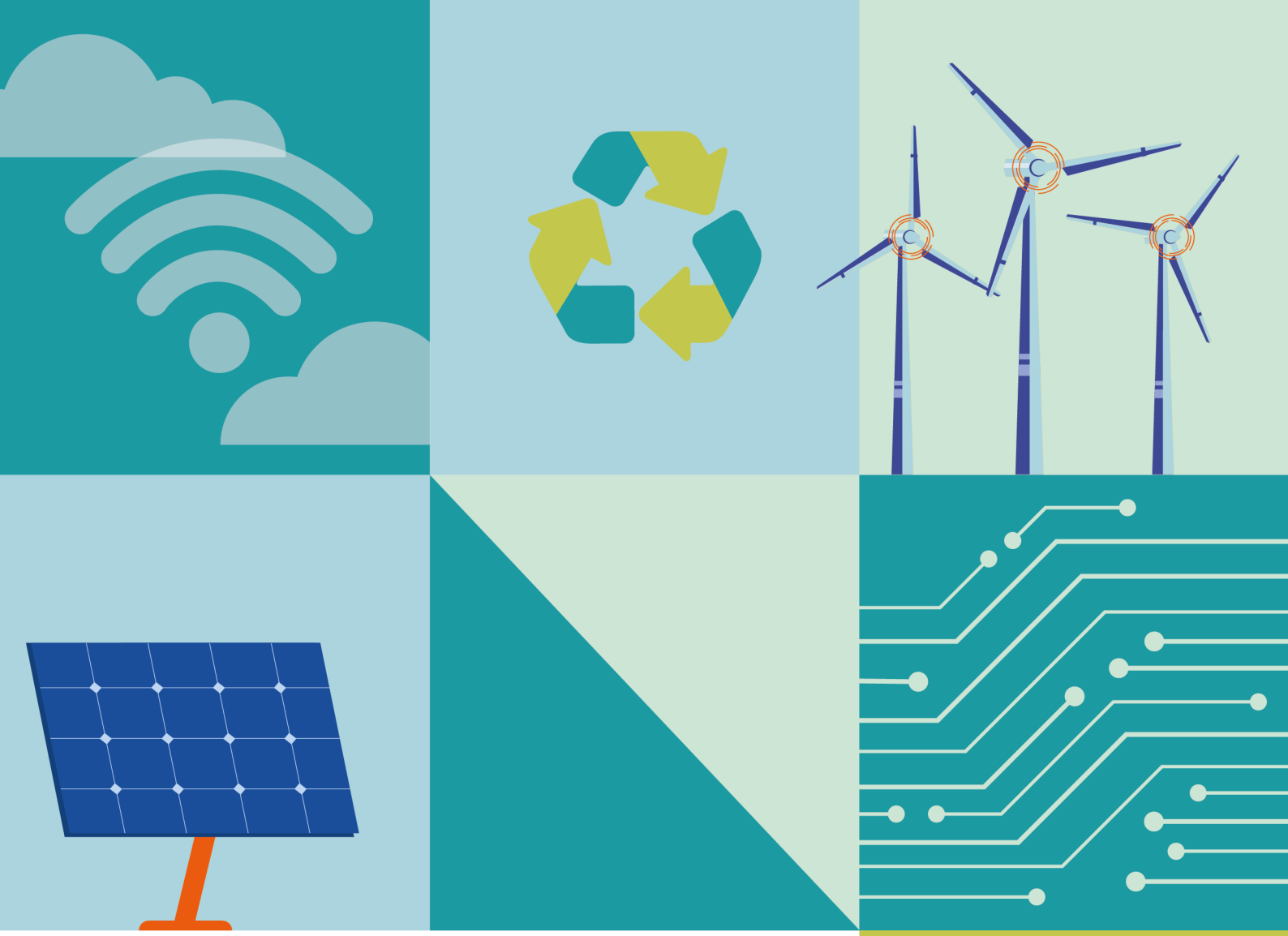

World Benchmarking Alliance

Greening digital companies:

Monitoring emissions and climate commitments

Greening digital companies: Monitoring emissions and climate commitments

Copyright and publication information

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About International Telecommunication Union:

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs), driving innovation in ICTs together with 193 Member States and a membership of over 900 companies, universities, and international and regional organizations. Established over 150 years ago in 1865, ITU is the intergovernmental body responsible for coordinating the shared global use of the radio spectrum, promoting international cooperation in assigning satellite orbits, improving communication infrastructure in the developing world, and establishing the worldwide standards that foster seamless interconnection of a vast range of communications systems. From broadband networks to cutting-edge wireless technologies, aeronautical and maritime navigation, radio astronomy, oceanographic and satellite-based earth monitoring as well as converging fixed-mobile phone, Internet and broadcasting technologies, ITU is committed to connecting the world. For more information, visit www.itu.int.

To help countries and the ICT sector meet the targets of the Paris Agreement and achieve the Sustainable Development Goals (SDGs), ITU develops standards that provide guidance on how to set science-based targets and achieve net zero emissions. Recommendation ITU-T L.1470 provides ICT companies with an emissions trajectory for reaching the 1.5° scenario in the Paris Agreement. Two Supplements provide guidance to decarbonize following a 1.5C pathway, specifically to operators of mobile networks, fixed networks, and data centres as well as to manufacturers. Moreover, ITU has developed net zero guidance specifically for ICT companies (Recommendation ITU-T L.1471) which builds on net zero approaches by initiatives such as the SBTi, the UNFCCC Race to Zero and others. The ITU has also developed technical standards that provide methodologies for assessing energy consumption and GHG emissions for ICT organizations such as Recommendations ITU-T L.1420, L.1302, L.1310, L.1330 and L.1350.

About World Benchmarking Alliance:

Launched in 2018, the World Benchmarking Alliance (WBA) is a non-profit organization that assesses the performance of world's most influential companies on meeting the United Nations Sustainable Development Goals (SDGs). WBA identified seven transformations that need to take place to put the world on a more sustainable path to achieve the SDGs. To turn these transformations into action, WBA develops in collaboration with its allies a series of benchmarks assessing 2 000 of the world's most influential companies (SDG2000). The Digital Inclusion Benchmark assesses the world's top 200 technology companies on their performance in enhancing access to digital technologies; improving digital skills; fostering trustworthy use; and innovating openly, inclusively and ethically. The WBA Climate and Energy Benchmark measures corporate progress against the Paris Agreement and covers 450 of the world's most influential companies in high-emitting sectors such as the automotive, electric utilities, oil, gas, and transport sectors. WBA insights aim to serve as an accountability mechanism, incentivizing companies to become successful drivers of change and deliver on the SDGs. For more information, visit: www.worldbenchmarkingalliance.org.

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Acronyms and abbreviations

CDP	Formerly referred to Carbon Disclosure Project
GHG	Greenhouse gas
ICT	Information and Communication Technology
ITU	International Telecommunication Union
tCO_2e	Metric tonnes of carbon dioxide equivalent
MW	Megawatt
MWh	Megawatt-hour
PPA	Power Purchase Agreement
SBTi	Science Based Targets initiative
TWh	Terawatt-hour
WBA	World Benchmarking Alliance

Executive summary

Digital technology companies are playing a notable role in the race to a low-carbon transition. From huge purchases of renewable energy to investment in carbon removal and issuance of green bonds, digital companies are at the forefront of efforts to reduce greenhouse gas (GHG) emissions. Digital products and services are also having a significant impact in enabling emissions reductions across other sectors.

This joint report between the International Telecommunication Union (ITU) and the World Benchmarking Alliance (WBA) documents the emissions and energy use of 150 of the world's leading digital companies. ITU is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). It is involved in several climate change activities including research, capacity building and developing international standards. ITU develops standards that provide guidance on how to set science-based targets and achieve net zero emissions. ITU provides ICT companies with an emissions trajectory for reaching the 1.5°C scenario in the Paris Agreement (Recommendation ITU-T L.1470), and two Supplements (ITU-T L Suppl. 37 and ITU-T L Suppl. 38) provide guidance to decarbonize following a 1.5°C pathway, specifically to operators of mobile networks, fixed networks, data centres and manufacturers. Moreover, ITU has developed net zero guidance specifically for ICT companies (Recommendation ITU-T L.1471) which builds on net zero approaches by initiatives such as the SBTi, the UNFCCC Race to Zero and others. ITU has also developed technical standards that provide methodologies for assessing energy consumption and GHG emissions for ICT organizations such as Recommendation ITU-T L.1420. WBA is a non-profit organization that assesses and ranks the performance of the world's most influential companies on the United Nations Sustainable Development Goals (SDGs). The Digital Inclusion Benchmark annually assesses the world's leading technology companies on their performance in enhancing access to digital technologies, improving digital skills, fostering trustworthy use, and innovating openly, inclusively and ethically. The WBA Climate and Energy Benchmark measures corporate progress against the Paris Agreement and covers 450 of the world's most influential companies in high-emitting sectors such as the automotive, electric utilities, oil, gas, and transport sectors.

