that contribute to a better society as well as proactively address environmental and social issues. Samsung Electronics releases its annual sustainability report with detailed activities structured under five sustainability pillars — Environment, Our Employees, Empowering Communities, Digital Responsibility, and Sustainable Supply Chain.[33] These pillars have evolved and expanded since Samsung Electronics started publishing its annual sustainability report in 2008 (summarized in Table 4. For a detailed overview, refer to Appendix 5).

Table 4: Evolving focus and key elements of Samsung's ESG strategy, 2008-21

Year of reporting *ESG reports* Reporting frameworks	Environment	Social/ People	Governance
2021 *1. Sustainability report*	- **Climate actions:** governance, risk ma nagement, emission reduction at worksites, product energy efficiency	- **Stakeholder engagement & communication** : to define sustainability approach	- **Digital responsibility**- personal information

Year of reporting *ESG reports* Reporting frameworks	Environment	Social/ People	Governance
2. *Samsung Electronics Manufacturing (UK) Limited Pension and Life Assurance*	-**Circular economy:** efficient use of resources, extending product lifespan, take -back & recycling of e -waste, waste, water, chemical management -**Supply chain:** responsible	**Empowering communities:** corporate citizenship, support for enterprises & startups **Employees:** labour & human rights, workplace	protection, AI ethics, cybersecurity, digital well being Corporate
3. *Samsung Pension Scheme* GRI, TCFD, SASB	supply chain & minerals sourcing -**Foundation:** materiality assessment, sustainability value creation	health & safety	leadership
2008 1. *Sustainability report* GRI G3	-Climate change response: policies, opportunities & threats -Environment-friendly product development, materiality assessment, green workplaces	Healthy development of local communities Talent management Stakeholder engagement	Corporate governance: organizational structure, ethics & compliance

Compiled by authors (2022)

The company's ESG journey however started in 1992 with the Samsung Environment Declaration wherein the company started managing its environmental responsibilities as a necessary corporate investment rather than an optional expense.[34] In the past 14 years, the company has expanded its ESG commitments and has also added KPIs into the performance evaluation and compensation of executives — incentivizing sustainable management across all businesses.

Emissions Profile

Samsung Electronics has been measuring its emissions since 2005 and reporting them since 2008 — though the boundary of carbon measurement plus the guidelines and standards have changed. In the earlier reports, the company measured and reported its direct and indirect emissions as per the IPCC 2006 guidelines. In these reports, direct emissions included emissions from stationary combustion, mobile combustion, process and fugitive. The scope of indirect emissions was not clearly reported by the company until 2010. Post-2008, the company started reporting its scope 3 emissions from suppliers, logistics and business trips for worksites based out of South Korea.

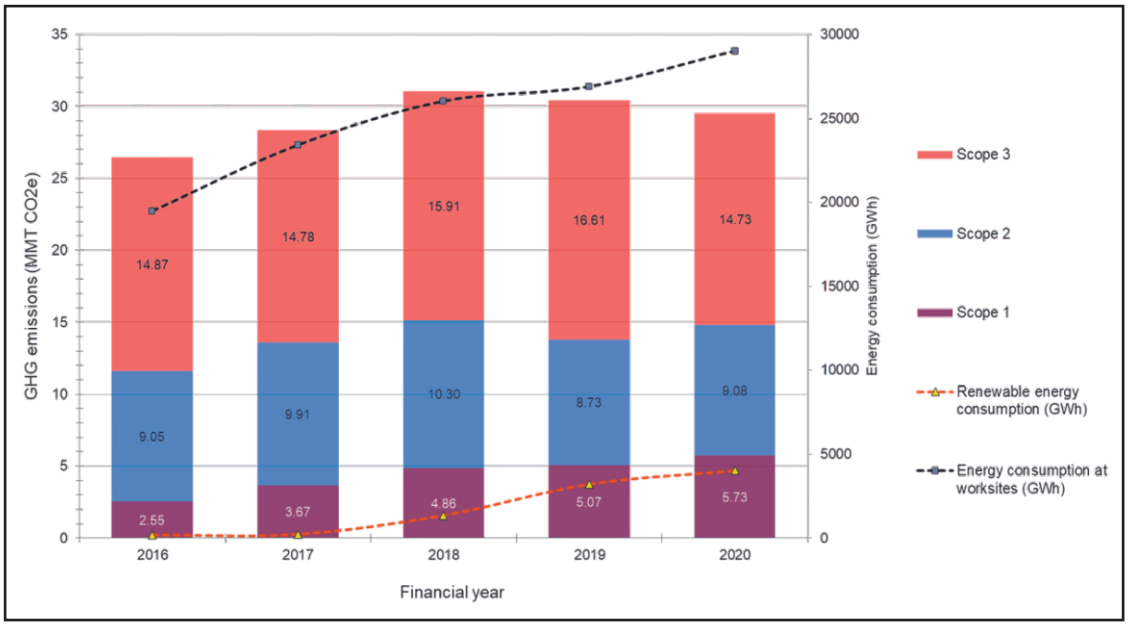


Figure 4: GHG emissions' profile of Samsung Electronics and corresponding use of energy and renewable energy, 2016-20 (in MMT CO2e) Developed by the author (2021)34

In the recent reporting, Samsung Electronics uses and collates multiple guidelines and standards. GHG emissions are now reported under two broad categories— GHG emissions from worksites and scope 3 emissions. Scope 1 and 2 are calculated using GHG management guidelines of each country where the company's worksites are situated, as well as IPCC guidelines and ISO 14064 standards.

Reported scope 1 accounts for emissions emanating from the consumption of fuel and semiconductor manufacturing; scope 2 accounts for emissions associated with electricity and steam consumption, and also reflects the emissions reduced via renewable energy. While the scope of emission inventory has expanded over the years, the company continues to measure and report emissions for limited facilities. Initially focusing on South Korea headquarters and major overseas subsidiaries, it now reports emissions for 36 production sites — overlooking 39 research and development centres, 15 regional offices, 7 design centres, and 53 sales offices around the world.[35]

Focusing on the past few years trend — with more common data points and methodology for emission accounting — the emission profile is dominated by scope 3 emissions (as indicated in Figure 4 and detailed in Appendix 6). The company added over 3.17 MMT CO2e of scope 1 emissions, i.e., 124% increase from 2016 to 2020. Scope 2 emissions increased by 0.36% in the five-year time

period, which can be attributed to a 22x increase in renewable energy — from 182 GWh in 2016 to 4030 GWh in 2020. The percentage of renewable energy consumption however continues to remain low at 14% of total energy consumed across 36 global production sites. Moreover, the company does not disclose the breakdown of renewable energy used or the methodology for calculating emission reduction from renewable energy use.

From 2016 to 2020, scope 3 emissions decreased by 1% — from 14.87 MMT CO2e in 2016 to 14.73 MMT CO2e in 2020. The actual quantum of scope 3 emissions would be much large as the company reports emissions arising out of business travels only for the production worksites based out of South Korea, and these emissions were reduced amid the pandemic in the 2019-20 period. Despite this challenge of emission accounting, scope 3 accounted for half or more than half of total emissions—with emissions emanating from suppliers dominating the profile (indicated in Figure 5). The latter includes GHG emissions produced from the manufacturing of Samsung Electronics' products by the top 90 percentile of suppliers in terms of business transactions.

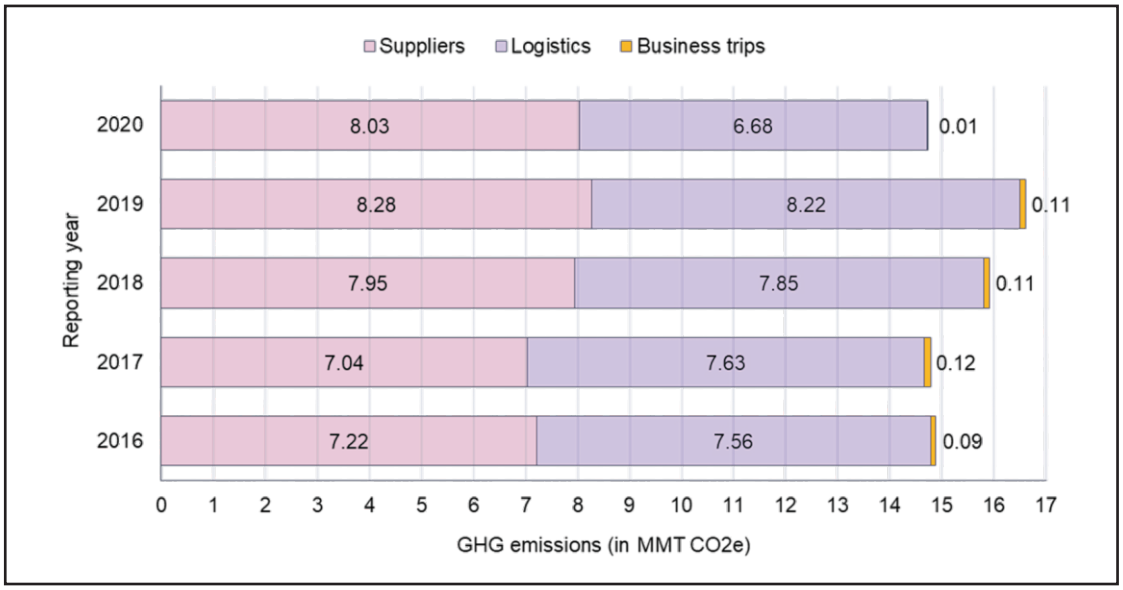


Figure 5: Breakdown of scope 3 emissions (in MMT CO2e) for Samsung Electronics, 2016-20
Developed by authors (2022)

Carbon Management Strategy

Samsung Electronics' carbon management strategy is structured around its three core businesses of consumer electronics, IT and mobile communications and device solutions. For the consumer electronics business, the company focuses on an upcycling program Eco-Package to reduce the environmental footprint of packaging and transport emissions. IT and mobile communications have their own upcycling program; and, devise solutions focusing on reducing energy consumption for products and carbon emissions in manufacturing.

Since 2008, the company has been working on several initiatives to reduce and safely handle emissions from operations, products and services across the three core businesses. In 2018, it committed to source 100% renewable energy by 2020 for all of its worksites based out of the U.S., Europe and China. It did fulfil its regional renewable commitment — via power purchase agreements, on-site solar, renewable energy certificates, and joining the green pricing system — but missed the target to reduce emissions by 70% in 2020 from 2008 levels. In 2020, the company recorded 3.2 tons of CO2e/KRW 100 million which was linked to the expansion of the company's semiconductor production line and product output.

In January 2022, Samsung Electronics announced a new set of commitments for 2025 and expanded its carbon management efforts to adopt new, low impact product manufacturing practices, footprint reducing packaging, more sustainable customer experience, and responsible disposal of products near the end of their life cycles.[36] To manage its carbon footprint, it focuses on four key actions areas and primarily carbon reduction — via fuel switching to 100% renewable energy in select geographies, compact product packaging, improving the energy efficiency of products during the use phase (summarized in Table 5).

Table 5: Action areas, initiatives and outcomes of Samsung Electronics carbon strategy

Key action areas *Carbon management focus* *Geographic focus*	Initiatives	Key outcome and achievements
A. Climate actions *Carbon reduction* ***Reduction of worksites' GHG emissions:** U.S., China, Europe* ***Product energy efficiency:** Global*	1. **Reduction of GHG emissions at worksites:** expanding use of renewable energy, reduction in energy use and process gas manufacturing process 2. **Product energy efficiency:** energy-saving technology for product use phase 3. **GHG reduction in other stages of the value chain:** supporting suppliers to monitor GHG emissions, optimizing	1. In 2020, source 100% renewable energy to meet electricity demand in the U.S, China and Europe. 2. Increasing emission reduction during product use —from 26 MMT CO_2e in 2018 to 31 MMT CO_2e in 2020 3. Joined CDP Supply Chain Program in 2019. Reduced emissions from product delivery process by 19% in FY 20 from 2019

Key action areas *Carbon management focus* *Geographic focus*	Initiatives	Key outcome and achievements
GHG reduction in other stages of the value chain: *Global* ***Managing other GHG emissions:*** *active projects in South Korea, Kenya*	logistics efficiency, transitioning South Korea fleet to electric by 2030 4. **Managing other GHG emissions** : via the acquisition of carbon credits through external emission reduction projects	via optimized delivery routes, load efficiency, and delivery management 4. Bioethanol cookstove project in Kenya earned credits for ~0.2 MMT CO_2e via delivery of 10,000 cookstoves
B. Circular economy Carbon reduction ***Efficient resource use:*** *Global* ***Extending product lifespan:*** *Global* ***Take-back/recycling e-waste:*** *Global* ***Waste process innovation, water & chemical management:*** *Global*	**1. Efficient resource use:** modular design, use of renewable or recyclable materials **2. Extending produc t life span:** increasing reparability, durability, software updates **3. Take-back and recycling e-waste:** to reduce the amount of petrochemical raw materials and manufacturing emissions **4. Waste treatment technology and process innovation** **5. Water manageme nt:** reducing water use, river biodiversity conservation activities **6. Chemical management:** monitoring chemical use from purchase to disposal	1. Increased use of recycled plastics in the product line—31,000 tons of recycled plastics used in 2019 & 2020 2. In January 2021, started selling devices in France with responsibility rating label 3. Increasing collection of e - waste—from 42,000 tons in 2018 to 51,000 tons in 2020. 4. In 2020, recycled 95% of waste generated across 36 worksites 5. Increased water re used at semiconductor plants by 1.2% from 2019-2020
C. Sustainable supply chain Carbon reduction ***Supply chain management:*** *Global* ***Responsible supply chain:*** *Global* ***Responsible mineral sourcing:*** *Global*	**1. Supply chain management:** selecting new supplie rs via open sourcing, improving the competitiveness of suppliers **2. Responsible supply chain:** compliance of suppliers with Supplier Code of Conduct, work environment management process, compliance improvement efforts, chemical substance management, EHS improvement, emission reduction of suppliers **3. Responsible mineral sourcing:** sourcing minerals from smelters with Responsible Minerals Assurance Process certification	1. Received highest Win -Win Index rating for 9 consecutive years in Korea[1] 2. Conducted o n-site audits and comprehensive evaluation of suppliers. 2018 suppliers in FY15 had ISO 14001 certification to promote environmental management activities. 3. From 2018 to 2020, the company sourced Cobalt from 27 smelters, all of which were RMAP certified

Key action areas *Carbon management focus* *Geographic focus*	Initiatives	Key outcome and achievements
D.Sustainability foundation Carbon reduction ***Materiality assessment:*** *Global* ***Sustainability value creation:*** *Global*	**1. Materiality assessment:** prioritizing sustainability issues as per stakeholder and business impact. Climate change and energy management are one of the 7 priority issues **2. Sustainability value creation:** measures positive and negative effects of activities in sustainable value creation and converts it to monetary value	1. Identifies climate change strategy, energy management, circular economy and chemical management as a priority issue. 2. In FY20, the total value of sustainable management created by the company amounted to KRW 47 trillion (~$39 billion)—an increase of 21% from FY19 due to increased net income

Developed by authors (2022)

Summary: Corporate Carbon Review

Samsung Electronics has been one the earliest technology companies to embrace environmental stewardship. Reviewing the company's emission profile and carbon performance, it is evident that:

One, Samsung Electronics reports an incomplete picture of its global carbon footprint. Reporting scope 1, 2 and 3 emissions for 36 production facilities across the globe, the company does not disclose the quantum of emissions emanating from its remaining 114 facilities. Moreover, the company does not report scope 3 emissions from product use or their life cycle.

Two, Samsung Electronics does not have a firm date and target to achieve several of its key carbon management aspirations. It aims to increase the use of renewable energy globally, but it does not assign a firm date or proportion of electricity it seeks to source for its global operations. The company made progress during 2018-20 in purchasing renewable energy for its worksites based out of the United States, China and Europe but globally the company continues to rely on fossil fuels. In 2020, it was able to match less than 15% of its global electricity demand with renewables. With the concentration of major production sites in South Korea and Vietnam — where market regulations limit company's ability to purchase power from independent renewable energy generators, and where the supply of renewable energy is limited — switching to low-carbon electricity will continue to be tough. The company does not report on how it plans to overcome these challenges and the lack of firm timeline and

target indicates the company's lack of confidence in moving from intent to impact.

Three, it does not disclose the scale of impact envisioned from its cross-cutting carbon reduction solutions. In the late 1990s, the company launched its e-waste recycling and take-back program for the domestic electronics industry which now operates across 55 countries. With this spatial-temporal expansion of recycling programs, the quantum of products collected for recycling and the material recycled and reused in the company's product line has increased. But, how emissions from recycling and the use of recycled materials over virgin materials affect a company's carbon footprint is not clear. The company does not disclose the target emission reduction from recycling either.

Four, scope 3 emissions offer opportunities to make an impact. Emissions emanating from supplier and logistics account for over 90% of total reported scope 3 emissions. To better manage this concentration of emissions, the company could explore cost saving opportunities and carbon reduction potential from other strategies — such as a preferential partnership with suppliers and logistics using renewables and/or with a lower carbon footprint.

Five, the company does not have a long-term carbon commitment such as carbon-negative or carbon-neutral or net zero. But, it is a key part of South Korea's national commitment to become carbon neutral by 2030. Whether it will align with the national goal has not been formally disclosed.

Summing up, Samsung Electronics as one of the largest global manufacturers of consumer electronics—with an expanding portfolio of products, supply chains and logistics network—is well-positioned to make an impact. Over time, the impetus and outlook for the company's carbon management efforts have shifted from selective corporate spending to essential investments enabling value creation. The company should now expand its monitoring and measurement capabilities to include the entirety of its value and supply chain. Based on the comprehensive carbon footprint, it should realign its business strategies and carbon management efforts.

Case Three: Google LLC

Google or Google LLC, the leading subsidiary of parent company Alphabet Inc., was founded in 1998. It is an American multinational technology company known for its web-based search engine and witnessed its first growth spurt in 2000 when it became the default search engine for Yahoo! In 2004, Yahoo! and Google separated but the latter continued to expand. Over time, the company's portfolio has expanded and diversified — to include cloud computing, online advertising, hardware, web-based email, online document creation, developer tools, map-related products and navigation services, smartphones, tablets, notebooks, virtual reality headsets, smart speakers — and so has the company's market share, supply chains and distribution network.[38]

Corporate ESG strategy

Google's ESG strategy focuses on 3 billion people who are already online as well as the remaining 4 billion people who will join the internet world.[39] The company does not have a standalone report highlighting its ESG commitments, actions and progress. Rather, it has published an environmental progress report since 2016 and since 2019; it has been publishing the European Union Non-Financial Reporting Directive (NFRD) report — aligned with the 2017 EU rules that require large companies operating in the region to publish regular reports on social and environmental impacts of their activities.[40] This report covers the global operations of Google and all its subsidiaries. In 2017, it started publishing the supplier responsibility report focusing on the social component.

Table 6: Evolving focus and key elements of Google's ESG strategy, 2016-21

Year of reporting *ESG reports* Reporting frameworks	**Environment**	**Social/ People**	**Governance**
2021 *1. Environmental Report* *2. Alphabet's CDP Climate Change*	- **Environmental initiatives:** energy consumption, products, conservation, clean energy	- **Employee matters:** code of conduct, policy on harassment, retaliation - **Social impact:**	- Anti-corruption and bribery matters
3. European Union NFRD report *4. Supplier Responsibility Report*	- **Target-based progress:** efficient data centres, carbon-free	diversity & inclusion, digital skills training, racial justice, economic empowerment for females	

Year of reporting *ESG reports* Reporting frameworks	Environment	Social/ People	Governance
CDP Climate Change and supply chain, EU NRDF 2014/95/EU	energy, sustainable workplaces, building better devices, empowering users - **Supply chain:** end reliance on raw materials	- **Respecting human rights:** enlisted in Universal Declaration of Human Rights, UNGPs, GNI Principles - **Strengthening communities:** supplier diversity, responsible sourcing - **Suppliers:** audit, safe & healthy workplaces, ethical operations	
2016 *1. Environmental Report* *2. Alphabet's CDP Climate Change* *3. Modern Slavery Statement* CDP Climate Change Questionnaire	- **Environmental initiatives & target - based progress:** designing efficient data centres, advancing renewable energy, sustainable workplaces, empowering us ers with technology	- **Training, risk assessment and policies** for ethical conduct and prevention of modern slavery	- **Internal management, accountability & programs** for ending modern slavery in supply chains

Compiled by authors (2022)

Since the first set of reports were published in 2016, Google's ESG strategy has broadened in scope of commitments, actions, and reporting metrics (as indicated in Table 6. For details, refer to Appendix 7). The focus on carbon management across the supply chains and across company operations has increased as well. In 2020, Google established a five-year strategy for the company to blend sustainability into everything it does and focus on three pillars — accelerating carbon-free and circular transition by decoupling business growth from material use and carbon intensity; using technology to empower everyone in tackling sustainability challenges and driving net-positive impact; and sharing benefits with people and places where Google operates.[41]

Emissions Profile

Google started calculating its annual carbon footprint in 2006 and publicly reporting it in 2009. Using the GHG Protocol, it estimates its scope 1, 2, and 3 emissions. For scope 1 calculations, it measures direct emissions from company

vehicles, generators at Google offices and data centres. Scope 2 calculations include emissions from the production of electricity purchased to run its global operation and heating of office spaces. Scope 2 is calculated using the location-based and market-based methodology. The location-based method reflects the average carbon intensity of the electricity grids where energy consumption occurs for the company. Market-based estimations reflect procurement choices and are 20%-to-50% of the location-based estimates (indicated in Appendix 8). In scope 3 estimations, it counts emissions from business travel and suppliers.

From 2016 to 2020, the total reported emissions have increased by 3.6-times—from 2.8 MMT CO2e in 2016 to 10.3 MMT CO2e in 2020—despite the company sourcing 100% of total electricity demand from renewable resources from 2017 onwards. Of the total renewable energy procurement, 74-82% is sourced from power purchase agreements and on-site, and less than 25% is sourced from the grid. Scope 3 emissions dominate the profile and account for 45% of total emissions in 2016 to 91% emissions in 2020 (illustrated in Figure 6).

This increase in reported scope 3 emissions is also attributed to the expansion of reporting boundaries in 2018 to include emissions associated with food served in Google offices, hardware manufacturing emissions beyond tier 1 suppliers, use of sold products, and end-of-life treatment of sold products. Also, the company started estimating teleworking emissions in 2020 as employees started working remotely amid the COVID-19 pandemic.[42] Apart from the three scopes of emissions, Google also reports its biogenic emissions from the combustion of landfill gas and liquid biofuels — which reduced from 0.009 MMT CO_2e in 2016 to 0.005 MMT CO_2e in 2020.

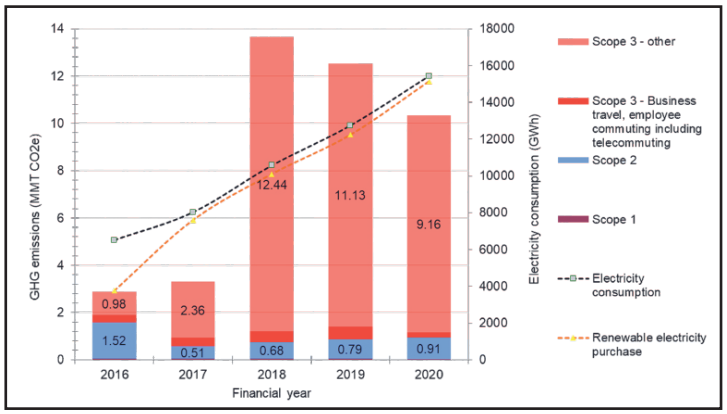


Figure 6: GHG emissions' profile (in MMT CO2e) of Google LLC and corresponding use of energy and renewable energy (in GWh), 2016-20 Developed by the author (2022)

Table 7: Action areas, initiatives and outcomes of Google's carbon management strategy

Key action areas *Carbon management focus* *Geographic focus*	Initiatives	Key outcome and achievements
A. Efficient data centres *Carbon reduction* ***Energy efficiency & carbon-neutral cloud:*** *Global* ***Embedding circularity:*** *active projects in Finland, Belgium, U.S.*	1. **Energy efficiency:** data centres, commercializing new software that can help match real-time carbon-free energy supply **2. Embedding circularity:** in server management, zero waste to landfill for data centre operations, water stewardship **3. Carbon -neutral cloud:** matching 100% electricity with renewable energy since 2017	1. Delivery 6x computing power with the same amount of electricity as in FY16. 2. In FY20 diverted 81% of waste from global da ta centre operations away from landfills 3. Zero operational GHG emissions from Google Cloud via procurement of renewable energy and carbon credits
B. Carbon-free energy Carbon reduction + removal ***Renewable energy:*** *Active in U.S., Chile, Europe, Taiwan* ***Carbon footprint:*** *Global (methane capture in the U.S., NBS in Australia, Spain, U.S.)*	**1. Investing in renewable energy:** procurement, advancing clean energy policies, driving technological innovation. **2. Carbon footprint:** reduced energy consumption, purch asing renewable energy and carbon offsets	1. Renewable energy purchases between 2011-19 reduced scope 1 & 2 emissions by 59%. Carbon-intelligent computing shifts non-urgent jobs at data centres to times when low-carbon power sources are most abundant on regional grids 2. Net operational carbon emissions zero since 2007
C. Creating sustainable workspaces Carbon reduction ***Healthy ecosystems:*** *Global* ***Green buildings & office operations:*** *Global*	**1. Healthy ecosystems:** science and community-driven approach to managing land use on campuses **2. Green buildings:** LBC & LEED standards and practices for design, construction and operation of workplaces **3. Office operations:** sustainable initiatives on water, waste, food, transportation	1. Google has an egret rookery in its Mountain View, California campus to conserve the nesting area 2. Over 1.4 million m^2 of office facilities have LEED certification 3. In FY19, 71% landfill diversion rate for waste from offices globally.
D. Building better devices and services Carbon reduction ***Consumer hardware devices, circular materials, energy savings:*** *Global*	**1. Consumer hardware devices:** material composition, life cycle GHG emissions and energy efficiency **2. Circular materials:** for consumer hardware products, creating dema nd for recycled materials **3. Energy savings:** via Nest thermostat	1. In FY19, shipments of Made by Google products to and from direct customers were carbon neutral 2. External enclosure of Google Nest Mini is made from 41% recycled plastic. 3. In FY19, Nest thermostats helped save customers over 17 billion kWh of energy

Key action areas *Carbon management focus* *Geographic focus*	Initiatives	Key outcome and achievements
E. Empowering users with technology Carbon reduction *Mapping world & AI for social good: Global* *Tools for everyone: Global (active projects in the U.S., Europe)*	**1. Mapping world:** expanding geospatial programs and utility of Google Earth, Google Earth Engine, Google Maps **2. AI for social good:** using Google research, engineering and AI Impact Challenges **3. Tools for everyone:** to understand the environmental impact and science-based ways to reduce it	1. Launched Environmental Insights Explorer in 2018 to help cities measure emission sources, run analysis and identify strategies for emission reduction. 2. Launched a flood forecasting model for Patna, India in 2018. 3. Google flights h elps select less carbon-intensive options for select European countries.

Developed by authors (2022)

Summary: Corporate carbon review

From beginning to publicly report its emission profile in 2009 to announcing its pledge in 2020 to use only carbon-free energy by 2030, Google's carbon efforts have evolved significantly. Assessing Google's emission profile, carbon management initiatives and outcomes, it is evident that:

One, the company's carbon footprint excludes select emissions. Reporting issues of data availability and prioritization, the company's company-wide emissions reporting does not report emissions from upstream and downstream lifecycle emissions of data center equipment and buildings, electricity generated but lost during transmission and distribution, diesel use for onsite backup power, system coolants, and networking equipment deployed outside data centres.[44]

Two, Google has made significant progress in reducing its scope 1 emissions, but scope 2 and 3 is where comprehensive measurement and actions are needed. Despite an overall decrease in scope 1 and 2 emissions, scope 2 emissions from purchased electricity increased post-2017. Scope 3 emissions reported in 2020 were over 7x times of 2016 levels. Within scope 3, the category of "other"—emissions other than business travel, employee commuting including telecommuting — has increased from 0.98 MMT CO2e in 2016 to 11.12 MMT CO2e in 2020. Google should clarify the scope and methodology of calculation in this category of scope 3 and develop actions to manage it.

Three, the company's carbon-neutral boundary accounts for a fraction of the total reported emissions. Since 2007, it reports its operations as carbon neutral

and in 2020 claimed to achieve carbon neutrality for its entire operating history. But, the success of this carbon neutralization relied on buying offsets and paying other organizations to decrease emissions — rather than reducing its own emissions. Moreover, this boundary — inclusive of scope 1, market-based scope 2, and scope 3 emissions from business travel, employee commuting and telecommuting — accounted for approximately 11% of total emissions in 2020 and 2019, 9% in 2018, 18% in 2017, and 66% of total reported emissions in 2016. The company should expand its carbon-neutral boundary and incrementally expand the scope and scale of investments for decarbonizing across its value chain.

Four, Google is shifting its energy procurement goals towards carbon-free energy. In 2020, it pledged to source carbon-free energy to 24/7 operate its worldwide campuses and data centers. This shift — from renewable energy purchases to carbon-free energy — was guided by Google insights highlighting that even when the company matched 100% of its annual global electricity consumption with renewable purchases, on an hourly basis only 61% of its data center electricity use was matched with carbon-free sources in 2019.[45] Diversifying the scope of low carbon sources, Google will have to match and monitor the company's demand for low-carbon sources on an hourly basis. The company would also have to revise its energy purchase contracts accordingly across different government systems.

Five, Google is deploying technology to effect change across systems. For example, it is using its Environmental Insights Explorer — a platform allowing access to Google's mapping data and machine learning modelling capabilities — to work with 3,000 cities around the world to monitor and reduce their carbon emissions. The basis of selecting these 3,000 cities is not reported.

Summing up, Google is uniquely positioned to scale positive change in corporate carbon management. It has publicly acknowledged the limitations of renewable energy procurement for effective carbon reduction and is reworking its energy procurement strategy to source zero-carbon energy. Moving forward, the company should measure, monitor and report cost savings and other social-economic benefits accruing from each of its three key levers of carbon management — low-carbon energy procurement, carbon offsets, and nature-based solutions. Based on this cost-benefit analysis, the company can strategically manage its pre-existing carbon management efforts, and explore new levers for long-term impact.

Case Four: Amazon.com, Inc.

Amazon.com, Inc. started off as an American technology company in 1995 that promised to deliver a book to any reader anywhere. Since then, it has expanded to become an expansive internet-based enterprise selling books, movies, housewares, toys, music, and several other consumer products. Apart from e-commerce, the company specializes in cloud computing, consumer electronics, digital streaming, publishing and artificial intelligence. In select geographies, it is expanding its network of supermarkets and testing self-driving cars. From two fulfilment centres in its distribution network in 1997, Amazon has expanded to 100+ fulfilment centres.[46] Its distribution network and the larger supply chain — comprising a vast industrial real estate, truck fleet, air fleet — as well market penetration has expanded to 21 countries across Africa, Asia, Europe, Oceania and the Americas.[47]

Corporate ESG strategy

With the announcement of Climate Pledge in 2019, Amazon's ESG strategy has focused on environmental progress as well as commitments and initiatives to support employees, supply chain partners, communities around the world where it operates, and governance of mechanisms prioritizing sustainability work, SDGs, public policies on energy and climate. The company's ESG strategy and reporting have evolved significantly over the past 6 years — from publishing its Modern Slavery Statement in 2016 for UK entities alone to the annual sustainability reports and supplementing statements from 2018 (summarized in Table 8. For details, refer to Appendix 9).

In June 2021, Amazon published its third sustainability report titled *Further and Faster, Together.* Highlighting the company's ESG strategy and accomplishments towards ESG goals. The first such sustainability report was published in 2019 after Amazon co-founded and signed up for The Climate Pledge at the backdrop of hundreds of Amazon employees defying corporate policy to publicly condemn the company for its lukewarm actions on the climate crisis.[48] Until 2019, climate change may not have been a priority of corporate governance; ESG reporting may not have been an annual agenda item until 2019, but the company did engage on ESG issues — the extent of engagement and action is not clear as the reports are not in the public domain. For instance, in November 2014 Amazon made a public commitment to achieve 100% renewable energy usage for its global AWS infrastructure.[49]

Table 8: Evolving focus and key elements of Amazon's ESG strategy, 2016-21

Year of reporting *ESG reports* Reporting frameworks	Environment	Social/ People	Governance
2021 *1. Sustainability 2020 Report: Further and Faster, Together* *2 Human rights impact assessment: Amazon devices* SASB, TCFD, UNGP	- **Sustainable operations:** corporate, shipment, transportation, buildings - **Circular economy:** packaging, recycling, trade-in, product donations - **Packaging and products:** sustainable shopping, reducing packaging waste, sustainable products and materials, sustainably produced fabrics - **Cloud:** renewables, cloud efficiency, water stewardship	- **Human rights:** impact assessment, addressing risk - **Employees:** workplace well-being, health & safety; diversity, equity & inclusion; employee engagement; sustainability ambassadors - **Supply chain:** commitments, progress, responsible sourcing - **Community:** housing equity, access to food & basic needs, disaster relief, computer science program,	- **Mechanisms for prioritizing work** - **Corporate governance:** risk oversight, shareholder engagement - **Public policy actions:** on energy & climate - **Partnerships:** for ESG initiatives
2016 *1. Modern slavery statement (for UK entities)* No framework	<no reporting>	- **Supply chain:** standards	<no reporting>

Compiled by authors (2022)[50,51]

Emissions Profile

Amazon's emissions are quantified by the company's hybrid carbon footprint methodology that measures GHG emissions emanating from its direct and indirect operations across the world (indicated in Appendix 10). This hybrid approach converts physical and financial data into emission measurements and is used by the company to assess its impact on the global carbon budget, map the largest activities contributing to climate impact, and formulate carbon management strategies to realize its Climate Pledge goal for net-zero emissions across businesses by 2040.[52]

Amazon's emission profile (indicated in Figure 7) is measured and reported publicly for the period of 2018 to 2020. In this period, the emissions for Amazon increased by 36.6% (~6.7 MMT CO2e) and across all categories of emissions. Fossil fuel-based scope 1 emissions almost doubled from 4.7 MMT CO2e in 2018 to 9.37 MMT CO2e in 2020. Of the total emissions reported during the period,

scope 3 emissions increased by over 9 MMT CO2e and accounted for 78% of total emissions in 2018 and 75% of total emissions in 2020. In a span of three years, the total quantum of scope 2 emissions increased by 12%, despite witnessing a slight dip—from 5.5 MMT CO2e in 2019 to 5.27 MMT CO2e in 2020. This slight reduction is attributed to the increase in renewable energy procurement for Amazon operations from 42% in 2019 to 65% in 2020. However, there is no public disclosure on its breakdown — on-site, procured through the grid, or purchasing power agreements.

In general, the company's emission profile is indicative of its business growth, in particular, the rising demand for doorstep delivery amid the COVID-19 pandemic — which led to a decline of lifecycle emissions emanating from customer trips to physical stores by nearly 35% in the two years. The impact of the pandemic is reflected in decreasing carbon intensity as well—from 128.9 gCO2e per $ of gross merchandise in 2018 to 122.8 in 2019 to 102.7 in 2020.

This metric of carbon intensity is used by Amazon to benchmark its performance over time. While a key performance indicator at the company level, a mere reduction in intensity cannot be equated to good performance. If the base factor of the gross value of the merchandise is much larger than the total emissions, the intensity will reduce. For a complete carbon picture, we need credible data points on the quantum of merchandise sold annually, dollar value and inflation rate, and the scope of emissions accounted in the calculation.

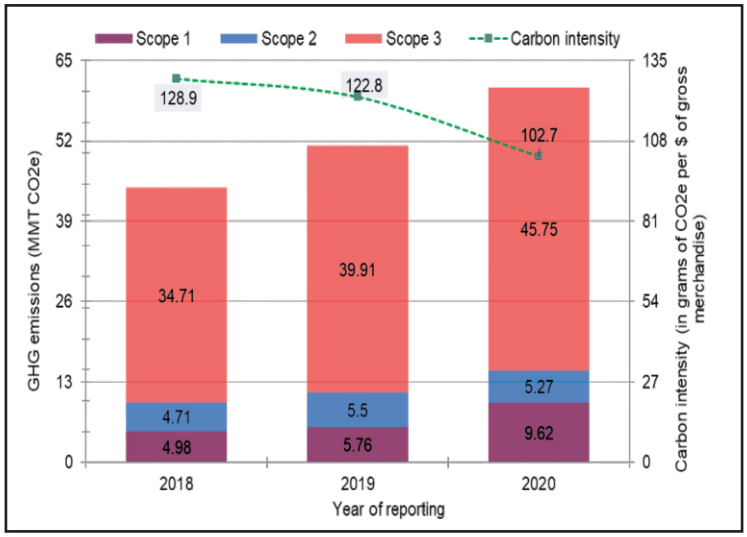


Figure 7: GHG emissions inventory (in MMT CO_2e) and carbon intensity of Amazon.com, 2018-20
Developed by authors (2022)[47]

Throughout the period, the company's emission profile is dominated by scope 3 emissions, particularly emissions from corporate purchases, capital goods and other indirect emissions (indicated in Figure 8). While the full extent of scope 3 emissions cannot be managed by Amazon alone, there are few components — packaging and capital goods — where Amazon exercises more direct control, and can thus make a long-term impact to better manage its carbon footprint and decarbonize its globally dispersed supply chains.