Beyond assessing the climate data and targets of leading technology companies, it is hoped that this report will serve as a resource for companies to learn from best practice to improve emissions reduction performance and accelerate the achievement of low-carbon free operations. Further, given the size and number of the companies assessed, 150 companies of which 41 are in the Fortune Global 500, the climate data provided has shone a light on the operational emissions and electricity use of the ICT sector.

Digital technology companies have wide ranging portfolios, some produce and sell equipment while others operate telecommunication networks or provide software and information technology services, including data centres and cloud computing, to name but a few. Each activity has different characteristics in terms of the type and scope of emissions and energy consumption. The operational GHG emissions of the assessed companies rose to 239 million tonnes in 2020 equivalent to 0.75 per cent of the world total. The digital sector relies heavily on electricity, consuming 425 terawatt hours or 1.6 per cent of the world total. Telecommunication operators account for over 60 per cent of operational emissions and half of electricity use of the group of companies assessed in this report. However, digital technology companies do not uniformly calculate full upstream and downstream emissions, which makes it difficult to estimate a total carbon footprint.

Emissions of these technology companies also vary by region. Twenty companies account for 75 per cent of all operational emissions of companies assessed in this report, of which nine have headquarters in East Asia and account for half of all emissions, mainly due to low use of renewable energy. According to their announced targets, and less ambitious climate-related strategies,

companies with headquarters in East Asia will not, on average, reach carbon neutrality until after 2050, more than two decades after companies elsewhere.

The vast purchasing power of digital technology companies is having a huge impact on scaling renewable energy markets across the world. These companies accounted for seven of the top ten largest corporate purchasers of renewable energy in 2020, and the digital sector alone made up almost half of all renewable energy purchased that year. Thirteen companies in this report purchase all of their electricity from renewable sources, and overall, renewable electricity among digital companies accounts for almost a third of energy consumption. Thirty-one of the companies participate in RE100 business group that targets fully renewable electricity use among its members. Digital companies are also working with suppliers to encourage them to use renewables in order to reduce their emissions.

Digital technology companies may pay for renewable electricity, but they do not always get what they pay for due to the way electrical grids are engineered. For example, Alphabet (parent of Google) purchases all of its electricity needs from renewable sources but finds it gets only 67 per cent of the renewable electricity it paid for on an hourly basis. The company is partnering with UN Energy and Sustainable Energy for All to face this challenge through the 24/7 Carbon-free Energy Compact. The goal is to accelerate the availability of renewable energy to purchasers over the grid 24 hours a day and seven days a week. This is critical for the ICT sector, which is highly electricity dependent, in order to power telecommunication networks and data centres.

Almost a third of the companies in this report are headquartered in middle-income countries while others have subsidiaries in these countries. Low- and middle-income countries face particular energy challenges. In some, rural areas do not have access to the electricity grid, or the grid is unreliable, resulting in, for example, mobile base stations using dirty diesel generators. While a number of companies are working to convert base stations to renewable sources of energy, others are hampered due to restrictions on the purchase of renewables. Governments need to create a favourable renewable energy environment. While in the past factors such as low costs were key in attracting foreign investment, environmental policies are increasingly influential. These companies can also provide a positive contribution since they often have considerable expertise with emissions reduction and their subsidiaries in low- and middle-income countries would fall under the umbrella of the often ambitious emissions reductions goals of the parent company.

Moreover, voluntary offsets for unavoidable emissions are being purchased for dozens of projects in low- and middle-income countries. These include solar and wind farms, reforestation projects as well as the provision of environmentally conscious cookstoves and Pay As You Go solar. Apart from helping to compensate for as yet unabated emissions, they have notable spillover effects for sustainable development.

Sixteen digital companies report that they are carbon neutral by reducing emissions as far as possible and using offsets for remaining unavoidable emissions. More than twenty other companies are targeting 2030 for that interim milestone. Technology companies are planning to move beyond carbon neutrality to net zero, which is reached when all emissions that can be reduced have been eliminated and unavoidable emissions for a company's full footprint are removed from the atmosphere. As a result, carbon removal is becoming essential for absorbing emissions that cannot be abated. Digital companies are active in this space, investing over USD 4 billion in carbon removal startups. This is helping to scale biological and technological solutions such as direct air capture to remove carbon from the atmosphere.

Products and services of digital companies are playing a major role in enabling emissions reductions in other sectors through the use of video conferencing and smart metering for buildings and transport systems. Telecommunication operators calculate that avoided emissions from use of their services amount to over six times their operational emissions.

Sixteen companies, all headquartered in Europe and the United States, demonstrate leading climate practices and performance. Transparency and quality of their climate data is high and all but two have climate data verified by third parties. Eight of this group are describing themselves as carbon neutral and most have targeted being so by 2030. These companies generally include their entire value chain emissions in target reductions and are working with suppliers to reduce emissions. All have above average rates of renewable energy and eight contract only renewables for their electricity needs. If the other digital companies could emulate these leaders, it would go a long way to making the digital sector the greenest in the world.

1 Introduction

The consequences of climate change are visible on almost a daily basis, from hotter weather to increasing floods and wildfires. The main contributor to climate change are emissions from the use of fossil fuels. With a global average temperature increase of 1.1°C above estimated pre-industrial levels, the international community is worryingly off track to meeting either the 1.5°C or 2°C targets called for in the Paris Agreement.[1]

The information and communication technologies (ICTs) sector is widely acknowledged as a cross-cutting enabler for sustainable development, but the sector is coming under increasing scrutiny because the production and use of digital technology also entails greenhouse gas (GHG) emissions. As the world becomes more reliant on a digital infrastructure, accelerated by COVID-19, the growing ICT sector and more Internet users (around two thirds of the world's population) are increasing energy needs that will have a negative impact on the climate if not mitigated.

Aggregate emissions of the ICT sector have been estimated as slightly below 2 per cent of the world total, [2] which is in a similar range of emissions for aviation, shipping, or deforestation.[3]

This report is a collaboration between the International Telecommunication Union (ITU), the United Nations specialized agency in the field of ICTs, and the World Benchmarking Alliance (WBA), a global non-profit organization that assesses key companies, such as those in the digital sector, on their contribution to sustainable development. While company data can be used to estimate regional and global emissions,[4] this report provides a comprehensive GHG emissions inventory of the world's leading technology companies as well as their initiatives and targets to mitigate climate change. Driven by investors, governments, clients and other stakeholders, sustainability and greening the industry are becoming focus areas for a growing number of digital sector companies[5] and increasingly they are divulging climate-related data such as GHG emissions in annual environmental, social and governance (ESG) reports. [6] The analysis presented in this report highlights climate mitigation progress to date, areas where companies will need to step up future efforts, and the key role of renewable energy production.

1.1 Methodology

1.1.1 Companies

The WBA regularly ranks and scores leading technology companies in its Digital Inclusion Benchmark (DIB).[7] As part of the 2021 exercise, 150 companies were assessed including disclosure of emissions

[1] World Meteorological Organization. 2022. WMO Global Annual to Decadal Climate Update. https://hadleyserver.metoffice.gov.uk/wmolc/WMO_GADCU_2022-2026.pdf

[2] ITU. 2020. Recommendation ITU-T L.1470. Greenhouse gas emissions trajectories for the information and communication technology sector compatible with the UNFCCC Paris Agreement. https://www.itu.int/rec/T-REC-L.1470-202001-I/en

[3] Hannah Ritchie, Max Roser and Pablo Rosado. 2020. CO_2 and Greenhouse Gas Emissions. https://ourworldindata.org/emissions-b

[4] Lundén, Dag, Jens Malmodin, Pernilla Bergmark, and Nina Lövehagen. 2022. Electricity Consumption and Operational Carbon Emissions of European Telecom Network Operators. Sustainability 14, no. 5: 2637. https://doi.org/10.3390/su14052637

[5] Civitta. 2021. Sustainability of the Telecommunication Companies Worldwide. https://tomas4itu.org/wp-content/uploads/2021/11/Telecom-Sustainability_Report_2021.pdf

[6] See the "Sources" worksheet in 2021 Digital Inclusion Benchmark data set. https://www.worldbenchmarkingalliance.org/research/digital-inclusion-benchmark-2021-data-set/

[7] World Benchmarking Alliance. 2022. Digital Inclusion Benchmark 2021 Insights Report. https://www.worldbenchmarkingalliance.org/research/2021-digital-inclusion-benchmark-insights-report/

data in annual ESG reports for the year 2020.[8] The data collected forms the basis for this report. Companies have been grouped into three digital sector industries: hardware, telecommunications, and IT services.[9] These companies and their assessments are listed in the annex.