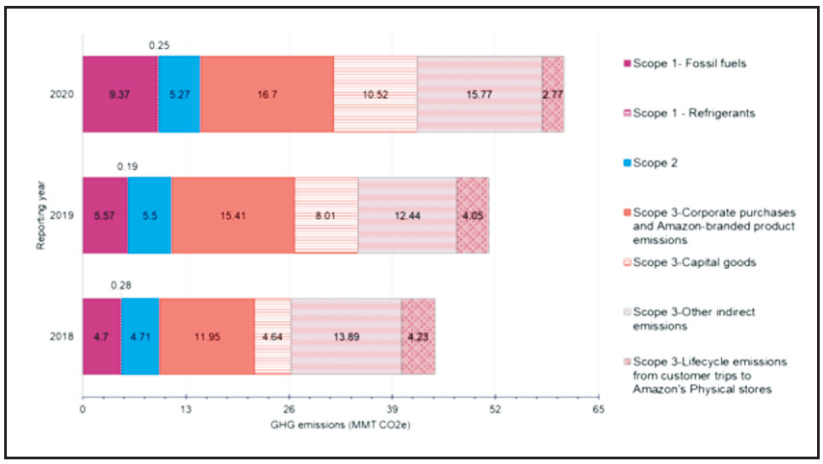


Figure 8: Breakdown of GHG emissions (in MMT CO_2e) profile for Amazon.com, 2018-20
Developed by authors (2022)

Carbon Management Strategy

Amazon's carbon management strategy is guided by its commitments to the Climate Pledge — co-founded by Amazon and Global Optimism on the premise that no business operates in a vacuum, and thus a collective, cross-sectoral action on the climate crisis is needed. 217 businesses across 26 industries and 21 countries have committed to this Pledge. Signatories to the Pledge commit to net zero carbon by 2040 by agreeing to three principal areas of action: regular reporting, carbon elimination and credible offsets.[53] These strategies involve business changes and innovations including efficiency improvements, materials reductions, renewable energy, and other carbon reduction strategies.

This Pledge and the journey to a net-zero carbon future is funded by the Climate Pledge Fund, Right Now Climate Fund and Bezos Earth Fund. The $100 million Right Now Climate Fund was established by Amazon in 2019 to restore and conserve forests, wetlands, and grasslands around the world, with an intent to avoid and remove carbon. The $2 billion Climate Pledge Fund was

established by Amazon in June 2020 to support the development of technologies and services that reduce carbon emissions and help preserve nature. In 2020, a $10 billion Bezos Earth Fund was launched to invest in scientists, activists and organizations driving systems change for net-zero emissions and shift towards nature positive development.[54] To amplify demand for scalable and accessible zero-carbon technologies, Amazon co-founded—with Apple Inc. and 33 other global companies — the First Movers Coalition.

To achieve its vision of net-zero carbon by 2040, Amazon's carbon management strategy is structured around four cross-cutting key action areas: sustainable operations, packaging and products, circular economy, and sustainability in the cloud (summarized in Table 9). Across all action areas, the focus is on carbon reduction via efficiency improvements, fuel switch to renewable energy, and material reductions. For select actions and initiatives, such as decarbonization of buildings, nature-based forestry projects are opted to balance the emissions that cannot be reduced or removed.

Table 9: Action areas, initiatives and outcomes of Amazon's carbon management strategy

Key action areas *Carbon management focus* *Geographic focus*	Initiatives	Key outcome and achievements
A. Sustainable operations Carbon reduction & removal **Renewable energy**: Global **Decarbonise buildings**: Global **Shipment zero**: Global **Transportation**: active projects in U.S., EU, India, UK, Japan	1. 100% **renewable energy** by 2025 2. **Decarbonize buildings-** corporate offices, facilities, stores, data centres 3. **Shipment zero**: aim to deliver 50% of shipments with net-zero carbon by 2030. 4. **Transportation:** aims to deploy 100,000 EVs by 2030. Also, exploring micro-mobility via bicycle and foot delivery in New York City, Paris & Tokyo.	- 1. **65% renewable energy of total electricity** demand. - 2. Investment **in forestry projects** - 3. 90+ fulfilment centres powered by on-site rooftop solar - 4. The purchase order with Rivian for 100,000 electric vans by 2030. Testing hydrogen-powered trucks. Using CNG tractors in North America, UK, Germany & France. Secured 6 million gallons of sustainable aviation fuel in 2020
B. Product sustainability Carbon reduction **Sustainable shopping & product development**: U.S., EU **Device sustainability**: Global	**1. Sustainable shopping** initiatives: option to shop for sustainable products 2. **Product development:** material sourcing, design, manufacturing, capacity building of branded products' suppliers. **3. Devices and sustainability:** recycling materials, improving the energy efficiency of select Amazon devices	1. In 2021, customers had access to 0.2+ million Climate Pledge Friendly products 2. Joined initiatives on cotton, leather, palm oil, recycled materials, recycled fabric, product labels, cellulosic fibre-for better material sourcing and manufacturing 3. In 2020, Amazon added 'Low Power Mode' to reduce energy consumed during inactive periods in their lifetime.
C. Circular economy Carbon reduction **Packaging**: U.S, Europe **Recycling**: U.S., UK, Europe **Product donations**: Global **Reducing food loss**: U.S. **Amazon Second Chance**: US, Canada, UK, France, Germany, Italy, Spain, Sweden, and Japan	**1. Packaging** with right-sized, recyclable packaging to minimize waste **2. Recycling** initiatives for operations and partnerships that support recycling infrastructure **3. Product donations** of eligible surplus inventory to global charity	1. In June 2021, the weight of outbound packaging reduced by 36% (avoiding 1 million tons of packaging material) 2. In 2020, on-site plastic film recycling developed for the U.S. Carbon impact of recycling was not reported.

Key action areas *Carbon management focus* *Geographic focus*	Initiatives	Key outcome and achievements
	4. Reducing food loss & waste by 50% within U.S. by 2030 **5. Amazon Second Chance** to give products and their packaging a second life via trade-in, device recycling, etc.	3. In 2020, donated 25 million products to global charity partners 4. In 2020, 70 million meals were donated to Feeding America
D. Sustainability in the Cloud Carbon reduction **Renewable energy**: active projects in US, UK, China, Japan, South Asia, Southeast Asia, South Africa, Australia **Cloud efficiency:** focus on U.S., Europe **Water stewardship**: Global **ASDI**: Global	**1. 100% renewable energy** by 2025 for AWS **2. Cloud efficiency** through comprehensive efficiency programs across global infrastructure **3. Water stewardship initiatives** to use less potable water to cool data centres, and community water programs to return water to communities	1. AWS purchases renewable energy credits and Guarantees of Origin to cover non-renewable energy use across the U.S. West Oregon and GovCloud, Central Canada, Ireland, and Frankfurt 2. In 2021, AWS joined Climate Neutral Data Centre Pact with the data centre
	4. Amazon Sustainability Data Initiative (ASDI) minimizes the cost and time to acquire and analyse large sustainability datasets to promote research and innovation	industry in Europe envisioning climate-neutral data centres by 2030 3. Community water programs in U.S., India, Indonesia, Cape Town, and São Paulo 4. AWS with Group on Earth Observations awarded $1.5 million of cloud services across 17 developing countries

Developed by authors (2022)[55]

Summary: Corporate Carbon Review

Amazon is relatively new to join the global decarbonization race. Focusing on net-zero carbon by 2040, the company has launched a flurry of actions post-2019 for carbon management. Reviewing the company's emission profile and carbon management strategies, it is evident that:

One, Amazon.com is utilizing its purchasing power to improve its carbon metrics. The company invests significantly to procure renewable energy via power purchase agreements and guarantees of origin to cover non-renewable energy use for its global operations. It is also investing in nature-based forestry solutions to sequester carbon that it cannot remove or reduce from its global real estate portfolio. While PPAs allow the company to purchase electricity directly from a renewable energy generator, whether these agreements are additional and reduce fossil fuel use remains questionable. More importantly, the quality and durability of carbon removal via forestry solutions cannot be ascertained as carbon sequestered in terrestrial ecosystems can be easily released into the atmosphere via fires, pests and other risks.

Two, scope 1 and 2 is good place to start for carbon management, but scope 3 accounts for the bulk of emissions. Assuming that the company reports 100% of its carbon footprint, scope 3 emissions account for more than two-thirds of total annually reported emissions. The bulk of its scope 3 emissions — linked to capital goods, corporate purchases and Amazon-branded products, and other indirect emissions from packaging, transportation and upstream activities — are not entirely out of the company's operational control and offers opportunities for better carbon management.

Three, the methodology guiding the formulation of Amazon's big, bold commitments — and the associated scale of impact estimated by Amazon.com — is unclear. The company aims to procure 100,000 electric delivery vans by 2030 to deliver packages. It's a significant number, but it does not communicate: How does it equate to the total fleet of Amazon.com across the world? How will these 100,000 EVs be distributed globally? How will the existing fleet be phased out and if that will have more negative impacts than adding up EVs? What will be the effective scale of emission reduction? In essence, these bold goals leave key questions unanswered.

Four, there are key action areas and initiatives where the goal and/or timeline to achieve an aspiration is not defined. For product sustainability, the company is implementing initiatives on sustainable shopping, product development,

devices and sustainability. But, none of these initiatives defines the end goal. What does it aim to achieve by providing customers with more sustainable options? Does it aim to reduce consumer purchases for non-sustainable products? By how much and by when? Investing without having a clear end goal makes it tough to estimate the return of such investments — financially and on carbon reduction

Five, Amazon.com is investing largely towards carbon reduction or sequestration strategies. With its scale of operations and resource availability, Amazon.com should explore the return on investments from a blend of carbon removal and carbon reduction solutions that have a large and long-term impact. It's deploying CO_2 injections, a form of carbon capture and storage solution, to reduce the amount of water needed for the construction of new fulfilment facilities in select geographies. It helps the company reduce its water footprint and remove carbon from the atmosphere.

Six, Amazon does not define its carbon-neutral boundary. The company aims to be net-zero by 2040, but it does not disclose its carbon-neutral boundary. It does not indicate whether it aims to neutralize the full extent of scope 1, 2 and 3 emissions, or a fraction of it.

To sum it up, Amazon with its global scale of operations, the expanse of cloud infrastructure, expanding global network of trucks and planes — to fulfil the promise of easy purchase and quick delivery of products to a comprehensive catalogue of consumer desire — and resource base is uniquely placed in the industry and corporate world to scale efforts geared towards climate change. More than just bold commitments, it needs to assess and align its impact on the environment and strategically align business decisions for effective carbon reduction and removal.

Case Five: Microsoft Corporation

Microsoft is an American multinational technology company, founded in 1975, and operating in the software and services industry. From 1975 to 1990, Microsoft predominantly manufactured and supplied hardware. Post-1990s, a large portion of Microsoft's revenue was linked to sales of personal computers. In 2011 and 2016 respectively, Microsoft acquired Skype and LinkedIn. In 2021, Microsoft was the world's fifth-largest technology company by revenue.[56]

Corporate ESG strategy

The ESG function of Microsoft sits within the corporate external and legal affairs department and looks after transparency, investor relations and reporting as per the standards and guidelines established by GRI. A signatory to the UN Global Compact and one of the first few companies following the UNGPs, Microsoft annually publishes its progress to the Compact.[57] In 2020, the company joined the Climate Pledge. In 2003, the company started communicating ESG concerns and progress via citizenship reports, which were renamed corporate social responsibility reports in 2016. These reports highlight the progress of Microsoft's citizenship initiative built on three pillars demonstrating responsible business practices, improving security and internet safety, and advancing the knowledge economy.[58]

Table 10: Evolving focus and key elements of Microsoft's ESG strategy, 2003-21

Year of reporting *ESG reports* Reporting framework	Environment	Social	Governance
2021 *1. UNSDG Report* *2. CDP water security response* *3. CDP climate change response* UN SDGs, CDP	- **4 focus areas:** carbon negative, water positive, zero waste, ecosystems	- **Inclusive economic opportunity:** SDG targets and progress - **Protecting fundamental rights:** alignment with SDGs	- **Earning trust:** partnerships - **Compliance & ethics:** standards - **Corporate leadership**
2003 *1. Microsoft Citizenship report* *No framework indicated*	- **Environmental impact:** recycling & conservation at corporate HQ, products & packaging	- **Equal employment:** anti-harassment, anti-discrimination, development & support, diversity	- **Internet safety:** safer computing, intellectual property, digital rights

Compiled by authors (2022)[59]

Microsoft's ESG strategy has evolved in scope, commitments and actions over time (summarized in Table 10. For details refer to Appendix 11). Initially, ESG concerns were key conversation topics for Microsoft with its European investors and public pension funds, but they are increasingly becoming a part of the governance engagement with investment banks. In the last 4 years, the focus on human capital management has increased while climate change and carbon management continue to be priority material concerns for the company.[60]

Emissions Profile

Microsoft Corporation has voluntarily reported its carbon footprint since 2004, as per CDP guidelines. Data filed to the CDP on GHG emissions represent 100% of the company's global operations and revenue, including the emissions linked to the acquisition and integration of LinkedIn in 2016. The company has adjusted data prior to 2016 to reflect this integration and enable comparison year-over-year. For emissions profile, it measures and reports its scope 1, market- and location- based scope 2 and scope 3 emissions. The boundary of scope 3 emission accounting is vast (refer Appendix 12) and includes emissions from purchased goods and services, capital goods, fuel and energy-related activities, upstream transportation, waste, business travel, employee commuting, downstream transportation, use of sold products, end-of-life sold products, and downstream leased products. In business travel, Microsoft counts emissions emerging from hotel night stays, rail and air travel, taxi, mileage reimbursement, and rental cars.

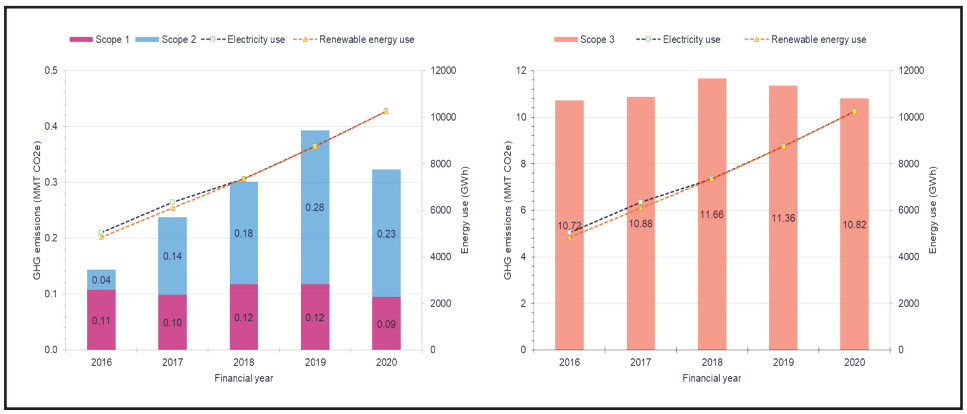


Figure 9: Emissions profile Microsoft Corporation, 2016-2020
Developed by authors (2022)[61]

Microsoft's emission profile is dominated by scope 3 emissions — accounting for 96-97% of total emissions between 2017-2020 (illustrated in Figure 9). Scope 1,

accounting for approximately 1% of total reported emissions, witnessed an increase of ~10% — from 107,452 tons CO2e in 2017 to 118,100 tons CO2e in 2020. Despite the company purchasing 100% of its electricity from renewable resources, market- and location-based scope 2 have increased — by 64% and 52% respectively. Of the total renewable energy purchased from 2017 to 2020, on-site renewable accounted for 0.01% while 99.9% is linked to power purchase agreements and energy credits.

Scope 3 emissions, accounting for roughly 97% of total emissions reported in 2020, is dominated by emissions from purchased goods and services, capital goods, and the use of sold products (illustrated in Figure 10). While the company does not have direct control over a majority of emissions in this category, the extensive nature of scope 3—covering all parts of the company's value chain, from building material to business travel to product lifecycle and the electricity consumed by customers—and dominance in emission profile makes it one of the biggest areas for improvement.

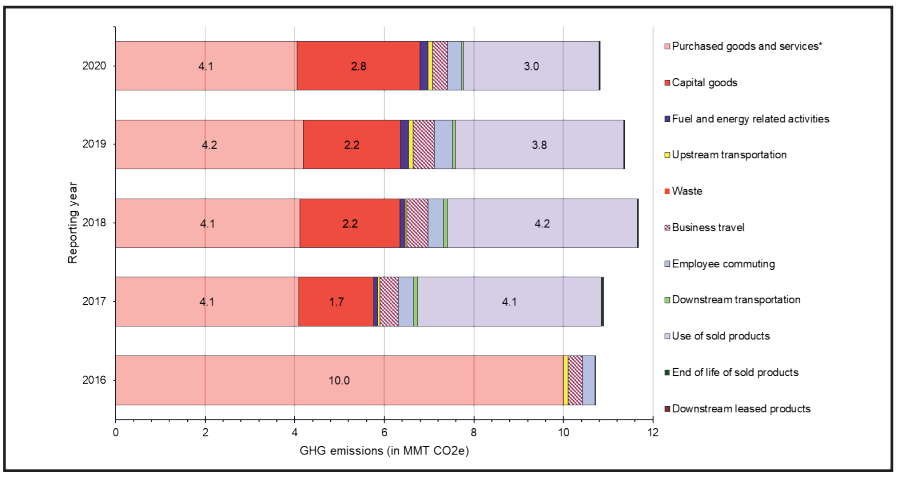


Figure 10: Breakdown of scope 3 emissions (in MMT CO2e) for Microsoft Corporation, 2016-20
Developed by authors (2022)

Carbon Management Strategy

Microsoft's carbon management strategy is guided by the company's pledge to be carbon negative by 2030 and by 2050 remove from the environment the total quantum of carbon the company has emitted since its foundation (Figure 11). Building on this pledge, Microsoft has announced several new commitments for four key areas of carbon, waste, ecosystems, and water (refer Table 11).

Each of these four action areas has five strategic pillars: operations, products and services, customers and partners, policy, and employees. The company takes responsibility for its carbon, waste, water and land footprints associated with operations, sourcing, manufacturing, and management of end-of-life of products and services. On the policy front, Microsoft supports new initiatives accelerating carbon, water, waste and ecosystem opportunities. The product and services pillar stresses the development of new technology and services to further environmental sustainability. It is also helping its customers and partners across the world to reduce their carbon, water, waste and land footprints. In doing all this, Microsoft identifies its employees as important assets in creating new opportunities and advancing innovations towards pressing challenges.