A company-based approach to ICT sector emissions reporting presents some challenges. In general, company data included in ESG reports refer to a parent company with several subsidiaries (group of companies). While most companies report emissions for the whole group, there are exceptions where coverage is limited.

Another issue with group level reporting is that some companies are involved in more than one ICT industry. For instance, Apple sells devices but also provides services. In such cases, companies are classified within the industry from which they earn the majority of their revenue.

A further challenge rises from companies that operate across different segments within an industry. For instance, Samsung produces semiconductors as well as consumer devices. Where relevant, data limitations and aggregations have been noted. While data sources present some boundary issues, this does not affect the overall emissions data presented for the sector. In future reports, greater granularity in ESG reporting will enable further insights.

As noted, emissions-related data are generally presented at the company group level. Although the headquarters of companies are indicated in the annex of this report, emissions and energy use are spread geographically and not necessarily limited to the location of the headquarters. This is particularly true for large multinational firms included in the data set. While many leading companies provide disaggregated data broken down by country, presenting a complete geographical picture of ICT sector emissions is beyond the scope of this report.

1.1.2 Emission standards framework

A wide range of emissions-related standards provide methodologies to assess and report emissions energy use and GHG emissions, such as ITU standards (Recommendation ITU-T L.1420)[10] and the International Standards Organization (ISO) guidance (ISO 14064)[11]. In addition, many companies follow the Greenhouse Gas Protocol (a corporate accounting and reporting standard) to calculate their carbon dioxide equivalent (CO_2e) emissions[12] for which specific ICT sector guidance has been published.[13] The protocol identifies three "scopes" in reference to GHG emissions (Figure 1.1):

Scope 1 emissions are those resulting directly from the result of company operations such as the purchase and use of diesel and other fuels.

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[8] Sources for the company data used in this report are available from here: https://www.worldbenchmarkingalliance.org/research/digital-inclusion-benchmark-2021-data-set/ . No evidence of an emissions disclosure was found for 20 small and mainly privately held or government owned companies.

[9] See the "ICT sector definition" based on the OECD guidelines in: United Nations. 2008. International Standard Industrial Classification of All Economic Activities. Revision 4. https://unstats.un.org/unsd/publication/seriesm/seriesm_4rev4e.pdf Note ITU uses another categorization from Recommendation ITU-T L.1450 based on ISIC. https://www.itu.int/rec/dologin_pub.asp?lang=e&id=T-REC-L.1450-201809-I!!PDF-E&type=items

[10] ITU. 2012. Recommendation ITU-T L.1420. Methodology for energy consumption and greenhouse gas emissions impact assessment of information and communication technologies in organizations. https://www.itu.int/rec/T-REC-L.1420

[11] Greenhouse gases — Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals https://www.iso.org/standard/66453.html

[12] World Business Council for Sustainable Development and World Resources Institute. 2004. A Corporate Accounting and Reporting Standard (Revised Edition). https://ghgprotocol.org/corporate-standard

[13] GeSI and Carbon Trust. 2017. ICT Sector Guidance built on the GHG Protocol Product Life Cycle Accounting and Reporting Standard. https://ghgprotocol.org/sites/default/files/GHGP-ICTSG%20-%20ALL%20Chapters.pdf

Scope 2 refers to indirect emissions not controlled by the company such as those provided by utility companies. The main driver of emissions in this scope is electricity used to power office buildings, factories, telecommunication infrastructure, and data centres.

In 2015, new guidance for Scope 2 emissions were published.[14] They were designed to account for the difference between the type of electricity companies purchase (market-based) and what they actually receive over the grid (location-based). This was partly an effort to recognize that while some companies were paying for renewable energy, the electricity grid was not always supplying them with it. The revision to Scope 2 is an effort to recognize this and to encourage greater demand for renewable energy, which will lead to supply chain growth. Presumably, the renewable energy purchased by companies but not used by them is used by someone elsewhere, and thereby reducing overall emissions.

This report shows both Scope 2 emission types and according to the GHG protocol, companies are supposed to disclose both market-based and location-based emissions. Note that market-based emissions can be higher than location-based for some emission sources. This happens when the attributes of the renewable energy purchased cannot be proven. In that case, companies have to use the so-called "residual mix" emission factor which can be higher than the location-based grid emissions factor. The residual mix is the sum of all electricity on a grid whose source cannot be ascertained.[15]

Scope 3 refers to upstream and downstream emissions related to a company's activities. For instance, this would include suppliers that digital hardware companies outsource for their production needs. It also includes product use emissions from devices such as computers and smartphones sold by digital companies. Note that while scope 3 emissions are part of a company's overall footprint, they are not part of the company's operational emissions but are attributable to another company. There are 15 categories of scope 3 emissions (Table 1.1).

Table 1.1: Scope 3 upstream and downstream activities (by category)

Upstream activities	Downstream activities
Category 1: Purchased goods and services	Category 9: Downstream transportation and distribution
Category 2: Capital goods	Category 10: Processing of sold products
Category 3: Fuel- and energy-related emissions[16]	Category 11: Use of sold products
Category 4: Upstream transportation and distribution	Category 12: End-of-life treatment of sold products
Category 5: Waste generated in operations	Category 13: Downstream leased assets
Category 6: Business travel	Category 14: Franchises
Category 7: Employee commuting	Category 15: Investments
Category 8: Upstream leased assets	

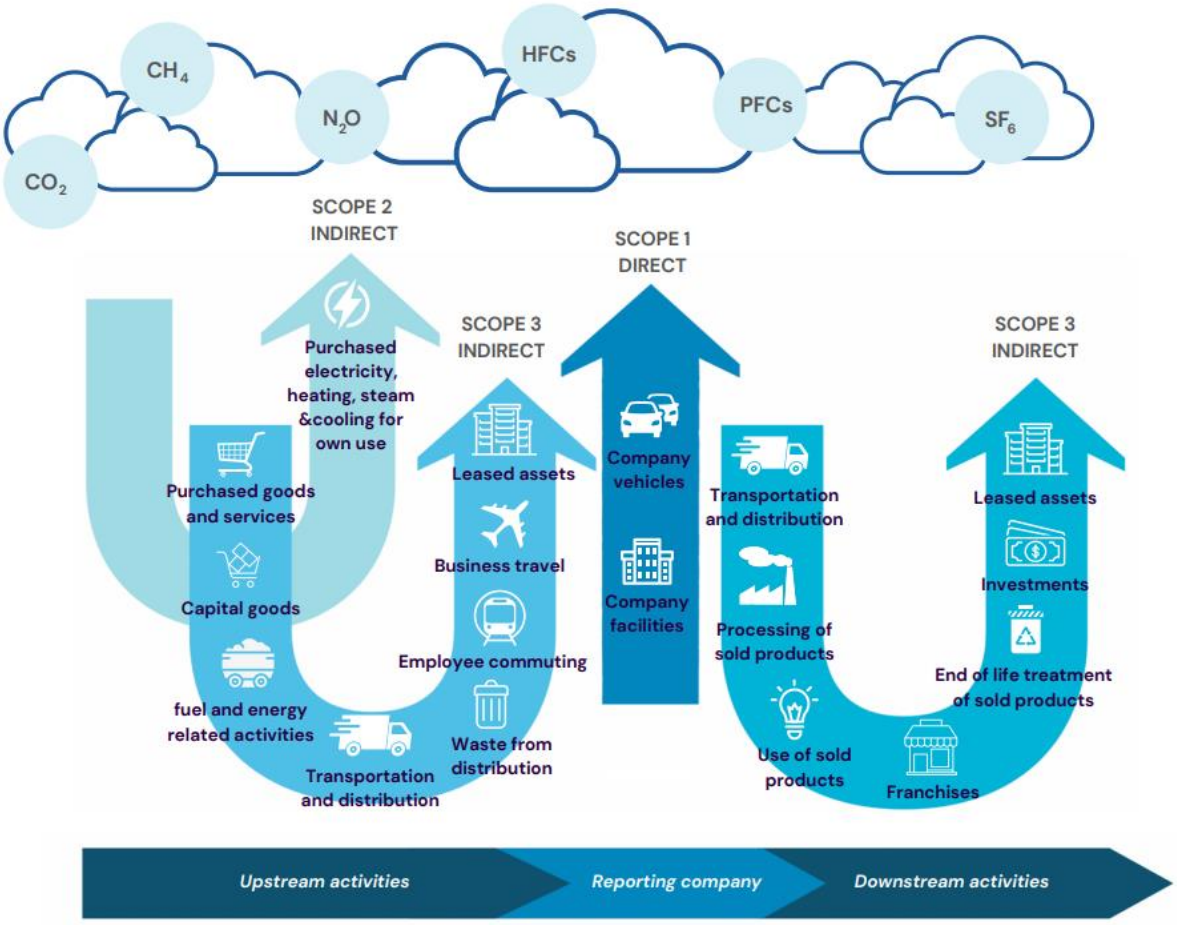
Source: World Resources Institute and World Business Council for Sustainable Development. 2011. Corporate Value Chain (Scope 3) Accounting and Reporting Standard. https://ghgprotocol.org/standards/scope-3-standard

[14] World Resources Institute and World Business Council for Sustainable Development and World Resources Institute. 2015. GHG Protocol Scope 2 Guidance: An amendment to the GHG Protocol. https://ghgprotocol.org/scope_2_guidance

[15] For an example of how the residual mix is calculated and used in Ireland see: Commission for Regulation of Utilities. 2021. Fuel Mix Disclosure 2020. https://www.cru.ie/document_group/fuel-mix-and-co2-emissions-disclosure-2/

[16] This category is usually to be considered when deriving aggregated emissions of a company at a sector level for other purposes than company accounting in line with ITU Standards (such as Recommendation ITU-T L.1420).

Figure 1.1: Emissions scopes



Adapted from: https://ghgprotocol.org/standards/scope-3-standard

Box 1.1: Double counting in scope 3

A company-based approach to reporting emissions data presents challenges for scope 3:

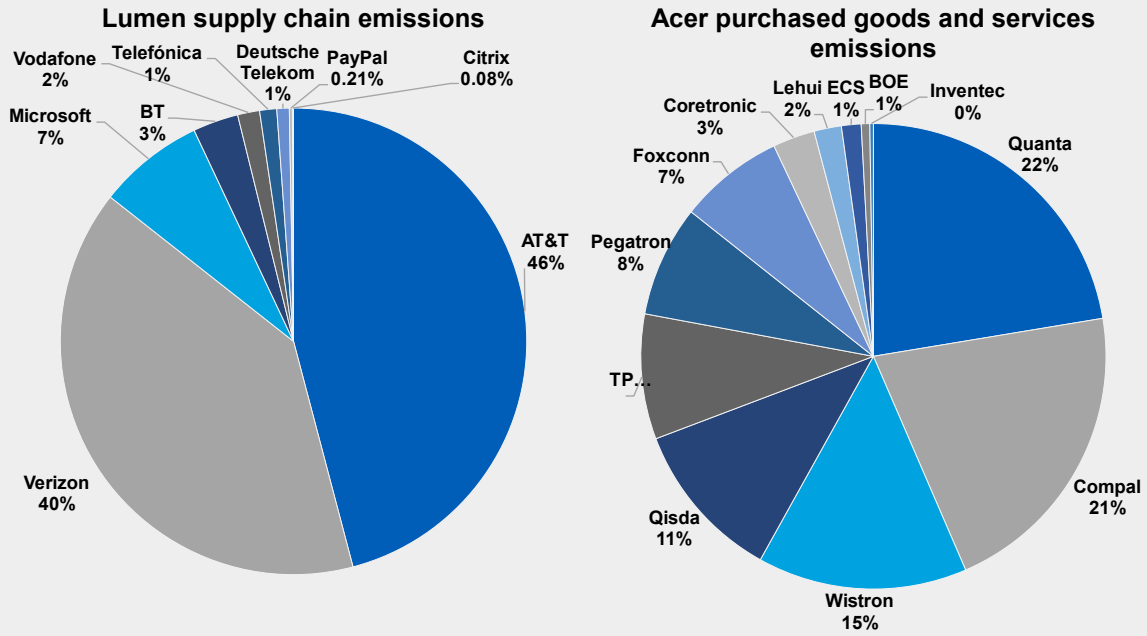
- The range of disclosure of scope 3 emissions varies. Some companies do not report it at all, some report only relatively simple to calculate emissions, such as business travel, while others calculate all relevant categories.
- The interpretation of scope 3 emissions reporting should be treated with caution because upstream scope 3 reporting of one company could be reported as operational emissions (scope 1 and 2) of another company, resulting in double counting. For example, the semiconductor sector includes companies that design the chip and have it manufactured by another company. Hence, scope 3 upstream emissions are already partly accounted for in the operational emissions (scope 1 and 2) of another company.

  Scope 3 emissions reporting is often an aggregate figure. However, identifying the interrelationships between upstream and downstream activities of digital companies would help to reduce double counting. Some companies do provide breakdowns of their supply chains that involve other companies. For instance, Lumen identifies companies that use its data centre services and the amount of related-emissions, and where its operational emissions (scope 1 and 2) are the upstream services emissions of another company. In another example, Acer, a consumer device manufacturer, lists the companies it purchased

goods and services from. This includes supplier-related operational emissions and results in double counting.

- In some cases, the same product is counted by more than one company (Category 11: Use of sold products[17]). Vendors of consumer devices include product use in scope 3 emissions counting but so too do some telecommunication operators and IT services companies. For example, if a telecommunication operator were to use Apple device emission factors to calculate product-use emissions that have already been included in Apple emissions reporting. Music streaming company Spotify includes listener use emissions, its second largest source of emissions from data traffic for streaming and downloads of the app resulting in charging the devices. When targets for emissions reduction includes company value chains, multiple companies could be targeting the same product use emissions.

Figure 1.2: Company emissions interrelationships, 2020



Note: The left chart shows the operational emissions Lumen has allocated to purchasers of its data centre services; these would be counted again as those companies upstream emissions. The right chart shows Acer upstream emissions which would be counted as operational emissions by the companies it purchases goods and services from. Source: Lumen (CDP Climate Change Questionnaire 2021) and Acer (Greenhouse Gas Verification Statement).

Companies typically report their emissions and energy use in annual sustainability or corporate responsibility reports.[18] A number of companies report through the CDP climate change questionnaires[19] and some make these disclosures publicly available in PDF format on their websites. Dedicated environmental reports are also used, as are financial disclosure reports, such as the Task Force on Climate-related Financial Disclosures (TCFD),[20] which often contain emissions data. Climate change related indicators used in this report are shown in Table 1.2.

[17] World Resources Institute & World Business Council for Sustainable Development. 2013. Category 11 Use of Sold Products. https://ghgprotocol.org/sites/default/files/standards_supporting/Chapter11.pdf
[18] Sources for the company data used in this report are available from here: https://www.worldbenchmarkingalliance.org/research/digital-inclusion-benchmark-2021-data-set/
[19] https://www.cdp.net/en/
[20] https://www.fsb-tcfd.org

Table 1.2: Climate change indicators

Emissions	Unit	Energy	Unit
Scope 1	tCO_2e	Energy consumption	MWh / TWh
Scope 2 Location-based	tCO_2e	Renewable energy	%
Scope 2 Market-based	tCO_2e	Electricity consumption	MWh / TWh
Scope 3	tCO_2e	Renewable electricity	%

Note: tCO_2e refers to metric tonnes of carbon dioxide equivalent. MWh refers to megawatt hours. TWh refers to terawatt hours.

Emissions data reported by companies are subject to revision, such as changes to the operational boundaries of a company through mergers and acquisitions or disposals of subsidiaries. Emissions-related factors are also subject to revision necessitating a change to historical data, and calculating emissions is complicated and prone to mistakes. Such factors have limited impact on this report, which covers only 2020. Given the complexity of calculating emissions data, particularly for scope 3 emissions, some companies report on the previous year only. In those cases, 2020 data has been retrieved from more recent sources.

Verification and certification of data can reduce errors and increase transparency of emissions data. Standards and recommendations published by the ISO, the GHG protocol, and ITU provide guidance on reporting emissions, and a number of companies have their emissions data verified and certified. See the annexes to this report for verified emissions data and other information on the companies covered in this report, including energy use and climate targets.