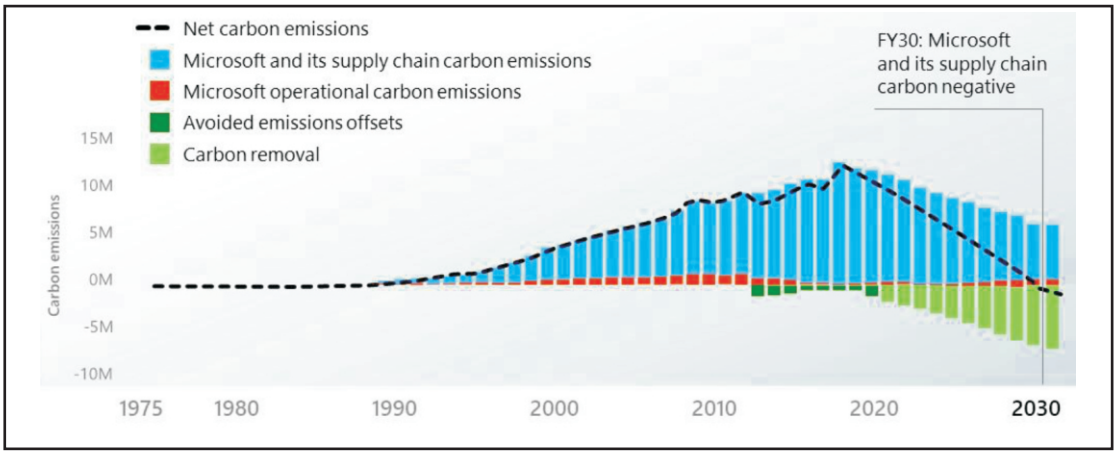


Figure 11: Microsoft's proposed pathway to carbon negative by 2030
Source: Microsoft (2021)

To amplify global impact and realize its carbon-negative commitments, Microsoft is deploying three key financial instruments — one, Climate Innovation Fund investing $1 billion over four years to scale up existing climate technologies and invest in technology that is too niche for broad adoption; two, a carbon fee that is applied across the entire carbon footprint of Microsoft; and, three, a $100 million grant to Breakthrough Energy Catalyst. The Catalyst is a program within the Breakthrough Energy network founded by Bill Gates to amplify the development of climate-smart technologies for a net-zero economy.[62] The Catalyst enables Microsoft to function as a donor driving the net-zero economy and capital necessary for early market development as well as lowering green premiums in four key areas for carbon management: direct air

capture, green hydrogen, long-duration energy storage and sustainable aviation fuel.[63] Launched in 2012 to fund carbon neutrality commitments, the carbon fee enables Microsoft to function as an investor and a customer of carbon reduction and removal solutions.

Table 11: Action areas, initiatives and outcomes of Microsoft's carbon management strategy

Key action areas *Carbon management focus* *Geographic focus*	Initiatives	Key outcome and achievements
A. Carbon negative Carbon reduction, Carbon removal ***Scope 1, 2, 3 reductions:*** *Global* ***Removing carbon:*** *active projects in Peru, U.S., Nicaragua, India, Europe, Australia* ***Digital tools for carbon reduction:*** *Global*	1. **Reducing scope 1 and 2 emissions:** zero-carbon power and diesel-free generation, zero-carbon transport, improving operational efficiency in buildings, improving energy efficiency in data centres, 100% renewable **2. Reducing scope 3 emissions:** improving supplier emissions data tracking and reporting, extending internal carbon fee to include scope 3 emissions, improving the energy efficiency of devices and software, reducing embodied carbon, rethinking travel and events, reducing carbon from travel with sustainable aviation fuel	1. 0.58 MMT CO_2e emissions were reduced across all scopes of emissions in FY20. Signed Climate Neutral Data Centre Pact and committed to reach climate neutrality across its data centres in Europe by 2030. Use of hydrogen fuel cells for data centres 2. Scope 3 emissions linked to devices reduced by 8.9% from 2017-20. Updated Supplier Code of Conduct to require GHG emission disclosure 3. 1.3 MMT of carbon removal procured from
	3. Removing carbon: reforestation, improved forestry, soil carbon removal, biochar, engineered solutions of direct air capture and bio-oil sequestration **4. Digital tools for carbon reduction:** Microsoft sustainability calculator to calculate their carbon emissions from cloud usage, Embodied Carbon in Construction Calculator	direct air capture & other projects (11% of total emissions in FY20) 4. Became a founding member of Transform to Net-Zero. Launched Microsoft Sustainability Calculator to provide transparency on carbon to customers. Invested $50 million in Energy Impact Partners
B. Water positive Carbon removal ***Reducing water footprint & digitsing water:*** *Global*	**1. Reducing water footprint:** net-zero water campus, using less water in new offices, cooling data centres with less water, community engagement	1. Solar project for Arizona data centre saved 350 million litres water 2. 20 water replenishment projects funded by 2020

Key action areas *Carbon management focus* *Geographic focus*	Initiatives	Key outcome and achievements
Replenishing water: India, U.S. *Improving water access: India, Indonesia, China, Brazil, Mexico, South Africa, Malaysia*	**2. Replenishing water:** investing towards wetland restoration, removal of impervious surfaces, water conservation **3. Improving water access** via microfinance **4. Digitizing water** to measure quality, consumption and leaks	across 2 countries 3. Invested $10 million in Global Water Impact Fund to support technologies for water conservation, access and quality. 4. Launch of solutions accelerators on Azure IoT Central to include real-time water quality and consumption monitoring
C. Zero waste Carbon reduction **Getting to zero waste**: Global (active projects in EU, U.S.) **Digital tools for circularity**: Global	**1. Getting to zero waste:** zero waste facilities, the launch of circular centres for new major data centre campus to process servers on-site, extending circularity in data centres to packaging, community engagement, cutting waste in devices, engaging employees **2. Digital tools for circularity:** monthly e-waste data for real-time, chain-of-custody API reporting, blockchain for tracking materials over the full supply chain, IoT to cut food waste, recycling, improving circularity	1. 60,000 metric tons of campuses and datacentres waste diverted from landfills. Achieved zero waste certification for data centres in Dublin, Ireland, Virginia. 2. Piloted Microsoft Circular Center in Amsterdam to increase the reuse of servers by 90% by 2025. Invested $30 million in Closed Loop Partners to build circular economy at scale.
D. Ecosystems Carbon reduction **Responsibility for land footprint**: Global **Planetary Computer**: Global	**1. Responsibility for land footprint:** committed to permanently protect and restore more land than used (11,000 acres of land in use globally in FY20) company-wide **2. Building the Planetary Computer:** provides access to key environmental datasets enabling and supporting scientists in environmental monitoring, forecasts, planning and attribution	1. Established partnerships with Nature Conservancy and National Fish and Wildlife Foundation to protect more land than in use by 2025 2. Onboarded 10 petabytes of environmental and Earth observation data to Azure in FY2020 for free use by the conservation community

Developed by authors (2022)

Carbon reduction is the general focus for Microsoft but it is increasing investments for long-term and permanent carbon removal via engineering solutions such as direct air capture. The scale of impact for most initiatives is global but for select initiatives—on carbon removal, zero waste, or cloud infrastructure—key projects are active in Europe, U.S., India, Peru, Australia, Nicaragua.

Summary: Corporate Carbon Review

Microsoft Corporation is not new to managing carbon. It focuses on four key areas—carbon, ecosystems, water and waste — where it can make the greatest impact. From expanding its carbon measurement and reporting — that historically focused on scope 1 and 2 — to amping up its carbon commitments in 2019-20, Microsoft is testing new areas and amplifying pre-existing investments for carbon management. Reviewing Microsoft's carbon performance, it is evident that:

One, Microsoft is increasing transparency on the effectiveness of its carbon management investments and the need for scaling up carbon goals. The company reports being carbon neutral since 2012, primarily by funding forest preservation projects to sequester carbon, buying offsets and power purchase agreements. Noting the limited effectiveness of its carbon neutralization efforts, the company shifted its focus from carbon neutrality to carbon negative in 2020.

Two, the company's carbon-neutral boundary accounts for 5-7% of its reported emissions. The scope of emissions included in Microsoft's carbon-neutral boundary includes scope 1, scope 2-market based, and scope 3 emissions emanating from air travel of employees—accounting for 5.5% of total emissions reported by the company in 2020, and 5.1% of total emissions reported in 2017.

Three, despite the initial focus on scope 1 and 2, the company is incrementally expanding the scope and scale of investments for decarbonizing its supply chains. In 2020, it expanded the internal carbon fee to cover each business group's scope 3 emissions. This fee for scope 3 was kept lower than the fee for scope 1 and 2 emissions — with an intent to ramp it up over time till there is one common carbon fee across the entire emission portfolio. While the timeline for ramping up the fee is not disclosed, the company updated its supplier code of conduct to improve supplier emission reporting and data tracking. In May 2021, Microsoft joined the 1.5oC Supply Chain Leaders group and thus committed to encouraging its small and medium-sized suppliers to reduce GHG emissions by

half before 2030 and achieve net-zero by 2050. How effective this internal carbon fee and updated supplier code of conduct will be in achieving net-zero by 2050 is yet to be determined.

Four, Microsoft is broadening the scope of fuel switching from renewable energy procurement to zero-carbon power and diesel-free generation. Noting the limited efficiency of renewable energy procurement in reducing reliance on fossil fuels, the company now has a 100/100/0 vision — 100% of electricity consumption, 100% of time matched by zero-carbon sources—for 2030 to decarbonize the grid it purchases electricity from.[64] For this zero-carbon energy procurement, it will be important for Microsoft to diversify the portfolio of low-carbon resources as well as match and monitor corporate demand for low carbon supplies on an hour-by-hour basis. It will have to tailor its energy purchase mechanisms across geographies to bring more zero-carbon energy into the grid.

Microsoft's commitment towards carbon management and climate change is admirable, making several headways, and setting good practices for others to learn from. It is initiating new conversations on historical emissions and openly acknowledges that reducing emissions, buying offsets, and investing in nature-based carbon removal projects is not enough. It is working towards a carbon negative future, and implementing a cocktail of reduction and removal strategies. The latter includes seeding new forests and expanding existing forestry projects, soil carbon sequestration by adding microbes and nutrients to parched earth, direct air capture, and producing bioenergy from carbon capture and storage (BECCS). However, the availability of high-quality, long-term carbon removal and storage solutions, such as direct air capture and BECCS, is limited and expensive at the present.

Comparative Assessment of Carbon Performance by Technology Companies

In the past few years, tech companies such as Google, Amazon, Apple, Microsoft and Samsung Electronics have announced and ramped up their voluntary commitments and investments to reduce carbon footprint — with each company striving not to be the last. Climate change and carbon management have become a corporate agenda, and not merely a subject dealt with by the public relations department. This section highlights the key differences across the select five companies in terms of emissions profile, reported carbon metrics, energy use, and carbon management.

Emissions Profile and Carbon Metrics

The extent of carbon metrics reported by each of the five companies differ. However, there are two key elements on which each company evaluates its carbon performance: emission inventory and share of renewable energy in total electricity consumption (for details, refer to Appendix 13).

How comprehensively a company reports its different scope of emissions differs. For instance, Samsung Electronics, Google LLC and Microsoft Corporation report their total scope 1 emissions, while Amazon.com and Apple report a breakdown of their scope 1 emissions. A majority of the companies under study report market-based scope 2 emissions, to reflect the impact of renewable energy procurement on emissions from purchased electricity. Google and Microsoft report market- as well as location-based emissions from purchased electricity. Google's market-based scope 2 emissions were roughly 20% of location-based emissions in 2020; Microsoft's market-based scope 2 emissions varied from 2% to 8% of location-based emissions during the 2016-20 period.

More profound are the differences in measurement and reporting of scope 3 emissions. Google reports a breakdown of its scope 3 emissions into two categories: emissions emerging from business travel, employee commuting and telecommuting; and other. It remains unclear what all is measured in this “other” category. Samsung Electronics reports a breakdown of its scope 3 emissions from suppliers, logistics,

and business trips linked to South Korea worksites. Apple, Amazon and Microsoft disclose a much more expansive breakdown of its scope 3 emissions. This difference in what gets measured and what gets reported, particularly for scope 3, is linked to the different products and services each company provides. Despite these differences in emission inventory, scope 3 dominates the emission profile across the board (as indicated in Figure 12).

Among the five companies, Apple and Amazon have the largest footprint of scope 3 emissions. In 2020, Amazon's scope 3 emissions were twice the levels reported by Apple. In terms of total reported emissions, Amazon has the largest footprint, followed by Samsung Electronics. But we cannot ascertain where the latter stands among the five companies as it does not disclose its full-scale emissions. Scope 1 emissions are increasing for all, except Google. The most significant increase in scope 1 emissions is noted for Amazon followed by Samsung Electronics, Microsoft, and Apple. From 2018 to 2020, Amazon added over 4.6 MMT CO_2 of scope 1 emissions; Apple and Microsoft noted an increase of 0.02 MMT CO_2e and 0.03 MMT CO_2e from 2016-20. Reported scope 2 emissions decline for Apple and Google is linked to companies matching 100% of their electricity consumption with renewable energy procurement — and the accounting methodology that does not factor in reliance on fossil fuels despite 100% renewable procurement.

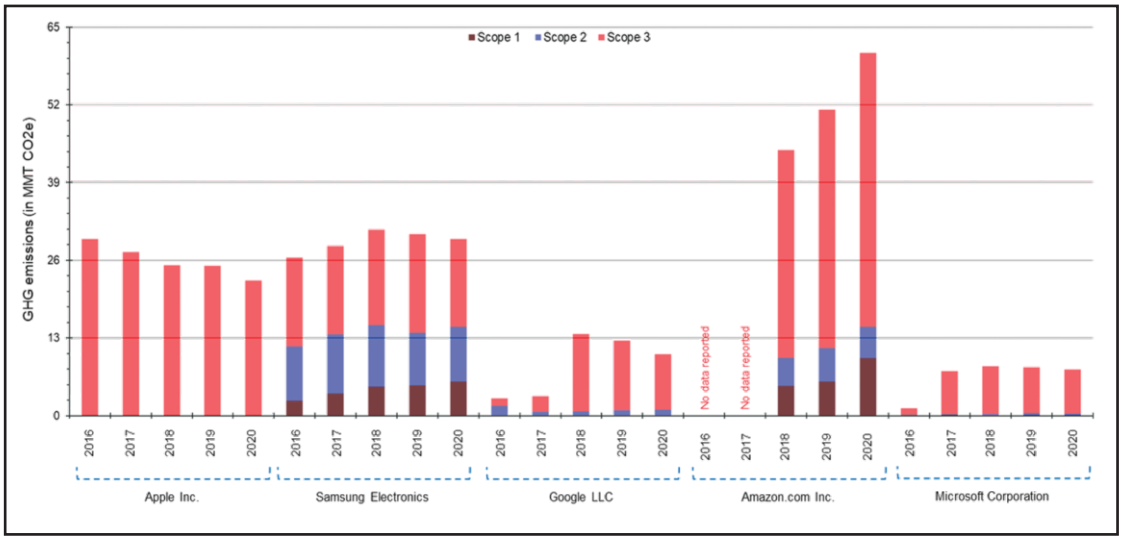


Figure 12: Emission profile for Apple, Samsung Electronics, Google, Amazon.com., and Microsoft
Developed by authors (2022)

Energy Consumption

Carbon reduction via fuel switch to renewables is one of the key strategies deployed by each of the five companies, irrespective of their total energy and electricity consumption (for details, refer to Appendix 14). Goals, targets, and scale of investments for this fuel switch differ. For instance, Apple Inc. set and executed a bold target to match its electricity consumption with renewable energy procurement — and achieved the target in 2019 and 2020 (as indicated in Figure 13). However, this 100% renewable energy matching to electricity consumption equates to 84-85% of total energy consumption — the latter accounting for electricity consumption as well as energy sourced from propane gas, gasoline, diesel, biogas, and natural gas. Sourcing over 80% of this renewable energy from power purchase agreements and other such contracts, the company does not factor in the hour-over-hour reliance on fossil fuels. In essence, the actual proportion of low-carbon energy used for the company's global facilities maybe even less than 84-85% of total energy consumption.

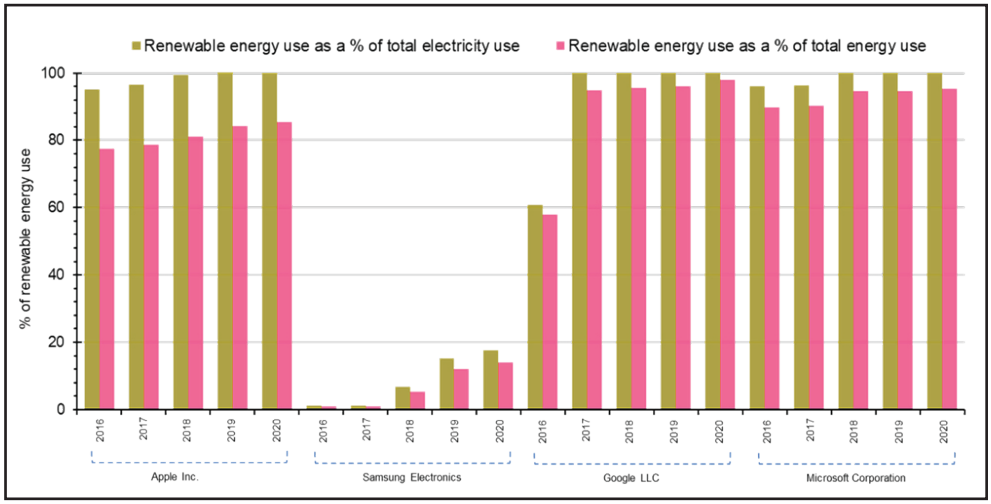


Figure 13: Renewable energy use as a percentage of total electricity use for Apple, Samsung Electronics, Google, Amazon.com, and Microsoft
Developed by authors (2022)

Similar is the case for Google and Microsoft Corporation. The difference between the latter two and the other three companies is that these two are expanding their fuel-switching efforts to include zero-carbon energy. Google has been relatively more transparent about the limitations of renewable energy procurement. For Samsung, energy consumption and fuel switching have been tough. In FY20, it consumed approximately 10x the energy consumed by Apple in the same year and sourced less than 14% of total energy from renewable

resources. Due to the limited supply of renewables in South Korea, and market regulations limiting the purchase of renewable energy from independent contractors in its two key manufacturing geographies of Vietnam and South Korea, Samsung Electronics has lagged behind in the corporate race of renewable procurement.