Chapter 2 analyses company emissions data, from manufacturing to services. Chapter 3 explores measures to reduce and eliminate emissions and carbon neutrality. Chapter 4 looks at the challenges low- and middle-income countries face moving to a carbon free digital environment. The ways digital companies are helping to reduce emissions by others are the subject of Chapter 5. Chapter 6 concludes by highlighting key findings and the outlook for digital companies in their transition to carbon free operations. The annex contains tables that highlight, list and benchmark GHG emissions, energy use and emissions reduction targets and metrics.

2 Emissions by ICT industry

Companies differ in upstream and downstream activities, the amount of energy they need, and emissions scopes. This chapter presents emissions data from different digital industries. Where companies operate across industries, they are shown under the industry where they generate the most revenue.

2.1 ICT manufacturing

This study focuses on three manufacturing industries within the ICT sector, which includes semiconductor and network communications equipment manufacturers, and end user equipment manufacturers.[21] The first two produce goods that are used in other upstream production or industry use. For instance, semiconductors are a component in network communications equipment and end-user equipment as well as increasingly in other products such as automobiles. Network communications equipment is mainly used by telecommunication operators to enable their services. Manufacturers of consumer devices produce goods for organizations and the general public.

Upstream and downstream scope 3 emissions data for ICT manufacturing are less accurate than scope 1 or 2 emissions data. For instance, manufacturers can outsource production, resulting in low operational emissions data. Scope 3 emissions data, particularly category 1 (purchased goods and services), are relevant in terms of the supplier footprint, but less accurate than scope 1 or 2 emissions data of suppliers.

This is also true for both network and end-user goods but less of an issue for category 11 (use of sold products) where telecommunication operators purchase communications equipment and scope 1 and 2 reflect the use of such equipment. Finally, although data collection from end-users is complex, scope 3 category 11 (use of sold products) is relevant for manufacturers of end-user devices since it forms a large part of the overall emissions footprint.

2.1.1 Consumer products

The manufacturing of ICT-related consumer products covers computers, mobile phones, storage, and input/output devices capable of sending and receiving data from a computer and includes companies that also manufacture televisions and game consoles.

Table 2.1 lists 14 companies that represent at least 77 per cent of global computer sales in 2020[22], over 50 per cent of smartphone sales,[23] and includes the leading manufacturers of gaming consoles (Sony and Nintendo), storage (Seagate and Western Digital) and input devices (Logitech). Table 2.1 also shows that Samsung produced the most operational emissions, and that HP and Apple reported the highest emissions from purchases of goods and services, reflecting a high proportion of outsourced production. Renewables in this group of companies account for less than a fifth of electricity use. Apple and Logitech stand out for their high level of green energy use whereas most of the companies with headquarters in Asia report low levels of green energy use or do not report this metric.

[21] This follows the OECD classification of the ICT sector not the ISIC classification, which is used in Recommendation ITU-T L.1450. Methodologies for the assessment of the environmental impact of the information and communication technology sector. https://www.itu.int/rec/T-REC-L.1450-201809-I/en

[22] IDC. 2022. Growth Streak for Traditional PCs Continues During Holiday Quarter of 2021, According to IDC. Press Release, 12 January. https://www.idc.com/getdoc.jsp?containerId=prUS48770422

[23] IDC. 2022. Smartphone Shipments Declined in the Fourth Quarter But 2021 Was Still a Growth Year with a 5.7% Increase in Shipments, According to IDC. Press Release, 27 January. https://www.idc.com/getdoc.jsp?containerId=prUS48830822

Table 2.1: ICT manufacturing emissions, consumer products, 2020

Company	Region of headquarters	tCO_2e				Electricity	
		Location based	Market based	Scope 3 Category 1 Purchased goods and services	Scope 3 Category 11 Product Use	MWh	Renewable (%)
Samsung	East Asia	1 812 000	1 812 000			3 262 000	18
Sony	East Asia	1 471 239	1 392 990	3 791 000	11 403 000	2 406 919	6
LG	East Asia	1 294 000	1 294 000		58 976 000	1 633 888	4
Seagate	Europe	1 190 152	1 199 080	1 200 000	7 000 000	1 626 187	0
Western Digital	North America	1 002 695	1 045 457	1 610 139	6 862 142	1 865 600	7
Apple	North America	937 619	47 430	16 100 000	4 300 000	2 580 000	100
Dell	North America	405 700	219 800	3 748 600	11 280 000	958 000	54
HP	North America	254 200	171 000	26 400 000	15 800 000	480 595	40
Lenovo	East Asia	184 947	28 788	2 283 500	15 551 000	292 751	11
Xiaomi	East Asia	31 347	31 347			45 416	
ASUS	East Asia	20 430	20 430	862 972	319 852	38 725	0
Acer	East Asia	18 118	12 199	43 732	1 542 689	31 735	54
Logitech	Europe	16 504	1 889	650 060	343 915	28 580	92
Nintendo	East Asia	5 270	5 270			15 713	13
Total		**8 644 221**	**7 281 680**			**15 266 109**	**28**

Note: * Scope 1 and 2 excluding semiconductor operations.
Source: Digital Inclusion Benchmark 2021.

Box 2.1: Product use

The ICT manufacturing industry produces goods that are used by others and generate downstream emissions. As noted above, this is not a major concern for the semiconductor or network communications equipment manufacturers. Semiconductors are a component in an upstream manufacturing process and captured in the emissions of the company using the semiconductor for its product (e.g., a computer or smartphone manufacturer assembling the semiconductor in its device). In the case of network communications equipment, the hardware is mainly sold to telecommunication operators and other organizations that capture the use of the equipment in their emissions reporting. Scope 3 product-use emissions are therefore of most interest concerning end-user devices such as computers and smartphones as their usage is to a large extent associated with consumers and as such not part of any reporting scheme.

In contrast to scope 1, 2, and 3 reporting which refers to companies and value chains, the life cycle assessment (LCA) methodology provides a framework for estimating the potential environmental impact of a product.[24] Many of the leading consumer equipment manufacturers produce estimations of product life cycle environmental information that can be used to inform estimates for computer and smartphone use emissions. Such values are seen as parameterized life cycle estimates rather than full LCAs. Many companies publish such estimates for their GHG emissions. Apple is one such company which publishes life cycle emissions reports for all its products covering sourcing of materials, manufacturing, distribution, product use and recycling. The iPhone 12 for example, will generate 70 kilograms (kg) of CO_2e over its lifetime (3-4 years according to Apple), with 14 per cent of that from product use. While use emissions over a product life cycle are captured in a company scope 3 emissions in the year the device was manufactured, they do not show the annual emissions of the product. This can be derived from the use stage of the life cycle and estimated number of years of life. In the case of the iPhone 12, annual use emissions are on average 2.8 kg CO_2e (70 * 14% [product use] / 3.5 [years of use]).

[24] ITU. 2014. Recommendation ITU-T L.1410: Methodology for environmental life cycle assessments of information and communication technology goods, networks and services. https://www.itu.int/rec/T-REC-L.1410

Figure 2.1: Lifecycle emissions of an Apple iPhone 12

Note: The share of emissions is Source Material and Make (Production, 12%), Package and Ship (Transport, 2%), Use (14%) and Recover (End-of-life processing, < 1%).
Adapted from: Product Environmental Report iPhone 12 at:
https://www.apple.com/environment/pdf/products/iphone/iPhone_12_PER_Oct2020.pdf

2.1.2 Semiconductors

Semiconductors are an increasingly strategic industry.[25] Companies covered include seven of the top 10 vendors by revenue in 2020 as well as others not in the top-ten list.[26] The companies assessed have their headquarters in either the United States or East Asia. Unlike other digital companies, semiconductor manufacturers emit significant scope 1 emissions, in some cases more than their scope 2 GHG emissions due to the chemicals and gases used in semiconductor production.[27]

Table 2.2 shows that there is a notable difference in GHG emissions per unit of revenue among this group of companies. Those with a low value are "fabless" semiconductor companies: they design the chip but outsource manufacturing and thus have far lower scope 1 and 2 emissions. For example, AMD and NVIDIA outsource their chip production to TSMC, while Qualcomm uses TSMC and Samsung. Use of renewable electricity is relatively low for this group with the exception of Intel, which purchased 82

[25] Ma Tieying. 2021. Implications of the global semiconductor race. DBS, 2 June. https://www.dbs.com.hk/treasures/aics/templatedata/article/generic/data/en/GR/062021/210602_insights_semiconductor.xml#
[26] Gartner Says Worldwide Semiconductor Revenue Grew 10.4% in 2020. Press Release, 12 April 2021. https://www.gartner.com/en/newsroom/press-releases/2020-04-12-gartner-says-worldwide-semiconductor-revenue-grew-10-4-percent-in-2020
[27] Udit Gupta et al. 2020. Chasing Carbon: The Elusive Environmental Footprint of Computing. Arxiv, 28 October. https://arxiv.org/pdf/2011.02839.pdf

per cent of renewables for its electricity needs in 2020 avoiding 2.8 million tonnes of indirect emissions.