In essence, none of the five technology companies under study is sourcing 100% of their energy demand from low-carbon sources — despite the bold claims. A company is said to operate on 100% renewable energy when the total energy use matches with renewable energy. Right now, it only matches with electricity use for select companies, not total energy use. For most companies, this electricity use is 75-90% of total energy use. Summing up, corporate procurement of renewable energy is helping reduce the reliance on fossil fuels, accelerating the energy transition and helping clean regional grids, but it is not ending the use of fossil fuels. Moving beyond a 100% renewable energy goal is imperative for deep decarbonization of the corporate value chain and supply chains.

Corporate Carbon Management

Corporate ESG strategy for the five companies broadly focuses on leveraging business as a force for good and using technology to respond to pressing global challenges, including climate change (for details, refer to Appendix 15). Carbon management goals and the time horizon to achieve these goals differ. Google and Apple, for instance, have set the goal of net-zero by 2030. Amazon pledged net-zero by 2040 and Microsoft takes responsibility for its historic carbon footprint and aims for carbon negativity by 2050. These goals however are all voluntary and unregulated.

A company's voluntary commitment to neutralize its carbon emissions aims to effectively add no carbon to the atmosphere. Accounting for a fraction of total reported carbon emissions, these five companies have defined their own carbon neutral boundaries and neutralizing emissions via a diverse portfolio of investments — such as removing a ton of carbon from the atmosphere for every ton it produces through forestry and other nature-based solutions; offsetting emissions by paying others to reduce emissions it cannot; and, reducing emissions via fuel switching to renewable energy, energy efficiency, and material efficiency. All of these neutralization efforts reduce the quantum of emissions entering the atmosphere but do little to remove them permanently.

To better understand how each company is progressing towards decarbonization of its global operations, value chain, and supply chains we

developed a ranking system (indicated in Table 12) that serves as a framework to examine a company's carbon performance via three parameters: emission inventory, carbon commitment, and reported progress in the last five years. Aligned with the 2015 Paris Agreement, commitments made at COP 26 in Glasgow, and IPCC climate risk models, this framework or its rankings should not be used or viewed as a tool to criticize or lash out at any particular company.

Five ranks are developed for this framework — with D indicating the lowest rank and AA indicating the highest rank. A company reporting total scope 1 and 2 emissions will be ranked D for the parameter of emission inventory; a company reporting a total of scope 1, 2 and 3 as well as a breakdown of each scope of emissions will be ranked B. It is possible that several companies in the technology industry, or any other industry, may not be ranked for one or more parameters either because they do not have an ambitious target on carbon or the reported target lacks clarity.

Assessing the five technology companies under study using this ranking system, it is noted that when it comes to emission inventory everyone is reporting the breakdown of scope 1, 2 and 3 emissions, but not everyone is disclosing the full extent of emissions from their operations and value chain (as indicated in Table 13). Microsoft and Apple are setting good examples in reporting their scope 1, 2 and 3 emissions globally as well as scope 1 and 2 emissions across different geographies. In terms of carbon commitments, everyone except Samsung Electronics has a specific goal of net-zero or carbon-negative with a firm date to monitor progress. Amazon.com has a specific goal for net-zero by 2040, but it does not specify the scope of emissions it aims to neutralize by 2040. Hence, these two companies' carbon commitment cannot be ranked in this framework.

Table 12: A rank-based framework for assessing corporate carbon performance

Ranking	Emission inventory	Carbon commitment	Reported progress in carbon reduction/removal (FY 2016-2020)		
			Scope 1	Scope 2	Scope 3
AA	Nearly 100% of global scope 1, 2, 3 emissions measured and reported. Plus, scope 1 and 2 or scope 1, 2, and 3 reported across regions	Carbon negative + accounting legacy footprint by 2050 and carbon neutral by 2035	Upto 80% reduction	Upto 80% reduction	Upto 50% reduction

Ranking	Emission inventory	Carbon commitment	Reported progress in carbon reduction/removal (FY 2016-2020)		
			Scope 1	Scope 2	Scope 3
A	Nearly 100% of global scope 1, 2, 3 emissions measured and reported. Plus, scope 1 or 2 or 3 reported across regions	Carbon negative by 2050 and carbon-neutral across scope 1, 2 and 3 by 2035	Upto 50% reduction	Upto 50% reduction	Upto 30% reduction
B	Breakdown of scope 1, 2 and 3 reported	Carbon neutral by 2050 and 50% reduction in total scope 1, 2, and 3 by 2035	Upto 40% reduction	Upto 40% reduction	Upto 15% reduction
C	Total of scope 1, 2 and 3 reported	80% reduction in scope 1 and 2 by 2050 and 35% reduction in scope 3 by 2035	Upto 20% reduction	Upto 20% reduction	Upto 10% reduction
D	Total of scope 1 and 2 reported	Reducing scope 1, 2 and 3 emissions	Increase	Increase	Increase

Developed by authors (2022)

Each company has a different blend of carbon management strategies and scale of investments, and thus progress towards carbon management differs as well. Based on disclosures, none of these five companies—except Apple—has been able to make a big dent in reducing scope 3 emissions. This could be linked to the company's suppliers transitioning to renewable energy and/or the use of recycled gold, cobalt, aluminium, and rare earth elements, among other materials for Apple products. Despite increasing procurement of renewable energy, reducing scope 1 and 2 has been tough for all five companies.

Table 13: A comparative ranking of the five tech companies in terms of emission inventory, carbon commitment, and progress in carbon reduction or removal

Company	Emission inventory	Carbon commitment	Progress in carbon reduction/removal (FY 2016-2020)		
			Scope 1	Scope 2**	Scope 3
Apple	AA	B (aims to be carbon neutral across scope 1, 2 and 3 by 2030)	D (+38%)	AA (-100%)	A (-23%)
Samsung Electronics	B	Cannot be ranked	D (+124%)	D (+1%)	C (-1%)
Google	B	B (aims to be net -zero across scope 1, 2, and 3 by 2030)	A (-42%)	A (-40%)	D (+625%)

Company	Emission inventory	Carbon commitment	Progress in carbon reduction/removal (FY 2016-2020)		
			Scope 1	Scope 2**	Scope 3
Amazon.com*	B	Cannot be ranked	D* (+93%)	D* (+12%)	D* (+32%)
Microsoft	AA	AA	D (+25%)	D (+92%)	D (+1%)

** For Amazon, the progress is measured from 2018-2020 as it publicly discloses emissions for this period only*
*** market-based scope 2 emissions*

Increase in emissions, however, does not highlight that the companies' investments for carbon management have been futile. Rather, it indicates that carbon reduction or removal has not been able to keep up with the scale of expansion and diversification of a company's portfolio of products and services — and associated value chain, supply chains and internal operations.

Summary

GHG emissions are material ESG issues as these correlates with the cost of energy usage. These companies are implementing diverse projects to reduce their energy use and/or reduce the use of fossil fuels in the energy mix — as a competitive necessity. This adaptation raises the bar for operational effectiveness and emission reduction across the corporate value chain.

These five tech companies—despite the differences in their portfolio of products, services, emission profile, energy mix and carbon management investments — are equipped to tackle pressing global challenges, including climate change. Their scale of operations, global presence and immense footprint situate them well to make a global impact and amplify the scale and speed of deployment of breakthrough technologies that can effectively reduce and/or remove carbon from the atmosphere. They can not only help consumers but set good practices for others to follow or refer to. These companies shape how we engage with the world and the information we process daily. In essence, tech companies are uniquely placed to scale impact beyond measuring emissions. These companies should thus explore and expand efforts leveraging technology to create change across systems.

Companies should also report economic benefits, such as cost savings accruing from improvements on material ESG issues, including carbon management. This reluctance to disclose economic benefits or social benefits undermines the importance of ESG-related improvements and innovations. It overlooks the fact that ESG reporting and innovation of material issues can profoundly affect the strategic positioning of a company in the market and amplify cost savings across business divisions.

Discussion

A. Tech companies are setting good practices

Climate crisis is increasingly becoming material ESG concerns for companies around the world. In 2021, at least one-fifth of the world's 2000 largest public-listed companies made a net-zero commitment and by 2022, every tech unicorn is expected to have a net-zero plan.[65] In a 2020 survey of N100 companies, the technology sector was found to have a higher ESG reporting rate than other sectors. The technology sector was also found to fare better in terms of disclosure of carbon reduction targets. In 2017, around 61% of N100 technology companies were disclosing their carbon reduction targets and this quantum increased to 70% in 2020. While more than 70% of mining, utilities and automotive companies were disclosing their carbon reduction targets in 2020, less than 65% of N100 companies in the retail and financial services sector were disclosing these targets.[66]

B. Return on investments

Several attempts have been made in the past to measure returns on investments for carbon management, including carbon return and energy return on investment (ROI). Energy-ROI was conceptualized in the 1980s by Charles Hall to compute energy returns on energy invested for oil extraction. Hall argued that oil can be extracted with relatively little energy expenditure and yield a big EROI. But, as oil becomes harder to extract, more energy is needed for extraction—thereby diminishing EROI over time. Accounting for the energy required to extract, refine and transport fuels, it was argued that fuels with an EROI 14:1—fuels that deliver at least 14 times the amount of energy they consume—were worth investing in. The concept however remained academic for it did not respond to complexities in assessing full lifecycle energy inputs, conversion of energy, and collection of corresponding data.

Carbon-ROI is used to compute the return on investment generated over time in the long run.[67] It can help guide decision makers on priority action areas and investments for carbon management and energy transition. But, estimating these returns is complex because there is inadequate disclosure of data on how much investment is flowing towards what initiatives, what are the cost savings from each investment, and what is the corresponding quantum of carbon reduced or removed.

C. Outlook

Technology companies are uniquely positioned to make a difference in the corporate decarbonization race. Collaborations with peers, clients, investors, governments, NGOs and academia can help companies accelerate the decarbonization of their internal operations, entire value and supply chains. Scaling up existing technologies, innovating towards breakthroughs and commercializing early-stage technologies will be critical to progress towards a net-zero future. It is estimated that new technologies—for agriculture, carbon capture, hydrogen, power grid, and electrification of transportation, buildings and industry—could help reduce nearly 40% of global GHG emissions by 2050 and attract up to $2 trillion in annual investments.[68] Understanding Wright's law—that the cost of innovation falls as it scales—tech companies should acknowledge that early investment will help reduce costs and amplify the deployment of technologies that can permanently lock carbon out of the atmosphere.

- **Finding 1: There is no standardization or mandate for corporate ESG reporting.** The contents and structure of the report can be tailored by a company. Companies may choose to not disclose their performance on material ESG issues, or choose to disclose on select metrics of one or more ESG reporting frameworks. There is no harmonization or a mandate on what gets measured and reported. With this flexibility of metric and framework selection and periodicity of reporting, ESG reports are functioning more as a communication tool to improve investor relations and corporate branding.
- **Finding 2: Corporate carbon commitments, such as net-zero or carbon negative, are voluntary and unregulated.** In an attempt to be not left behind their peers, companies are voluntarily committing and setting targets for climate action—and thus carbon management. But there is no government oversight on a company achieving these targets. Companies can miss these targets and fall short on commitments, and no penalty will be imposed.
- **Finding 3: Companies are setting goals for a net-zero or carbon-neutral future, but using different definitions and methodologies to report carbon neutrality.** Carbon neutral boundary for companies focuses on scope 1 and scope 2 emissions. Within scope 3, companies have been accounting for business travel or a fraction of it in the definition of carbon neutral. With the recent expansion of the carbon-neutral boundary by Apple Inc. in 2020, the definition and extent of the carbon-neutral boundary have broadened to include the entire emission inventory comprising total scope 1, 2 and 3. But, there is no consistency across the five companies on the definition or reporting of carbon-neutral boundary or emissions included in this boundary.
- **Finding 4: There is limited harmonization in the measurement and reporting of GHG emissions.** Companies are measuring emissions from their direct and indirect activities using different methodologies. Even the companies using the GHG protocol are measuring and disclosing emissions differently. For instance, Amazon reports the breakdown of scope 1 emissions from the use

of refrigerants and fossil fuels. Most companies report scope 1 emissions as total emissions from internal operations. What gets included and what does not in this category of emissions is rarely disclosed. Scope 3 measurement and accounting carbon footprint for the entire value and supply chain is much more complex. It requires credible data from all users and suppliers and companies have adopted their methodology to measure these emissions.

- **Finding 5: Scope 3 emissions are tough to measure, monitor and report but they offer a broad spectrum of opportunities for corporate carbon management.** Scope 3 emissions account for the bulk of total reported emissions for the 5 companies in our study, but companies have limited direct control over them. Emissions linked to consumption and product use raise the question of who is responsible for how much of the emissions across the product life cycle. Should consumers buy less and/or search for only environment-friendly options, or should companies — directly contributing to climate change and environmental degradation through their portfolio of products and services—assume the role of deep decarbonization of their value chain and supply chains. These emissions are increasingly becoming multitiered as contractors are increasingly outsourcing to subcontractors, which makes tracing and tracking of carbon, complex.
- **Finding 6: Companies are relying on renewable energy procurement and the purchase of offsets to neutralise carbon.** The quality and efficiency of the two pathways in effectively reducing fossil fuel use or removing carbon from the atmosphere are limited. Even when a company can match 100% of its electricity demand with renewable energy, it does not guarantee an end to fossil fuel use. Similarly, offsets can help reduce the pace at which GHG emissions are added to the atmosphere, but they have little to no impact on permanently removing carbon from the atmosphere.

Based on the conclusions and findings of the analysis of the carbon management of the largest 5 companies in the technology space, we make the following recommendations to further develop ESG standards on carbon management reporting. While some of these recommendations might be particularly pertinent to the technology companies, they could also help inform standards that apply to other sectors.

- **Recommendation 1: The mandate and standard methodology for comprehensive carbon measurement and annual reporting should include the company's full extent of the value chain, supply chains and**

internal operations — including scope 3 emissions. There is also a need to develop best practices on the way companies track and measure emissions. This will help push companies to invest in more accurate, automated and consistent ways to measure, monitor and report emissions across corporate operations, supply and value chains. It will help companies and their investors understand what the business would look like in a net-zero world. It will also help company management and boards better understand how to transform global operations and supply chains to align with their commitment to net zero. Measurement and public disclosure of scope 3 emissions cannot remain an optional metric for corporate disclosure in the technology space. As companies ramp up efforts and targets for carbon reduction and removal, accountability will remain weak if scope 3 tracking and disclosure does not improve and remains optional. For each scope of emission, companies need to disclose the scope and methodology of data collection, emission calculation and reporting, as well as emissions that do not get reported and why.

- **Recommendation 2:** ESG reporting guidelines **should provide standards on the definition of science-aligned net-zero and the methodologies that companies can use to assess their carbon commitments' alignment with the global net zero.** These standards should emphasize protection and expansion of carbon sinks in the biosphere, reducing all categories of emissions across a company's value chain—especially reducing emissions over which companies have the most control—as well as shifting to long-term carbon storage, purchasing carbon removal, expanding the supply and reducing the cost of technological and engineering solutions for long-term carbon storage and removal.

- **Recommendation 3: Companies should monitor returns on investments geared towards carbon reduction and removal and ESG reporting standards should develop reporting guidelines.** As companies increasingly amplify the scope and scale of investments for carbon reduction and removal across the world, they should monitor, measure and report qualitative and quantitative returns on each carbon investment. Some of the key returns to measure and report should include economic, social and environmental returns from effective carbon management. Apart from the quantitative return, companies should also monitor, measure and report the quality of return. For instance, of the total carbon removed, how much is stored in terrestrial ecosystems and faces risks of release by fires, pests,

storms and changes in land use; and, how much of the carbon is stored in geological formations of rocks and minerals. Monitoring these returns can help companies realistically and systematically manage carbon across geographies and operations, value chains and supply chains.

- **Recommendation 4: Corporate pledges for climate action or carbon management should be consistent and focus on deep decarbonisation actions without delay.** These pledges should be assessed transparently and independently. These pledges, and efforts to achieve them, should be linked to robust climate governance systems and involve long-term goals that are ideally legislated and outlined in a domestic policy. These pledges must be easily accessible through open data and transparent plus independent reviews regularly — to verify and if necessary, challenge the communication of progress on how actions are being implemented.

A Note for Policymakers

In November 2021, India announced its commitment to become carbon neutral by 2070 at the Conference of Parties (COP) 26 held in Glasgow, Scotland. The national statement presented by Prime Minister Narendra Modi at COP26 is more aggressive in the climate action goals than the Intended Nationally Determined Contribution (NDCs) India submitted in the Paris Conference of Parties in 2015. India's new goal of achieving net-zero emissions by 2070 was one of the key elements of discussion of the national statement at COP 26 as India was one of the few nations in the G20 group that had not committed to a net zero target before Glasgow. The government is yet to realise details on the climate goals and roadmap for net-zero emissions in the next 50 years.

In the 2015 NDC, India pledged to reduce the emissions intensity of its Gross Domestic Product (GDP) by 33-35% by 2030-from 2005 levels. Using real GDP data from the International Monetary Fund and CO_2 emissions reported in the BP Statistical Review of World Energy 2021, it is estimated that India's emissions intensity in 2020 was already 22% lower than 2005 levels, and has been annually declining by 2% per annum since then. If the emissions intensity continues to decline at this rate, India is well on its way to achieving the 2015 NDC target.[69]

Compared to 2015 NDC targets for 2030, the net-zero commitment at COP26 gives India more time to realise its climate goals by 2070. However, one issue that remains central is the country's lack of a national-level climate policy and governance system that could guide, regulate and monitor climate change planning, actions and iterations at state and local levels. In addition, the Government of India is yet to clarify how it plans to augment financial resources to achieve these goals. Experience has shown that developed nations' promise to provide monetary support to developing nations, like India, is not always fulfilled—not entirely.

Whether India continues to focus on external funding support from development banks, multilateral and developed nations' governments, or explore possibilities of augmenting climate finance from less-explored sources—such as the corporate sector which has invested and collaborated with governments, civil society, and other stakeholders to support diverse socially responsible and environmentally friendly business practices and projects via corporate social responsibility (CSR)—remains uncertain.