Table 2.2: Semiconductor companies, 2020

Company	Region of headquarters	tCO_2e			GHG / Revenue (USD m)	Electricity	
		Scope 1	Scope 1 and 2 Location based	Scope 1 and 2 Market based		MWh	Renewable (%)
Samsung	East Asia	5 448 000	12 994 000	12 994 000	199	19 654 000	18
TSMC	East Asia	2 450 354	10 732 863	9 910 210	237	16 058 000	8
SK hynix	East Asia	2 711 409	7 548 329	7 548 329	279	23 167 536	0
Intel	North America	1 973 000	5 673 000	2 882 000	73	8 798 000	82
GlobalFoundries	North America	1 552 766	2 348 273	2 348 273	484	2 626 530	0.1
Texas Instruments	North America	938 506	2 133 617	1 916 743	148	2 461 723	18
Qualcomm	North America	112 479	357 556	315 526	15	451 768	11
Broadcom	North America	112 646	240 722	240 722	10	292 466	...
NVIDIA	North America	2 692	108 313	91 740	6	310 016	25
AMD	North America	2 335	32 251	32 251	3	116 000	29
Total		**15 304 187**	**42 168 924**	**38 279 794**	**137**	**73 936 039**	**17**

Note: * Scope 1 and 2 location-based
Source: Digital Inclusion Benchmark 2021

2.1.3 Network communications equipment

The network communication equipment sub-industry includes the top five vendors by revenue.[28] Table 2.3 show that there is a notable split between companies in Asia that do not calculate any scope 3 emissions and the other companies. Product use for Ericsson and Nokia is largely accounted for in the operational emissions of other digital companies, primarily telecommunication operators. Purchased goods emissions for scope 3 suggest that Nokia, Ericsson and Cisco outsource a notable portion of their production. There is also a difference in renewable electricity use between the two companies with headquarters in China with the impact reflected in their operational emissions. Huawei, which does not disclose an aggregated figure for its use of renewables, accounts for about half the total electricity use (and emissions) shown in Table 2.3.

Table 2.3: Network communications manufacturers by location-based emissions, 2020

		tCO_2e				Electricity	
Company	Region of headquarters	Scope 1 and 2 Location based	Scope 1 and 2 market based	Scope 3 Category 11 Product use	Scope 3 Category 1 Purchased goods and services	MWh	Renewable (%)
Huawei	East Asia	2 285 458	2 285 458	...	...	3 601 700	...
Cisco	North America	647 192	202 859	18 426 615	5 422 482	1 556 000	83
Nokia	Europe	496 500	379 900	32 400 000	2 487 400	893 000	39
ZTE	East Asia	451 074	451 074	...	...	534 178	0.5
Ericsson	Europe	196 000	114 000	34 000 000	2 299 500	572 000	68
Total		**4 076 224**	**3 433 291**			**7 156 878**	**57**

Source: Digital Inclusion Benchmark 2021.

2.2 Telecommunication services

Sixty eight of the 150 companies in the DIB 2021 provide telecommunication services.[29] This group accounts for 85 per cent of worldwide mobile subscriptions and over 70 per cent of fixed-broadband subscriptions. The top ten by operational emissions (Table 2.4) account for 75 per cent of the operational location-based emissions and three companies that have their headquarters in China

[28] Dell'Oro Group. 2021. Key Takeaways—Total Telecom Equipment Market 2020. https://www.delloro.com/key-takeaways-total-telecom-equipment-market-2020/

[29] Note that some of the operators also have commercial data centre operations. As a result figures for telecommunication services shown here are overstated whereas those for IT services are understated.

account for 68 per cent of the emissions of this group (note that data centres emissions are included). The average emissions per subscription (mobile and fixed) for the group was 13 kg CO_2e while average electricity use was 29 kWh per subscription.

Table 2.4: Top ten telecommunication operators by location-based emissions, 2020

Company	Region of headquarters	Scope 1 and 2 tCO_2e		Electricity	
		Location based	Market based	MWh	Renewable (%)
China Mobile	East Asia	34 150 000	34 150 000	54 919 000	7
China Unicom	East Asia	14 230 000	14 230 000	17 220 000	
China Telecom	East Asia	13 760 000	13 760 000	22 833 000	
AT&T	North America	6 675 263	5 780 000	14 100 000	16
Deutsche Telekom	Europe	5 050 684	2 511 868	11 716 000	58
NTT	East Asia	4 804 131	4 715 453	6 670 000	3
Verizon	North America	4 090 491	3 964 803	9 833 827	3
Jio	South Asia	3 600 685	3 600 685	3 749 479	0
América Móvil	Latin America	2 742 651	2 742 651	5 474 080	14
Vodafone	Europe	2 311 626	1 367 866	5 524 000	56
Top 10		**91 415 531**	**86 823 327**	**152 039 386**	**15**
58 others		**30 954 723**	**27 519 356**	**72 706 315**	**30**
Total		**122 370 254**	**114 342 682**	**224 745 701**	**20**
Top 10 %		**75%**	**76%**	**68%**	

Source: Digital Inclusion Benchmark 2021

2.3 IT services

IT services includes the top cloud providers,[30] the world's two largest multitenant data centre operators and Facebook (subsidiary of Meta), which owns hyperscale data centres to store content generated by its users. The group also features software developers, streaming services, e-commerce companies and other services. Ten IT services companies, all with headquarters in China or the United States, account for over 90 per cent of electricity consumption in the group. Except for JD.com, an e-commerce company, these are all companies that make significant use of data centres for their activities. Most of the top ten companies with headquarters in the United States make significant use of renewables resulting in a reduction of 20 million tCO_2e using the market-based indicator.

Table 2.5: Top ten IT services companies by location-based emissions, 2020

Company	Region of headquarters	tCO_2e		Electricity	
		Scope 1 and 2 Location based	Scope 1 and 2 Market based	MWh	Renewable (%)
Amazon	North America	14 890 000	14 890 000	24 000 000	65
Facebook	North America	7 584 000	38 000	7 170 000	100
Alphabet	North America	5 903 789	950 109	15 138 543	100
Microsoft	North America	4 220 545	346 294	10 244 377	100
Alibaba	East Asia	4 219 773	4 219 773	9 333 333	2
Digital Realty Trust	North America	2 997 417	1 866 188	8 318 712	50
Equinix	North America	2 335 300	382 800	6 460 000	91
JD.com	East Asia	1 002 412	1 002 412	332 138	...
Tencent	East Asia	930 766	930 766	1 703 233	23

[30] Gartner. Magic Quadrant for Cloud Infrastructure and Platform Services. 27 July 2021. https://www.gartner.com/doc/reprints?id=1-271OE4VR&ct=210802&st=sb

Company	Region of headquarters	tCO_2e		Electricity	
		Scope 1 and 2 Location based	Scope 1 and 2 Market based	MWh	Renewable (%)
IBM	North America	919 700	621 271	3 513 000	59
Ten above		**45 003 702**	**25 247 613**	**86 213 336**	**71**
41 others		**3 363 005**	**2 586 106**	**9 217 795**	**39**
Total		**48 366 707**	**27 833 719**	**95 431 131**	**68**
Share of top ten		**93%**	**91%**	**90%**	

Source: Digital Inclusion Benchmark 2021.

Box 2.2: Ride hailing companies and scope 3 product-use emissions

The benchmark includes ride-hailing companies which rely on digital apps for their business model and are classified as IT services companies. While their operational scope 1 and 2 GHG emissions are relatively low, their scope 3 emissions relating to fuel consumption are relatively high (Table 2.6). Ride hailing companies are working to reduce these emissions through programmes to introduce more electric vehicles as well as giving users the option of ordering a battery-operated vehicle. Uber has researched the impact on emissions from the switch to electronic vehicles and committed to 100 per cent electric vehicle use by 2030 in major cities in Europe, Canada, and the United States, and worldwide by 2040. [31] Both Gojek and Grab aim to have their fleets running on 100 per cent green energy by 2030.