Corporates in India are yet to actively join this global decarbonisation race, pledge time-specific commitments for climate action and unlock corporate investments for a diverse portfolio of climate actions. By the end of 2021, less than 100 Indian companies had established or committed to establishing science-based targets for climate action, even though most companies have renewable energy or energy efficiency targets.[70]

Apart from unlocking and utilising corporate investments for climate action and green growth opportunities, India needs to embed climate action metrics into decision-making at all levels of space, time and governance. Some of the key policy improvements the country needs to adopt to realise its climate commitments include:

1. Revisit the National Climate Action Plan on Climate Change of 2008 to align it with the COP26 commitments and Paris Agreement;
2. Revisit budget heads at the central, state and local levels to earmark dedicated funds for climate action;
3. Establish a regulatory body that monitors the flow of funds for climate actions and measures multifaceted impacts of such investments – and the quality thereof;
4. Update CSR and SEBI rules and regulations to mandate corporate climate commitments, disclosure of climate impact and risks, dedicating a fraction of corporate investments for climate action, and third-party evaluation of investment outcomes.
5. A close look and strategic translation on co-benefits between decarbonisation, adaptation and disaster risk resilience towards better synergies

Summing up, India needs a comprehensive climate policy framework that reflects India's latest goals and vision. This policy framework will need to incorporate perspectives from a diversity of stakeholders including natural and social scientists, corporates, civil society, local communities, academia and industry. This policy framework shall acknowledge differences in emission contribution and reduction potential across industries, sectors, cities and states. Moreover, governments at the central, state and local levels need to create an enabling environment to unlock new investments for climate action from the corporate sector.

Appendix

Appendix 1: Carbon metrics measured by key sustainability reporting frameworks

The scope of carbon management differs across sustainability frameworks. It is evident that the frameworks—if at all they include carbon management in their scope—focus on identifying climate change as a risk to business operations and/or portfolio of assets. In terms of management, a few focus on accounting for GHG or CO2eq emissions. Of the 11 sustainability frameworks analyzed and tabulated below, only ISO 14000 standards on environmental management measure GHG emissions and carbon removals at the organization level as well as a project level. It also includes standards to measure the carbon footprint of products. In essence, the extent of carbon management is not comprehensive. While GHG accounting is a metric for carbon management in select sustainability reporting frameworks, it often excludes Scope 3 emissions and emissions across supply chains.

Reporting Frameworks Year of Launch Voluntary/Mandatory	Purpose	Scope of carbon management
ILO labour standards 1919 Voluntary recommendations plus legally binding conventions	Progress in promoting rights at work, creating decent jobs, improving working conditions, extending social protection, and supporting sustainable enterprises	**No mention** 1. No standard to measure or report carbon emissions or any aspect of carbon 2. Identifies climate change as a disruptor to work
International Organization for Standardization (ISO) standards - social responsibility (ISO 26000 introduced in 2010), - environmental management (ISO 14000 adopted in 1996) - risk management (ISO 31000 adopted in 2009) Voluntary	Guide businesses and organizations to operate in a socially responsible way (ISO 26000), or manage their environmental responsibilities (ISO 14000), or manage risks (ISO 31000)	**Explicit** 1. ISO 14000 explicitly measures and manages carbon metrics: GHG emissions and removals at the organization level and project level, the carbon footprint of products, and GHG emissions in energy intensive industries
ICC Business Charter for Sustainable Development 1991 Voluntary	Promote corporations to develop policies and programs for better environmental management and SDG implementation	**Implicit** 1. Principle of environmental responsibility and management focuses on the provision of incentives and policy guidance to drive efficiency in the use and reuse of natural resources, beyond carbon and energy

Reporting Frameworks Year of Launch Voluntary/Mandatory	Purpose	Scope of carbon management
SA8000 Standard 1997 Voluntary	Accountability for employee rights and fair working environments	**No mention** of carbon or emissions or climate change in the set of SA8000 standards
United Nations Global Compact (UNGC) 2000 Voluntary	Support companies to conduct business responsibly by aligning strategies and operations with Ten Principles and initiate strategic actions to advance broader goals such as the SDGs	**Implicit** focus on measuring, monitoring and acting on a company's environmental footprint.
Equator Principles (EPs) 2003 Voluntary	Determine, assess and manage environmental and social concerns of projects financed across the world and all industrial sectors	**Explicit** 1. Identifies carbon intensive sectors-oil and gas, thermal power, cement and lime manufacturing, integrated steel mills, base metal smelting and refining, foundries, pulp mills and potentially agriculture 2. Alternatives' analysis highlights technical and financial feasibility as well as cost-effective options available to reduce project-related GHG emissions during the design, construction and operation of Project 3. Annual quantification and reporting of combined Scope 1 and Scope 2 GHG emissions and GHG Efficiency Ratio
United Nations Principles for Responsible Investment (PRI) 2005 Voluntary	Understand investment implications of ESG factors and incorporate these factors into investment and ownership decisions	**Implicit** 1. Identify climate change as the highest priority of ESG issues facing investors, but no explicit mention of measuring, monitoring or managing carbon
OECD Guidelines for Multinational Enterprises 2010 Voluntary	Responsible business conduct in areas of employment and industrial relations, human rights, environment, information disclosure, taxation, and science and technology	**Implicit** 1. Guidelines encourage a second set of disclosures for areas where reporting standards are evolving, such as GHG emissions. 2. Reduction of GHG emissions as one of the possible environmental performance enhancing activities at an enterprise level as well as supply chain

Reporting Frameworks Year of Launch Voluntary/Mandatory	Purpose	Scope of carbon management
UN Principles for Sustainable Insurance (PSI) 2012 Voluntary	Foster a resilient insurance industry based on holistic and far-sighted risk management	**No mention** 1. Identifies climate change as a risk to the insurance industry 2. Identifies the need to develop products and services that respond to the needs of a dynamic world undergoing climate change
Sustainable Development Goals (SDGs) 2015 Voluntary	Global call for action to end poverty, protect the planet, and ensure that all people enjoy peace and prosperity by 2030	**Explicit** 1. SDG 9, Target 9.4.1 measures CO_2 emissions per unit of value added 2. SDG 13, Target 13.2.2 measures total GHG emissions per year
UN Environment Programme Finance Initiative (UNEP-FI) Principles for Responsible Banking (PRB) 2019 Voluntary	Mobilize private sector finance for sustainable development	**Implicit** focus on signatory banks to align their business strategy and practice with SDGs and the goals of the Paris Agreement 1. No specific requirement to measure carbon emissions in a bank's operation or portfolio

Developed by Agrawal (2022) [71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81]

Appendix 2: Purpose and disclosures of key ESG reporting frameworks

ESG Frameworks Year of launch	Purpose	Information to report
GRI Standards (Universal, Sector, Topic Standards) 1997	To help businesses, governments and other organizations report on economic, environmental and social impacts of business considering a wide range of interests and critical sustainability issues	1. General disclosures on the organization's profile, ethics and integrity, stakeholder engagement, governance, and reporting process. 2. Economic data points on market presence, indirect economic impacts, procurement practices, anti-corruption, anti-competitive behaviour 3. Environment disclosures on materials, energy, water and effluents, biodiversity, emissions, waste, environmental compliance, and supplier environmental assessment 4. Social data points on employment or labour management, occupational health and safety, training and education, diversity and equal opportunity, non-discrimination, freedom of association, collective bargaining, child labour
CDP 2000	To capture environmental performance data related to GHG emissions, water, forests, supply chain	1. Climate change risks and low-carbon opportunities 2. Forests and how organizations' produce, source and use major soft commodities that have a negative impact on natural resources 3. Water security and company's management, use, governance, and stewardship of water resources 4. Supply chains and management of climate change, forests, and water security
IIRF 2010	To establish Guiding Principles and 8 Content Elements for companies to produce integrated reports that explain how companies create value over the short, medium and long term — both financially and non-financially.	1. General disclosures on organization and external environment 2. Governance structure and how it supports value creation in short, medium and long terms 3. Business model of the organization 4. Risks and Opportunities affecting value creation and how these risks and opportunities are managed 5. Strategy and resource allocation 6. Performance and outcomes plus their implications on capital 7. Outlook on future challenges and uncertainties, and their implications on the business model and future performance 8. Basis of presentation in its integrated reports
		There are 12 reporting requirements (REQ): 1. REQ-01 Governance of environmental policies, strategy 2. REQ-02 Management's environmental policies, strategy and targets

ESG Frameworks Year of launch	Purpose	Information to report
CDSB Framework 2017	Enhance efficient allocation of capital by providing investors with decision-useful environmental information	3. REQ-03 Material environmental risks and opportunities 4. REQ-04 Sources of environmental impacts 5. REQ-05 Performance and comparative analysis with results reported in prior period 6. REQ-06 Outlook on the effect of environmental impacts, risks and opportunities on organization's future performance 7. REQ-07 Organizational boundary 8. REQ-08 Reporting policies and their consistency 9. REQ-09 Reporting period-annual 10. REQ-10 Restatements 11. REQ-11 Conformance with the CDSB Framework 12. REQ-12 Assurance of reported information
SASB Standards 2012	To facilitate the disclosure of material sustainability information in SEC filings	1. Environmental impacts of the company 2. Social capital and the company's performance on human rights, local economic development, customer privacy, access to products and services 3. Human capital and issues affecting employees 4. Business model and innovation: impact of sustainability issues on innovation and business models, and their integration in value creation 5. Leadership, governance and management of issues linked to business model, industry practice, stakeholder interests
TCFD Framework 2017	To encourage firms to align climate-related risk disclosures with investors' needs	1. Governance around climate-related risks & opportunities 2. Strategy: the actual and potential implications of climate-related risks and opportunities on the organization's businesses, strategy, and financial planning 3. Risk management by the organization and how it identifies, assesses, and managed climate-related risks 4. Metrics and targets used to assess and manage relevant climate-related risks and opportunities

Developed by authors (2022) [82, 83, 84, 85, 86, 87]

Appendix 3: Evolving Focus and Key Elements of Apple Inc.'S ESG Strategy, 2008-21

Year of reporting *ESG reports* Reporting frameworks	Environment	Social	Governance
2021 *1. 2021 ESG Report* *2. Environmental Progress Report 2020-21* *3. People and Environment in Our Supply Chain* GRI, TCFD, SASB	- **Supply chain:** carbon-neutral, energy efficiency, emissions abatement, water stewardship, eliminating manufacturing waste - **Environmental strategy:** smarter chemistry, resources, climate change (low carbon design, energy efficiency, renewable electricity, emissions abatement, carbon removal)	- **Supplier responsibility:** standards, accountability - **Labour and human rights:** policy, materials sourcing - **Health, safety and wellness** - **Supplier performance and development**	- **Corporate leadership:** diversity & compensation - **Commitment to human rights:** policy, progress - **Ethics and compliance:** - **Tax payments** - **Stakeholder engagement**
2020 *1. Environmental Progress Report* *2. Supplier Responsibility 2020 Progress report* *3. CDP-Climate Change questionnaire* CDP	- **Environmental strategy:** smarter chemistry innovation, mapping, engagement); resources (materials, water stewardship, zero waste); climate change (low carbon design, energy efficiency, renewable electricity, emissions abatement, carbon removal) - **Supply chain:** water, zero waste, clean energy, green factories	- **Labour and human rights:** code, actions - **Health and safety:** code and standards, design, culture - **Education initiatives:** skill-building on manufacturing, coding - **Responsible materials sourcing:** toolbox	- **Supply chain:** supplier selection, capacity building - **Governance risks** in material sourcing
2019 *1. Environmental Progress Report 2018-19* *2. Supplier Responsibility 2019 Progress report* GHG Protocol	- **Environmental strategy:** smarter chemistry (assessment & management, innovation, mapping and engagement); resources (materials, water stewardship, zero waste); climate change (carbon footprint, renewable energy, low carbon design, energy efficiency) - **Supply chain:** water stewardship, safer process chemicals, waste elimination, green supply chains	- **Upskilling**: new skills, degrees, pathways - Health education - Supplier workplace rights training: ending modern slavery in supply chain	- **Stakeholder engagement:** roundtables, customer engagement, partnerships - **Policy engagements:** climate and energy

Year of reporting *ESG reports* Reporting frameworks	Environment	Social	Governance
2018 *1. Environmental Responsibility Report 2017-18* *2. Supplier Responsibility 2018 Progress report* GHG Protocol	- **Environmental strategy:** safer materials (worker safety, eliminating toxins); resources (materials, water stewardship, zero waste, green buildings); climate change (carbon footprint, renewable energy, energy efficiency, emission reduction) - **Supply chain:** zero waste, clean energy, energy efficiency	- **Environmental, health and safety education** - Supplier workplace rights training: ending underage labour, bonded labour	- External engagement to minimize or eliminate toxins in supply chain
2017 *1. Environmental Responsibility Report 2016-17* *2. Supplier Responsibility 2017 Progress report* GHG Protocol	- **Environmental strategy:** safer materials (biocompatibility, eliminating toxins); resources (water stewardship, zero waste, green buildings); climate change (renewable energy, emission reduction) - **Supply chain:** zero waste, responsible sourcing, energy efficiency, water management	- **Supplier workplace rights training:** ending underage labour, bonded labour	- **Policy engagements:** climate and energy
2016 *1. Environmental Report 2015-16* *2. Supplier report* GHG Protocol	- **Environmental strategy:** safer materials (biocompatibility, eliminating toxins); resources; climate change - **Supply chain:** EHS	- **Empowering workers:** understanding one's rights, raising education standard - Labour & human rights	- **Accountability** code of conduct, audit, verifying improvement
2015 *1. Environmental Report* *2. Supplier report* GRI	- **Environmental responsibility:** renewable resources, resources, climate change; toxins - **Supply chain:** environment, health and safety, uncovering hazards	- **Empowering workers:** understanding rights - **Labour & human rights**: work hours, recruitment	- **Accountability** code of conduct, audit
2014 *1. Environmental Responsibility Report 2013-14* *2. Supplier Responsibility 2014 Progress report* GRI	- **Environmental responsibility:** resources (conserving materials, recycling), climate change (carbon footprint, product usage, transportation, recycling); greener materials (testing, removing toxins) - **Supply chain:** emergency preparedness, reducing risk	- **Educating & empowering workers:** responsible practices, learning - **Labour & human rights**: work hours, ethical employment, responsible sourcing	- **Accountability** code of conduct, responsibility standards, audit, core violations, corrective action

Year of reporting *ESG reports* Reporting frameworks	Environment	Social	Governance
2013 *1. Facilities report* *2. Supplier report* GRI	- **Energy use** (focus on US facilities) - Renewable energy, water use (building cooling, landscape irrigation, sanitary), waste, transportation, EHS policy - **Supply chain:** standards, environmental responsibility	- **Educating & empowering workers** - **Labour & human rights** - **Health & safety:** working conditions, identifying hazards	- **Accountability** code of conduct, audit, core violations, corrective action, workplace ethics, protection for the whistle-blower
2012 *1. Facilities report* *2. Supplier responsibility report* GRI	- **Environmental impact:** energy use, renewable energy, transportation, water use, waste and recycling - EHS policy and guiding principles - **Supply chain:** environmental audit	- **Labour & human rights**: audit - **Worker health & safety:** core violations, combustible dust	- **Ethics:** audit, core violations
2011 *1. Facilities report* *2. Supplier report* GRI	- **Environmental impact:** energy use, transportation, water use, waste, recycling, EHS policy - **Supply chain:** conflict-free sourcing	- **Protecting foreign contract workers** - **Preventing underage labour**	- **Monitoring compliance:** audit, core violations
2010 *1. Facilities report* *2. Supplier report* GRI	- **Environmental impact:** energy use, transportation, water use, waste, recycling, EHS policy - **Supply chain:** monitoring	- **Empowering workers** - **Protecting foreign contract**	- **Monitoring compliance** - **Accountability:** improving supplier
2009 *1. Facilities report* *2. Supplier report* GRI	- **Environmental impact:** energy use, renewable energy, transportation, water use, waste and recycling - EHS policy and guiding principles	- **Empowering workers:** training, education, development, audit	- **Monitoring compliance:** audit, corrective actions, audits
2008 *1. Facilities report* *2. Supplier report* GRI	- **Environmental impact:** energy use, transportation, water use, waste, recycling, EHS policy	- **Supplier training**	- **Supply chain audit:** KPIs, core violations

Compiled by authors (2022)[88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103,104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115]

Appendix 4: Carbon Metrics Reported by Apple Inc., 2016-20

GHG emissions (tCO_2e)	2016	2017	2018	2019	2020
Scope 1	34,370	47,050	57,440	52,730	47,430
Natural gas, diesel, propane	27,000	36,210	42,840	40,910	39,340
Fleet vehicles	7,370	8,300	11,110	6,950	4,270
Process emissions	-	2,540	3,490	4,870	3,830
Scope 2 (market based)	41,000	36,250	8,730	0	0
Total Scope 3	29,504,000	27,333,000	25,070,340	24,981,000	22,547,000
Business travel	118,000	121,000	337,340	326,000	153,000
Employee commute	186,000	172,000	183,000	195,000	134,000
Manufacturing	22,800,000	21,100,000	18,500,000	18,900,000	16,100,000
Product transportation	1,200,000	1,200,000	1,300,000	1,400,000	1,800,000
Product use of sold products	4,900,000	4,700,000	4,700,000	4,100,000	4,300,000
End of life treatment	300,000	40,000	50,000	60,000	60,000
Total emissions =	**29,579,370**	**27,416,300**	**25,136,510**	**25,033,730**	**22,594,430**
Corporate facilities energy use (MWh)					
Electricity use total (MWh)	1,419,000	1,832,000	2,181,000	2,426,000	2,581,000
Electricity use (U.S.)	1,157,000	1,536,000	1,830,000	2,075,000	2,192,000
Electricity use (international)	262,000	296,000	351,000	351,000	389,000
Total fuel (natural gas, biogas, propane, gasoline, diesel)	325,480	420,650	494,460	462,680	439,170
Renewable electricity - Corporate facilities					
Renewable electricity use (GWh)	1,350	1,770	2,170	2,430	2,580
Scope 2 emissions avoided (tCO2e)	948,000	899,000	690,000	589,000	541,000
Renewable electricity - supplier facilities (GWh)					
Operational renewable energy capacity	0.7	1.2	1.9	2.7	4.5
Committed renewable energy capacity	1.3	2.0	3.3	5.1	7.9

Appendix 5: Evolving Focus of Samsung Electronics' ESG Strategy, 2008-21

Year of reporting *ESG reports* **Reporting frameworks**	**Environment**	**Social**	**Governance**
2021 *1. 2021 Sustainability report* *2. 2021 Samsung Electronics Manufacturing (UK) Limited Pension and Life Assurance* *3. Samsung Pension Scheme* **GRI, TCFD, SASB**	- **Climate actions:** risk management, emission reduction at worksites, product energy efficiency - **Circular economy:** efficient use of resources, extending product lifespan, take-back & recycle of e-waste, waste accounting, water resource, chemical management - **Supply chain:** responsible supply chain & minerals sourcing - **Foundation:** materiality assessment, sustainability value creation	- **Stakeholder engagement & communication** - **Empowering communities:** corporate citizenship, support for small and medium sized enterprises & start-ups - **Employees:** labour & human rights, diversity and inclusion, workplace health & safety, human resources development	- **Digital responsibility-** personal information protection, AI ethics, cybersecurity, accessibility, digital well being - Corporate leadership
2020 *1. 2020 Sustainability report* **GRI, TCFD, SASB**	- Product stewardship: eco-conscious product development, energy efficiency - Supply chain: management, transparency, partnerships - Foundation: materiality assessment, sustainability value creation	- Stakeholder engagement & communication - Employees: labour and human rights, diversity & inclusion, health & safety management - Tech for good: innovation	- Corporate leadership - Digital responsibility: accessibility, digital well-being, AI ethics
2019 *1. 2019 Sustainability report*	- Product stewardship: recycling, responsible material sourcing, energy efficiency - Operations:	- Enabling people: employee volunteering, corporate citizenship, youth education program - Investing in employees: labour & human	- Alignment with SDGs - Corporate leadership - Risk management - Responsible

Year of reporting *ESG reports* **Reporting frameworks**	**Environment**	**Social**	**Governance**
GRI, TCFD	renewable energy, energy efficiency - Supply chain: responsible management, strengthening competitiveness - Materiality assessment, sustainable management & value creation	rights, health & safety - Stakeholder engagement & communication - Tech for good: innovation	business
2018 *1. 2018 Sustainability report* **GRI standards core option**	- Product stewardship: recycling, green management, eco-conscious products, circular economy - Environmental management in operations - Responsible mineral sourcing - Sustainability value creation	- **Empowering society** via education, innovation - **Labour & human rights** - **Health & safety** - **Supplier responsibility:** Strategic actions for Tier 1 & 2 suppliers	- Alignment with SDGs - Corporate leadership - Risk management - Compliance management
2017 *1. 2018 Sustainability report* **GRI G4**	- Sustainability strategy: framework, management value creation - Circular economy, sustainable supply chain, eco-friendly workplace	- Stakeholder engagement - Protecting human rights - Customer value enhancement	- Risk management, corporate leadership, transparency
2016 *1. 2018 Sustainability report* **GRI G4 Core principles**	- Green policy: green management, green communication, climate action - Eco-products: procurement, design, distribution, circularity - EHS management:	- Stakeholder engagement - HR development - Human rights - Corporate citizenship: initiatives	- Corporate leadership - Risk management - Compliance management - Data protection - Supply chain

Year of reporting *ESG reports* **Reporting frameworks**	**Environment**	**Social**	**Governance**
	management of energy, water, chemical substances, waste, pollutants, biodiversity		
2015 *1. 2018 Sustainability report* **GRI G4 Core principles**	- Green management: response to climate change, eco-products, green operation, GHG reduction and energy management, water resource management, pollutant management, waste management	- Stakeholder communications - HR development - Workplace environment	- Corporate leadership - Risk management - Compliance management - supply chain
2014 *1. 2018 Sustainability report* **GRI G4**	- Green memory: energy efficient products - Material issues: products, water, minerals	- Stakeholder engagement - Health and safety - Product accessibility	- Corporate leadership - Supplier compliance
2013 *1. 2018 Sustainability report* **GRI G3**	- Green memory - Material issues: eco-products, water management, minerals - Green management: life cycle responsibility, green operation sites	- Stakeholder engagement - Health and safety - Product accessibility - Talent management	- Corporate leadership & value enhancement - Supplier CSR
2012 *1. 2018 Sustainability report* **GRI G3, AA1000APS**	- Material issues - climate change, energy, water management - Green management	- Stakeholder engagement - Employee health and safety	- Integrity management - Corporate leadership - Supplier CSR

Year of reporting *ESG reports* **Reporting frameworks**	**Environment**	**Social**	**Governance**
2011 *1. 2018 Sustainability report* **GRI G3, AA1000APS, ISO 26000**	- Material issues - Sustainable growth: research & development, new businesses - Green management: eco-products, green workplace, green communication, recycling and reuse	- Stakeholder engagement - Talent management: diversity, recruitment, labour & human rights, employee health, competencies	- Pre-emptive risk management - CSR - Compliance management
2010 *1. 2010 Sustainability report* **GRI G3, AA1000APS**	- Green management: climate change response, eco-products, eco-friendly workplaces, green communication	- Talent management: work life balance, employee value - Social contributions: pursuing a happier society, partnerships - Customer trust and delight service	- Integrity management: compliance, ethics, intellectual property protection
2009 *1. 2009 Sustainability report* **GRI G3, AA1000APS**	- Sustainability management system - Green management: convergence and climate change response	- Social contributions: pursuing a happier society - Innovative customer satisfaction service: strengthening product competitiveness	- Corporate governance - Corporate ethics - Integrity management
2008 1. 2008 Sustainability report GRI G3	Climate change response: policies, opportunities & threats Environment friendly product development Materiality assessment Green workplaces	Healthy development of local communities Talent management Stakeholder engagement	Corporate governance: organizational structure, ethics & compliance

Compiled by authors (2022)[116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128]

Appendix 6: Carbon Metrics Reported by Samsung Electronics, 2016-20

Environmental performance	2016	2017	2018	2019	2020
Scope 1 ('000 tons CO_2e)	2554	3668	4855	5067	5726
Scope 2 ('000 tons CO_2e)	9046	9907	102 96	8733	9079
Total Scope 3	14868	14782	15908	16607	14726
Scope 3 - Suppliers ('000 tons CO_2e)	7219	7038	7952	8278	8030
Scope 3 - Logistics ('000 tons CO_2e)	7562	7625	7846	8223	6682
Scope 3 - Business trips ('000 tons CO_2e)	87	119	110	106	14
Renewable energy consumption (GWh)	181.8	229	1356	3220	4030
Energy consumption at worksites (GWh)	19478	23419	26028	26899	29024
% of renewable energy consumption	0.9	1.0	5.2	12.0	13.9

Appendix 7: Evolving Focus and Key Elements of Google's ESG Strategy, 2016-21

Year of reporting *ESG reports* Reporting frameworks	Environment	Social	Governance
2021 *1. Environmental Report* *2. Alphabet's 2021 CDP Climate Change Response* *3. EU NFRD report* *4. Supplier Responsibility Report* CDP Climate Change & supply chain reporting, EU NRDF 2014/95/EU	- **Environmental initiatives:** products, clean energy - **Target-based progress:** efficient data centers, carbon -free energy, sustainable workplaces, building better devices, empowering users - **Supply chain:** working to end reliance on raw materials	- **Employee matters** - **Social impact:** racial justice, economic empowerment - **Respecting human rights:** Universal Declaration of Human Rights, UNGPs, GNI Principles - **Strengthening communities:** supplier diversity, responsible sourcing - **Suppliers:** safe & healthy workplaces	- Anti-corruption and bribery matters
2020 *1. 2020 Environmental report* *2. Alphabet's CDP Climate Change response* *3. Supplier Responsibility Report* *4. EU NFRD report* *5. Modern slavery report* CDP Climate Change & supply chain reporting, EU NRDF 2014/95/EU	-**Environmental initiatives & target-based progress:** designing efficient data centers, carbon -free energy, sustainable workplaces, building better devices and services, empowering users with technology - **Supply chain:** working to end reliance on raw materials	- **Employee matters:** code of conduct, policy on harassment, discrimination, retaliation, etc. - **Suppliers:** supplier assessment, safe & healthy workplaces - **Social impact:** digital skills training, racial justice, economic empowerment for females - **Respecting human rights** - **Strengthening communities:** supplier diversity, community resilience, responsible sourcing	- Anti-corruption and bribery matters

Year of reporting *ESG reports* Reporting frameworks	Environment	Social	Governance
2019 *1. Environmental Report* *2. Supply Chain report* *3. Alphabet's CDP Climate Change Response* *4. EU NFRD report* *5. Statement against modern slavery* CDP climate change & supply chain reporting, EU NRDF 2014/95/EU	- **Environmental initiatives & target-based progress:** designing efficient data centers, carbon-free energy, sustainable workplaces, building better devices and services, empowering users with technology - **Supply chain:** working to end reliance on raw materials	- **Employee matters:** code of conduct, policy on harassment, discrimination, retaliation, etc. - **Suppliers:** safe & healthy workplaces, ethical operations - **Social impact:** economic empowerment for females - **Respecting human rights** - **Strengthening communities:** supplier diversity, responsible sourcing	- Anti-corruption and bribery matters
2018 *1. Environmental Report* *2. Supply Chain report* *3. Alphabet 's CDP Climate Change Response* *4. Modern Slavery report* CDP climate change & supply chain reporting	- **Environmental initiatives:** efficient data centers, advancing renewable energy, sustainable workplaces, empowering users with technology - **Supply chain** : materiality assessment	- **Supplier engagement and capacity building:** supplier & on-site assessment, safe & healthy workplaces, ethical operations, anti-human trafficking	- Supplier audits and conformance
2017 *1. Environmental Report* *2. Responsible Supply Chain report* *3. Alphabet's CDP Climate Change Response* *4. Modern Slavery Report* CDP Climate Change & supply chain reporting	- **Environmental initiatives & target-based progress:** designing efficient data centers, advancing renewable energy, sustainable workplaces, empowering users with technology - **Supply chain**: sources of impact	- **Supplier engagement and capacity building:** supplier & on-site assessment, safe & healthy workplaces, ethical operations, anti-human trafficking, responsible sourcing of conflict materials - **Supply chain** : risk assessments at country level, products-specific	- Supplier conformance - **Internal management, accountability & programs** for ending modern slavery in supply chains

Year of reporting *ESG reports* Reporting frameworks	**Environment**	**Social**	**Governance**
2016 *1. Environmental Report* *2. Alphabet's CDP Climate Change Response* *3. Modern Slavery Report* CDP Climate Change Questionnaire	- **Environmental initiatives & target-based progress:** designing efficient data centers, advancing renewable energy, sustainable workplaces, empowering users with technology	- **Training, risk assessment and policies** for ethical conduct and prevention of modern slavery	- **Internal management & programs** for ending modern slavery in supply chains

Compiled by authors (2022)[129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140]

Appendix 8: Carbon Metrics Reported by Google, 2016-20

Emissions inventory (tCO2e)	2016	2017	2018	2019	2020
Scope 1	66,218	66,549	63,521	66,686	38,694
Scope 2 (market based)	1,518,643	509,334	684,236	794,267	911,415
Scope 2 (location based)	2,902,554	3,301,392	4,344,686	5,116,949	5,865,095
Total Scope 3	1,292,268	2,719,024	12,900,467	11,669,000	9,376,000
Scope 3 -Business travel, employee commuting including telecommuting	314,028	356,060	463,467	542,000	213,000
Scope 3 -other	978,240	2,362,964	12,437,000	11,127,000	9,163,000
Total (Scope 1, Scope 2 market based, scope 3 total)	2,877,129	3,294,907	13,648,224	12,529,953	10,326,109
Scope 1, 2 (market based), 3 (business travel, employee commuting, including telecommuting)	1,898,889	931,943	1,211,224	1,402,953	1,163,109
Scope 1, 2 (location based), and 3 (business travel and employee commuting, including telecommuting)	3,282,800	3,724,001	4,871,674	5,725,635	6,116,789
Total emissions reduced	3282800	3724001	4871674	5725635	6116789
Emissions reduced by renewable energy PPAs	1383911	2792058	3660450	4322682	4953680
Emissions compensated by carbon credits	1898889	931943	1211224	1402953	1163109
Total operational emissions	0	0	0	0	0
Energy consumption (MWh)	6,513,719	8,029,409	10,572,485	12,749,458	15,439,538
Total electricity consumption (MWh)	6,209,191	7,609,089	10,104,295	12,237,198	15,138,543
Total renewable purchase (MWh)	3,770,571	7,609,089	10,104,295	12,237,198	15,138,543
Renewable electricity PPAs & on-site (MWh)	2,817,913	6,244,788	8,246,508	9,721,283	12,076,382
Renewable electricitygrid (MWh)	952,658	1,364,301	1,857,787	2,515,915	3,062,161
% of electricity from renewables	61	100	100	100	100
Renewable as a % of total energy	58	95	96	96	98

Appendix 9: Evolving Focus and Key Elements of Amazon's ESG Strategy, 2016-21

Year of reporting *ESG reports* Reporting frameworks	Environment	Social	Governance
2021 *1. Sustainability 2020 Report: Further and Faster, Together* *2. Human rights impact assessment: Amazon devices* SASB, TCFD, UN Guiding Principles	**Sustainable operations:** corporate, shipment, transportation, buildings **Circular economy:** packaging, recycling, trade-in, product donations **Packaging and products:** sustainable shopping & products, reducing packaging waste, sustainable products- and materials, sustainably produced fabrics and recycled materials, devices - and sustainability **The cloud:** renewables, cloud efficiency, water stewardship	**Human rights:** impact assessment, mechanisms addressing risk **Employees:** workplace well-being, health & safety; investments; diversity, equity & inclusion; employee engagement; sustainability ambassadors **Supply chain:** commitments, progress, responsible sourcing **Community:** housing equity, access to food & basic needs, COVID-19 community response, disaster relief, computer science program,	**Mechanisms for prioritizing work:** priority issues, efforts Corporate governance: risk oversight, shareholder engagement **Public policy actions:** on energy & climate **Partnerships:** with industry partners for ESG initiatives
2020 *1. All In: Staying the Course on Our Commitment to Sustainability* *2. Assessment of standards and certifications - Climate Pledge Friendly* *3. Modern slavery statement* No framework	**Sustainable operations:** measuring and reducing carbon emissions in operations **Circular economy:** recycling, trade-in, product donations **Packaging and products:** reducing packaging waste, sustainably produced fabrics and recycled materials, devices **The cloud:** renewables for AWS, cloud efficiency, reducing water in data centers	**Human rights:** principles **Employees:** workplace health & safety, investments, diversity & inclusion, employee engagement, sustainability ambassadors **Supply chain:** standards and manual, responsible sourcing **Community:** children & young adults, Right Now Needs, AWS community outreach	**Mechanisms for prioritizing work:** science based, customer centric approach to sustainability **Sustainability Policy positions:** supporting clean energy expansion **Partnerships:** for ESG initiatives
2019 *1. Sustainability: Thinking Big* No framework	**Sustainable operations** **Packaging and products:** reducing waste & transit spills, circular economy **The cloud:** renewable energy mapping, cloud efficiency, water stewardship, sustainability data initiative	**Human rights** **Employees:** workplace safety, diversity & inclusion - **Supply chain:** standards and supplier manual **Community:** disaster relief, STEM program, housing & homelessness	Mechanisms for prioritizing work Sustainable policy positions **Partnerships:** with industry partners for ESG initiatives
2018 *1. Modern slavery statement* No framework	**GHG reporting:** Scope 1, Scope 2 (market based), scope 3	**Human rights:** risk assessment **Supply chain:** due diligence, stakeholder engagement	<no reporting>

Year of reporting *ESG reports* Reporting frameworks	**Environment**	**Social**	**Governance**
2017 *1. Modern slavery statement* No framework	<no reporting>	**Human rights** **Supply chain**: due diligence, stakeholder engagement	<no reporting>
2016 *1. Modern slavery statement* No framework	<no reporting>	**Supply chain**: standards	<no reporting>

Compiled by authors (2022)[141, 142, 143]

Appendix 10: Carbon Metrics Reported by Amazon.Com Inc., 2018-20

Carbon footprint	2018	2019	2020
Carbon intensity (g CO_2e per $ of gross merchandise)	128.9	122.8	102.7
Emissions (MMT CO_2e)			
Emissions from direct operations (Scope 1)	4.98	5.76	9.62
Fossil fuels	4.7	5.57	9.37
Refrigerants	0.28	0.19	0.25
Emissions from purchased electricity (Scope 2)	4.71	5.5	5.27
Emissions from indirect sources (Scope 3)	34.71	39.91	45.75
Corporate purchases and Amazon-branded product emissions (including operating expenses, business travel, and Amazon branded product manufacturing, use phase, and end-of-life)	11.95	15.41	16.7
Capital goods (eg. building construction, servers, and other hardware, equipment, vehicles)	4.64	8.01	10.52
Other indirect emissions (eg. third-party transportation, packaging, upstream energy related)	13.89	12.44	15.77
Lifecycle emissions from customer trips to Amazon's Physical stores	4.23	4.05	2.77
TOTAL emissions =	**44.4**	**51.17**	**60.64**

Appendix 11: Evolving Focus and Key Elements of Microsoft's ESG Strategy, 2003-21

Year of reporting *ESG reports* **Reporting frameworks**	**Environment**	**Social/ People**	**Governance**
2021 *1. Microsoft UNSDG Report* *2. CDP water security response* *3. CDP climate change response* **UN SDGs, CDP**	**4 Focus areas:** carbon negative, water positive, zero waste, ecosystems	**Inclusive economic opportunity:** SDG targets and progress **Protecting fundamental rights:** alignment with SDGs	**Earning trust:** partnerships **Compliance & ethics:** standards **Corporate leadership**
2020 *1. 2020 CSR report* *2. 2020 Environmental Sustainability report* *3. GNI 2019 Assessment* *4. Microsoft UNSDG Report* *5. CDP water security response* *6. CDP Climate change response* **GRI, SASB, TCFD, CDP, UNGPs, UN SDGs**	**4 Focus areas:** carbon negative, water positive, zero waste, ecosystems Planetary computer: using data and digital tech to help save Earth	**Inclusive economic opportunity:** accessibility to AI, broadband, data, disability representation, skills initiative, empowering nonprofits **Protecting fundamental rights:** defending democratic institutions, ethical supply chains, humanitarian support, AI for cultural heritage	**Earning trust:** cybersecurity, responsible AI, digital safety **Compliance & ethics:** standards of business conduct **Corporate leadership:** policies and guidelines
2019 *1. 2019 CSR report* *2. Modern slavery and human trafficking 2019* *3. CDP climate change response* *4. CDP water security response* **CDP, UNGPs**	**Commitment and approach for 4 focus areas:** carbon, energy, water, waste	**Closing opportunity gap:** broadband access, skills & employability, nonprofits **Empowering employees:** rewards, human rights, diversity & inclusion	**Trust and responsibility:** privacy, AI, human rights, cybersecurity, responsible AI, responsible sourcing