Table 2.6: Ride hailing company emissions (tCO_2e), 2020

Company	Region of headquarters	Scope 1	Scope 2	Scope 1 + Scope 2	Scope 3, Category 11 Use of sold products
Gojek	East Asia	0	616 650	987 591	987 591
Grab	East Asia	0	5 030	5 030	1 506 045
Uber	North America	1 121	131 701	132 822	3 102 101

2.4 Summary

Digital companies included in the Digital Inclusion Benchmark 2021 accounted for 239 million tons (location-based) of GHG emissions in their operations in 2020, equivalent to 0.7% of the world's emissions.[32] Using the market-based metric, GHG emissions were 179 million tons, or 60 million tons less. Scope 3 emissions were 612 million tons or 2.5 times higher than operational location-based emissions. This value has not been modified to avoid double counting, and the overall footprint of digital companies is estimated to be much higher since not all companies calculated scope 3 emissions or relevant categories were omitted from the reporting. Digital companies consumed 425 terawatt-hours of electricity in 2020, accounting for 1.6 per cent of global electricity production and double their share of global emissions. Around one third of electricity use consisted of purchased renewable power. These aggregated numbers are not comparable to estimates of the ICT sector footprint but represent only the companies included in the study.

Telecommunication operators have the highest operational emissions as well as energy use. One reason is they cannot choose green locations and need to provide services where their customers live. A second reason is that the largest operators use electricity to provide data centre services, which results in high emissions. While scope 3 figures are incomplete, hardware companies have by far the highest reported downstream and upstream emissions, which reflects the high degree of outsourcing

[31] Uber. 2021. Climate Assessment and Performance Report. https://www.uber.com/nl/en/about/reports/sustainability-report/

[32] Excluding emissions from electricity supply chain and distribution losses.

among ICT manufacturers in the benchmark as well as significant product-use emissions. IT services companies have a huge lead in the use of renewables; 68 per cent of their electricity use is from green energy compared to 32 per cent for all digital companies. This could be due in part to their ability to choose locations based on access to renewables in contrast to network communication services that demand local presence.

Table 2.7: Assessed companies by industry, emissions and energy use, 2020

	Hardware	Telecommunication services	IT services	Total
Million tons of CO_2e				
Scope 1	17	7	11	**36**
Scope 2 Location based	52	114	37	**203**
Scope 2 Market based	37	89	17	**143**
Scope 1 and 2 Location based	69	121	49	**239**
% of world	0.21%	0.38%	0.15%	**0.75%**
% of group	29%	50%	21%	**100%**
Scope 1 and 2 Market based	54	96	28	**179**
% of world	0.17%	0.30%	0.09%	**0.56%**
% of group				
Scope 3*	392	118	102	**612**
Terawatt-hours				
Electricity	105	225	95	**425**
% of world	0.39%	0.84%	0.36%	**1.58%**
% of group				
% of energy use	86%	96%	99%	**94%**
% renewable	20%	19%	68%	**32%**
Energy	121	233	96	**451**
% renewable	18%	16%	71%	**29%**

Note: bp Statistical Review of World Energy 2021 used for calculating the share of the benchmarked digital companies in world emissions, electricity and energy.

* Scope 3 is not comparable due to upstream and downstream emissions not being calculated by some companies or not all relevant categories being included. Also, one company scope 3 emissions could be another company scope 1 and 2 emissions- hence these aggregated values are not free from double-counting.

Emissions of digital companies are highly concentrated by region. Just 20 out of 150 companies account for 75 per cent of operational location-based emissions; of those, nine are headquartered in East Asia accounting for 66 per cent of the emissions of this group and almost half the emissions of all assessed companies (Table 2.8). Companies with headquarters outside East Asia account for over two thirds of renewable electricity consumed among the top 20 compared to just 10 per cent in East Asia. The ratio of GHG to USD revenue is 65 per cent higher in companies with headquarters in East Asia than other top ten companies. Target wise, companies with headquarters in East Asia will not reach carbon neutrality on average until after 2050, more than two decades on average for the other top ten companies. Greenpeace attributes the huge gap between technology companies in East Asia and others to the delay in adopting climate friendly strategies: "...major tech companies in East Asia are only just beginning to increase their renewable energy use and develop strategies to reduce GHG emissions."[33] This transition started much earlier in companies with headquarters outside East Asia.

Table 2.8: Top 20 companies by operational emissions (location based), 2020

Company	Region of headquarters	Scope 1 and 2 (tCO_2e millions)		Electricity use		Carbon neutral year**
		Scope 1 and 2 location-based	Scope 1 and 2 marked-based	Terawatt-hours	% Renewable *	
China Mobile	East Asia	34.4	34.4	55	7	2060
Samsung	East Asia	23.3	14.81	23	18	...

[33] Greenpeace. 2021. Race to Green. https://www.greenpeace.org/static/planet4-eastasia-stateless/2021/12/a29b3a1d-race-to-green-report.pdf

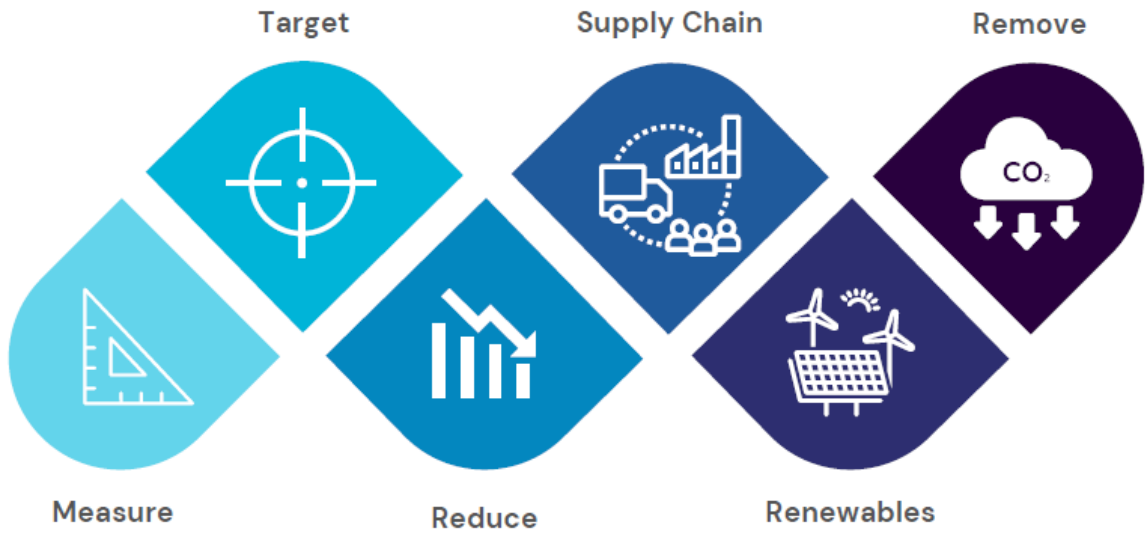
Company	Region of headquarters	Scope 1 and 2 (tCO_2e millions)		Electricity use		Carbon neutral year**
		Scope 1 and 2 location-based	Scope 1 and 2 marked-based	Terawatt-hours	% Renewable *	
Amazon	North America	14.9	14.89	24	65	2040
China Telecom	East Asia	13.8	13.76	23	...	2060
China Unicom	East Asia	13.8	14.23	17	...	2060
TSMC	East Asia	10.7	9.91	16	8	2050
Facebook	North America	7.6	0.04	7	100	2020
SK hynix	East Asia	7.6	7.55	23	0	2050
AT&T	North America	6.7	5.78	14	0	2035
Alphabet	North America	5.9	0.95	15	100	2020
Intel	North America	5.7	2.88	9	82	2040
Foxconn	East Asia	5.4	5.42	8	12	2050
Deutsche Telekom	Europe	5.1	2.51	12	58	2025
NTT	East Asia	4.8	4.72	7	3	2040
Microsoft	North America	4.2	0.35	10	100	2020
Alibaba	East Asia	4.2	4.22	9	2	2030
Verizon	North America	4.1	3.96	10	3	2035
Jio	South Asia	3.6	3.6	4	0	2035
Digital Realty Trust	North America	3.0	1.87	8	50	...
América Móvil	Latin America	2.7	2.7	5	14	2050
Top 20		**181**	**131**	**300**	**31**	**2039**
Top 20 share (%)						
East Asia		**65%**	**70%**	**40%**	**13%**	**2052**
Others		**35%**	**30%**	**60%**	**87%**	**2032**
Share of top 20 among all companies assessed						
East Asia		**49%**	**51%**	**43%**	**8%**	
Others		**51%**	**49%**	**57%**	**92%**	

Note: * The group percentages refer to the total amount of renewable electricity used.
** The group figure refers to the average.