Year of reporting *ESG reports* **Reporting frameworks**	**Environment**	**Social/ People**	**Governance**
2018 *1. 2018 CSR report* *2. Modern slavery and human trafficking 2018* *3. CDP climate change response* *4. CDP water security response* **CDP, UNGPs, GRI**	**Commitment and approach for 3 focus areas:** carbon and energy, water and ecosystems, waste minimization	**Empowering employees:** digital skills, career pathways, accessibility, human rights, rewards, wellness and safety	**Trust and responsibility:** privacy, data security, responsible sourcing
2017 *1. 2017 CSR report* *2. Modern slavery & human trafficking 2017* *3. CDP climate change response* *4. CDP water security response* *5. CDP Supply Chain* **CDP, UNGPs, GRI**	**Commitment and approach for 5 focus areas:** carbon, energy, water, ecosystems, circular economy	**Empowering employees:** digital skills, career pathways, accessibility, human rights, rewards, wellness and safety **Empowering communities:** broadband access, tech for social impact	**Trust and responsibility** **Compliance & ethics:** standards **Corporate leadership:** policies and guidelines
2016 *1. CSR report* *2. Modern slavery report* *3. CDP climate change response* *4. CDP water security response* *5. CDP Supply Chain* **CDP, UNGPs, GRI**	**Guiding principles and policies:** climate change, responsible sourcing **Focus areas**: carbon, energy, sustainable devices, water and waste	**Empowering employees:** diversity & inclusion, compensation & benefits, wellness, health and safety **Empowering others**: tech for social impact	**Trust and responsibility** **Compliance & ethics** **Stakeholder engagement** **Corporate leadership**
2015 *1. Microsoft 2015 Citizenship report* *2. CDP climate change response* *3. CDP water security response* *4. CDP Supply Chain*	**Guiding principles, policies & management:** climate change, responsible sourcing **Integrating sustainability:** products, business practices Water, waste	**Empowering employees:** diversity & inclusion, compensation & benefits, wellness, health and safety, training & development **Empowering**	**Privacy & data security** **Corporate leadership:** policies and guidelines **Ethical business conduct & governance:**

Year of reporting *ESG reports* **Reporting frameworks**	**Environment**	**Social/ People**	**Governance**
CDP, UNGPs, GRI	management **Supply chain:** environmental accountability	**others:** tech for social impact, humanitarian response, employee giving **Supply chain:** responsible sourcing	standards, policy engagement
2014 *1. Microsoft 2014 Citizenship report* *2. CDP climate change response* *3. CDP water security response* *4. CDP Supply Chain* **CDP, UNGPs, GRI**	**Climate change:** carbon neutrality, operational energy efficiency, carbon footprint **Operational impacts:** water, waste **Reducing impact across life cycle of devices:** recycling Tech for good **Supply chain:** environmental accountability	**Empowering employees:** diversity & inclusion, compensation & benefits, wellness, health and safety, training & development **Empowering others:** tech for social impact, humanitarian & disaster response, employee giving **Supply chain:** social accountability, responsible sourcing	**Privacy & data security** **Corporate leadership:** policies and guidelines **Ethical business conduct & governance:** standards, policy engagement
2013 *1. Microsoft Citizenship report* *2. CDP climate change response* *3. CDP water security response* *4. CDP Supply Chain* **CDP, UNGPs, GRI**	Carbon neutral **operations** Tech for good **Responsible sourcing:** hardware & packaging, conflict mineral sourcing	**Empowering employees:** diversity & inclusion, compensation & benefits, health and safety, training & development **Human rights:** power of tech, engagement **Empowering others:** tech for good, humanitarian response, employee giving, youth & education programs	**Privacy & data security** **Corporate leadership:** policies and guidelines **Compliance:** standards, policy engagement

Year of reporting *ESG reports* **Reporting frameworks**	**Environment**	**Social/ People**	**Governance**
2012 *1. Microsoft Citizenship report* *2. CDP climate change response* *3. CDP water security response* **CDP, UNGPs, GRI**	Carbon neutral **operations** Tech for good **Responsible sourcing:** hardware & packaging, conflict mineral sourcing	**Empowering employees:** diversity & inclusion, compensation & benefits, health and safety, training & development **Human rights:** power of tech, engagement **Empowering others:** tech for good, humanitarian response, employee giving, youth & education programs	**Privacy & data security** **Corporate leadership:** policies and guidelines **Compliance:** standards, policy engagement
2011 *1. Microsoft Citizenship report* *2. CDP climate change response* *3. CDP water security response* **CDP, GRI**	Focus areas: corporate operations & travel, data centers, buildings, waste Tech for good **Responsible sourcing:** conflict minerals, environmental standards, purchasing initiatives	**Empowering employees:** diversity & inclusion, compensation & benefits, employee community involvement **Empowering others:** humanitarian response, youth & education programs	**Privacy & data security** **Integrity & governance** **Compliance:** standards, policy engagement
2010 *1. Microsoft Citizenship report* *2. CDP climate change response* **CDP, GRI**	Energy efficiency via IT Responsible environmental leadership focus: data centers, travel, buildings, recycling, computer labs, waste, supply chain environmental footprint	**Empowering employees:** diversity & inclusion, compensation & benefits, learning & development, community involvement **Empowering others:** skills	**Online privacy & safety:** products, services, law enforcement **Governance & compliance:** leadership, commitments, responsible competition,

Year of reporting *ESG reports* **Reporting frameworks**	**Environment**	**Social/ People**	**Governance**
		development & innovation, tech for non-profits & humanitarian assistance **Responsible sourcing:** labour, safety, human rights,	public policy
2009 *1. Microsoft Citizenship report* **GRI**	**Environmental stewardship:** energy efficiency of products & operations	**Empowering employees:** freedom of expression, community involvement **Empowering others**: jobs & opportunities, local innovation, crisis assistance	**Responsible business practices:** privacy, internet safety & security; protecting intellectual property
2007-08 *1. Microsoft Citizenship report* ***(no framework indicated)***	**Environmental stewardship:** product packaging, energy efficiency, renewable energy	**Empowering people & communities:** innovation, jobs & opportunities, humanitarian assistance	**Accountability:** interoperability and security
2006 *1. Microsoft 2006 Citizenship report* **GRI**	**Environmental stewardship:** product packaging, collabourations with industry and governments	**Digital inclusion:** advancing knowledge economy and local economies **Social accountability**: for responsible business practices	**Security & internet safety** **Responsible business practices:** integrity, transparency
2005 *1. Microsoft 2005 Citizenship report* **GRI**	**Environmental stewardship:** product packaging	**Digital inclusion:** advancing knowledge economy & growth of local economies	**Internet safety** **Responsible business practices:** integrity, transparency, interoperability

Year of reporting *ESG reports* **Reporting frameworks**	**Environment**	**Social/ People**	**Governance**
2004 *1. Microsoft 2004 Citizenship report* **GRI**	**Environmental impact:** recycling & conservation at corporate HQ, products & packaging,	**Responsible employer:** diversity & inclusion, compensation & benefits **Digital inclusion:** software donations, learning grants	**Internet safety** **Responsible business practices:** integrity, transparency, interoperability
2003 *1. Microsoft Citizenship report* ***(no framework indicated)***	**Environmental impact:** recycling & conservation at corporate HQ, products & packaging	**Equal employment:** anti-harassment, anti-discrimination, development & diversity	**Internet safety:** safer computing, intellectual property, digital rights

Compiled by authors (2022)[144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159]

Appendix 12: Carbon Metrics Reported by Microsoft Corporation, 2016-20

GHG emissions (mtCO2e)	2016	2017	2018	2019	2020
Scope 1	94,651	107,452	99,008	117,956	118,100
Scope 2 - location based	2,139,709	2,697,554	2,946,043	3,557,518	4,102,445
Scope 2 - market based	37,087	139,066	183,329	275,420	228,194
Scope 3-purchased goods and services	10,000,000	4,090,000	4,120,000	4,190,000	4,050,000
Scope 3-capital goods	-	1,670,000	2,230,000	2,180,000	2,750,000
Scope 3-Fuel and energy related activities (location based)	440,000	540,000	550,000	650,000	770,000
Scope 3-Fuel and energy related activities (market based)	-	89,000	110,000	170,000	180,000
Scope 3- upstream transportation	100,000	50,000	50,000	100,000	100,000
Scope 3-waste	800	700	500	1,100	800
Scope 3-business travel	327,483	419,020	461,787	476,457	329,356
Scope 3-employee commuting	280,000	343,000	345,000	411,000	317,000
Scope 3-Downstream transportation	-	85,000	98,000	57,000	44,000
Scope 3-use of sold products	-	4,103,000	4,230,000	3,753,000	3,025,000
Scope 3-end of life of sold products	-	31,000	18,000	18,000	17,000
Scope 3-downstream leased products	7,600	700	1,700	800	4,600
TOTAL emissions (market based) =	10,847,621	11,127,938	11,947,324	11,750,733	11,164,050
TOTAL emissions (location based) =	13,390,243	14,137,426	15,150,038	15,512,831	15,628,301

Energy use (MWh)					
Total energy use	5,414,197	6,756,779	7,781,383	9,249,361	10,757,166
Electricity	5,048,891	6,344,700	7,357,636	8,744,834	10,244,377
Other fuels (natural gas, jet fuel, diesel, district heating, chilled water)	365,306	412,078	423,748	504,527	512,788
Renewable energy use	4,852,643	6,104,758	7,357,636	8,744,834	10,244,377
Renewable energy credits & PPA	4,852,101	6,104,340	7,357,235	8,744,247	10,244,059
On-site renewable energy	542	418	400	587	318
Percentage of renewable electricity	96.1	96.2	100.0	100.0	100.0
Renewable energy/total energy (%)	89.6	90.4	94.6	94.5	95.2

Appendix 13: Scope of Carbon Metrics Measured and Reported by Tech Companies

Company	Comprehensiveness of emission reporting	Other carbon metrics reported
Apple	1. Scope 1: Total emissions including emissions from: - Natural gas, diesel, propane gas - Fleet vehicles - Process emissions 2. Scope 2 (market-based) 3. Total scope 3 including emissions from: - Business travel - Employee commute - Manufacturing - Product transportation - Use of sold products - End of life treatment	1. Corporate facilities energy use: electricity and fuel 2. Energy efficiency of corporate and supplier facilities 3. Renewable electricity used at corporate and supplier facilities 4. Waste diverted from corporate facilities, supply chains, and product packaging footprint
Samsung Electronics	1. Scope 1: Total emissions 2. Scope 2 (market-based) including emissions from CO2, CH4, N2O, HFCs, PFCs, SF6 3. Scope 3: Total emissio ns including emissions from: - Suppliers - Logistics - Business trips	1. Intensity of GHG emissions 2. Energy consumption and intensity at worksites 3. Renewable energy consumption 4. Emissions reduced in product use phase 5. Reduction of products' energy consumption 6. Waste generated, processed and recycled
Google	1. Scope 1: Total emissions 2. Scope 2 (market-based & location-based) 3. Scope 3: Total emissions including emissions from: - Business travel, employee commuting including telecommuting - other	1. Emission reductions and compensations 2. Carbon intensity per unit of revenue, per full-time employee, per megawatt-hour 3. Energy and electricity consumption, energy efficiency, renewable energy purchased, carbon free energy % across data centres 4. Waste generated, diverted, refurbished and reused
Amazon.com	1. Scope 1: Total emissions including emissions from: - Fossil fuels - Refrigerants 2. Scope 2 (market-based) 3. Scope 3: Total emissions including emissions from: - Corporate purchases and Amazon-branded products - Capital goods - Other indirect emissions - Lifecycle emission from customer trips to Amazon physical stores	1. Total energy consumed 2. Percentage of grid electricity 3. Percentage renewable 4. GHG footprint of product shipments

Company	Comprehensiveness of emission reporting	Other carbon metrics reported
Microsoft Corporation	1. Scope 1: Total emissions 2. Scope 2 (market-based & location-based) 3. Scope 3: Total emissions including emissions from: - Purchased goods and services - Capital goods - Fuel and energy-related (market- & location-based) - Upstream transportation - Waste - Business travel - Employee commuting - Downstream transportation - Use of sold products - End of life of sold products - Downstream leased products	1. Total energy use - electricity and other fuels (globally and region-specific) 2. Renewable energy use - renewable energy credits and PPAs, and on-site renewable energy 3. GHG emissions within carbon-neutral boundary and offsets purchased 4. Waste generation, reuse, recycle, compost, landfill, incinerated, hazardous waste, recycling hazardous waste

Developed by authors (2022)

Appendix 14: Use of Renewable Energy for Apple, Samsung Electronics, Google, Amazon.Com and Microsoft, 2016-20

Year	Company	Total energy consumption	Total electricity consumption	Renewable energy use	Renewable energy use as % of total electricity use	Renewable energy use as % of total electricity use
2016	Apple Inc.	1745	1420	1350	95.1	77.3
2017	Apple Inc.	2253	1832	1770	96.6	78.6
2018	Apple Inc.	2676	2182	2170	99.5	81.1
2019	Apple Inc.	2890	2427	2430	100	84.1
2020	Apple Inc.	3019	2580	2580	100	85.5
2016	Samsung Electronics	21073	16587	181.8	1.1	0.9
2017	Samsung Electronics	23419	18450	229	1.2	1.0
2018	Samsung Electronics	26028	20558	1356	6.6	5.2
2019	Samsung Electronics	26899	21160	3220	15.2	12.0
2020	Samsung Electronics	29024	22916	4030	17.6	13.9
2016	Google LLC	6514	6209	3771	60.7	57.9
2017	Google LLC	8029	7609	7609	100	94.8
2018	Google LLC	10572	10104	10104	100	95.6
2019	Google LLC	12749	12237	12237	100	96.0
2020	Google LLC	15440	15139	15139	100	98.1
2016	Microsoft	5414	5049	4853	96.1	89.6
2017	Microsoft	6757	6345	6105	96.2	90.4

Year	Company	Total energy consumption	Total electricity consumption	Renewable energy use	Renewable energy use as % of total electricity use	Renewable energy use as % of total electricity use
2018	Microsoft	7781	7358	7358	100	94.6
2019	Microsoft	9249	8745	8745	100	94.6
2020	Microsoft	10757	10244	10244	100	95.2

Appendix 15: Corporate ESG Strategy and Carbon Management—Goals, Focus, Action Areas—for Apple, Samsung Electronics, Google, Amazon.Com and Microsoft

Company	Corporate ESG strategy	Carbon management goal	Carbon management focus	Key action areas for carbon management
Apple Inc.	Businesses should act as a force of good and leave the world in a better state while empowering others to do the same	Carbon neutral across entire business, manufacturing supply chain, and product life cycle by 2030	Carbon reduction Carbon removal	1. Climate change 2. Resources 3. Smarter chemistry
Samsung Electronics	Using human resources and technology to create products and service that contribute to a better society and proactively address environmental and social issues	Reducing environmental footprint, including emissions, from products and services	Carbon reduction	1. Climate change 2. Circular economy 3. Sustainable supply chain 4. Sustainability foundation
Google	Blend sustainability into everything it does	Achieve net -zero emissions across all operations and value chain by 2030	Carbon reduction Carbon removal	1. Designing efficient data centers 2. Advancing carbon -free energy 3. Creating sustainable workspaces 4. Building better devices and services 5. Empowering users with technology
Amazon.com	Supporting employees, supply chain partners, communities around the world where it operates and governance of sustainability work	Net-zero carbon by 2040	Carbon reduction Carbon removal	1. Sustainable operations 2. Product sustainability 3. Circular economy 4. Sustainability in the Cloud

Company	Corporate ESG strategy	Carbon management goal	Carbon management focus	Key action areas for carbon management
Microsoft Corporation	Demonstrating responsible business practices, improving security and internet safety, and advancing the knowledge economy	Carbon negative by 2030 and remove legacy footprint by 2050	Carbon reduction Carbon removal	1. Carbon negative 2. Water positive 3. Zero waste 4. Ecosystems

Compiled by authors (2022)

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About the Authors

Ms Mahak Agrawal, Officer of Research, Center on Global Energy Policy, Columbia University, New York City



Dr Samuel Julio Friedmann, Chief Scientist, Carbon Direct, New York



Dr Luisa Palacios, Senior Research Scholar, Center on Global Energy Policy, Columbia University, New York City



Prof Anil Kumar Gupta, Director of Projects & Head, Environment Climate & Disaster Risk Management Division, NIDM, Government of India, Delhi



Technical Assistance: Pritha Acharya, Research Associate, CAP-RES, NIDM, Delhi



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Pritha Acharya, Research Associate, CAP-RES, NIDM

About CECR and CAP-RES Project

About CECR:

The National Institute of Disaster Management (NIDM) was constituted under an Act of Parliament with a vision to play the role of a premier institute for capacity development in India and the region. Under the Disaster Management Act 2005, NIDM has been assigned nodal responsibilities for human resource development, capacity building, training, research, documentation and policy advocacy in the field of disaster management.

NIDM has a dedicated division for Environment, Climate and Disaster Risk Management (ECDRM) which has been designated as a Centre of Excellence on Climate Resilience (CECR) under the National Action Plan for Climate Change and Human Health (NAPCCHH). The CECR is implementing six research projects namely Climate Adaptive Planning for Resilience and Sustainable Development in Multi-hazard Environment (CAP-RES) with support of DST-Govt of India, National Agriculture Disaster Management Plan (NADMP) funded by the Ministry of Agriculture & Farmers Welfare, Health Resilience and Capacity Building (HER- CAP) with WHO, Crisis Management Plan for Dealing with Contamination of Water Bodies (CMP-WB) funded by CPCB, Disaster Management Plan for Ministry of Environment, Forest and Climate Change (NEFC-DMP) with the support of MoEFCC and Disaster Management Plan for the Dept. of Chemicals and Petrochemicals (NCPC-DMP) supported by DCPC, MoC&F. It also collaborates with a number of international and national organizations working in the areas of climate change adaptation, resilience, disaster management and disaster risk reduction.

Climate Adaptive Planning for Resilience and Sustainable Development (CAP-RES) Project:

“Climate Adaptive Planning for Resilience and Sustainable Development in Multi-Hazard Environment (CAP-RES)” aims at developing and implementing capacity building including a knowledge and training support system for wider use by related institutions and

training centres across sectors and regions. The CAP-RES focuses on three specific regional contexts, i.e. Indian Himalaya Region (special reference to North East), Coastal region and Central- western region. Region-specific climate-related hazard complex, including flood, drought, water scarcity, forest fire, cyclone/storm surge, coastal erosion, slope erosion/landslide, windstorms, heat wave, disease epidemics, industrial/chemical risks, etc.

CAP-RES aims at value-addition to programme sub-areas of the NMSKCC by engaging with the institutions/research centres and network of experts, researchers and practitioners, across the following 5 key sub-sets of the project focus:

- Green Growth and Disaster Risk Reduction
- Resilient Agriculture Systems
- Public Health Resilience
- Climate Proofing Disaster Relief and Recovery
- Environmental Policy Instrument in Disaster Risk Reduction

Resilient India - Disaster Free India

National Institute of Disaster Management (NIDM)
(Ministry of Home Affairs, Government of India)
Plot No.15, Pocket 3, Block-B, Sector-29, Rohini, Delhi-110042
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