3 Decarbonization practices of digital companies

The path to decarbonization involves several steps (Figure 3.1). The starting point is accurate measurement of a company emission inventory. Targets should be established elaborating company goals for emissions reductions. Another step is reducing energy use through efficiency measures such as insulation, lowering thermostats in the winter and increasing them in the summer, green buildings, etc. For telecommunication operators, network upgrades result in more efficient energy use. Supply chains are a significant source of upstream emissions for some digital companies and efforts need to be made with suppliers to reduce their carbon footprint. Contracting renewable energy is another step and the one that will have the biggest effect on reducing and eventually eliminating emissions in the ICT sector. After all possible emissions have been eliminated, some digital companies offset residual emissions in various ways and are transitioning to carbon removal. This chapter looks at practices digital companies are using in these areas.

Figure 3.1: Decarbonization steps



Source: ITU and WBA.

3.1 Measurement

There is a gap in the availability, depth and transparency of GHG emissions and energy data reported by digital companies. While some reported a full suite of emissions for all scopes—including market-based and location-based for scope 2 and a breakdown of all relevant categories for scope 3—others are more opaque. No emissions data are reported by 21 companies, and 32 do not report scope 3 emissions.

Most digital companies use the GHG Protocol methodology to compile their emissions data. There is also specific guidance for the ICT sector.[34] While in general data are clear, there are some areas of opaqueness. Units can be inconsistent with some companies reporting emissions in tonnes, millions of tonnes or kilograms; for energy use some companies report in joules while others report in watts and also in various units (e.g., GJ, TJ, kWh, MWh and GWh). While this lack of standardization can be

[34] See: GeSI and Carbon Trust. 2017. ICT Sector Guidance built on the GHG Protocol Product Life Cycle Accounting and Reporting Standard. https://ghgprotocol.org/sites/default/files/GHGP-ICTSG%20-%20ALL%20Chapters.pdf and ITU. 2012. Recommendation ITU-T L.1420. Methodology for energy consumption and greenhouse gas emissions impact assessment of information and communication technologies in organizations. https://www.itu.int/rec/T-REC-L.1420

adjusted by using the appropriate conversion factors, they add to a degree of opaqueness, and it has been noted in reviewing the data for this report some companies have made errors.

Regarding the different scopes, some companies only report market-based scope 2 emissions data though the guidelines call for location-based data to also be disclosed. Other companies report a single scope 2 figure without clarifying if it is market- or location-based. Scope 3 figures vary greatly with some companies not reporting this scope at all, others report only a few categories such as business travel and some use non-standardized terminology to refer to their upstream and downstream emissions, so it is not clear what categories they belong to. In addition, companies are sometimes opaque about the use of renewables in their energy and electricity consumption.

Reporting of offsets is often vague with a lack of clarity surrounding what emissions are being offset, what projects the offsets are for and how they clearly result in carbon neutrality.

Assurance of emissions data and energy use can increase transparency and reduce errors. While a number of companies report some degree of third party GHG data verification, they vary in the level of assurance and conformance with the GHG protocol and the international standard ISO 14064 specifying how emissions should be reported and verified.[35] Swisscom is the only company that publishes a standalone climate report aligned with ISO 14064.

3.2 Energy efficiency

Many companies reporting on climate activities mention some type of energy saving initiative such as adjusting thermostats and lighting, creating energy efficient buildings, and phasing out paper bills.

Telecommunication operators can reduce emissions by transitioning from legacy to newer technologies. For instance, a fourth generation (4G) mobile network is over four times more energy efficient per gigabyte (GB) than a 3G network and a 5G network seven times more efficient than 4G.[36] In 2020, Ericsson found that its 5G product portfolio was 6.6 times more energy efficient per data transferred than its 4G portfolio.[37] For fixed broadband, fibre-optic cable is more energy efficient than other technologies. A New Zealand study found that optical fibre generates on average 35 per cent less emissions than copper, 21 per cent less than hybrid coax fibre and over 90 per cent less than fixed wireless broadband.[38] Etisalat has deployed almost 11 million kilometres of fibre-optic cable, saving over three terawatt hours of energy per year and reducing GHG emissions by over 1.8 million tonnes.[39]

5G is enabling energy reductions per unit of data that are not possible with older generations of mobile technology. As a new greenfield technology, sharing 5G infrastructure from the start can save energy and reduce emissions. A joint 5G network developed between China Telecom and China Unicom saved electricity and reduced GHG emissions by six million tonnes in 2021, the equivalent of planting over three million trees.[40] Emissions from devices are also being cut; ZTE and China Unicom employed device power-saving solutions on 5G terminals and reduced power consumption by up to 20 per cent within 2 hours.[41] Innovation in 5G base station technology is also having an impact. In June 2020, Finnish telecommunication operator Elisa and network equipment manufacturer Nokia announced

[35] ISO 14064-1:2018 Greenhouse gases — Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals. https://www.iso.org/standard/66453.html

[36] https://groenlinks.nl/sites/groenlinks/files/2021-09/CE_Delft_210166_Carbon_footprint_unwanted_data-use_smartphones.pdf

[37] Ericsson. 2021. Sustainability and Corporate Responsibility Report 2020.

[38] https://enable.net.nz/assets/Misc/FINAL-REPORT_Broadband-emissions-footprint-Final-report-Nov-25-1.pdf

[39] Etisalat. 2021. Sustainability Report 2020.

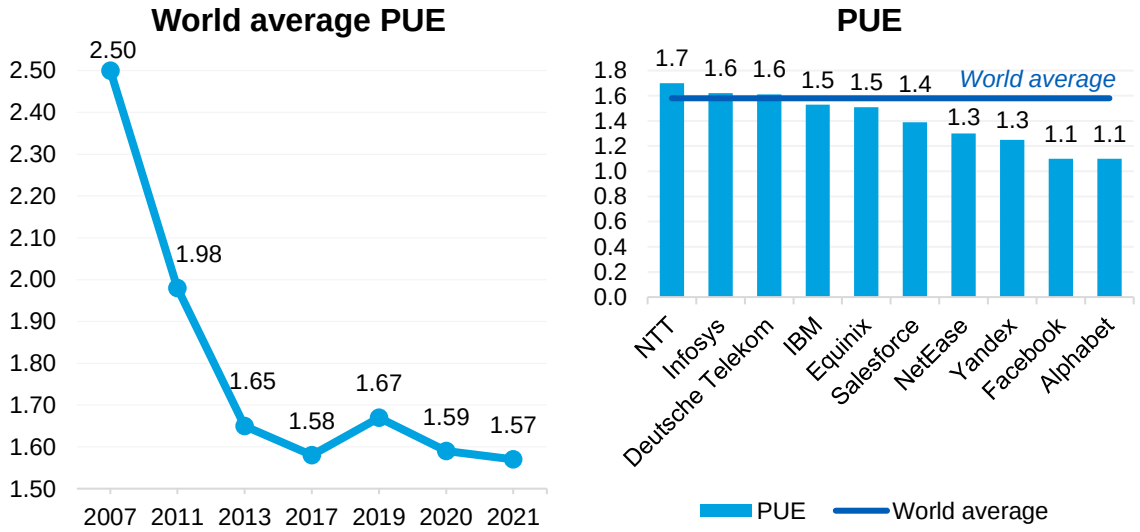
[40] Joseph Waring. 2022. "China Unicom chief pegs joint 5G capex savings at $33B." Mobile World Live, 31 March. https://www.mobileworldlive.com/asia/asia-news/china-unicom-chief-pegs-joint-5g-capex-savings-at-33b

[41] ZTE and China Unicom complete China's first comprehensive power saving function verification for 5G terminal. ZTE News, 4 January 2021. https://www.zte.com.cn/global/about/news/20210104e1.html

the world's first 5G liquid-cooled base station and cut emissions by around 80 per cent.[42] Apart from greater energy efficiency than previous mobile technologies, the very low latency, fast speeds and high reliability of 5G networks can potentially help avoid hundreds of millions of tonnes of GHG emissions through real-time remote monitoring of electricity and transportation networks.[43N] However, independent of how efficient a newer generation is in comparison with an older one, 5G will increase overall energy consumption if it is added on top of existing equipment. Hence, an important step for sustainable network development is the decommissioning of older systems (also outlined in Recommendation ITU-T L.1470[44]).

Data centres consume significant amounts of electricity to power servers and keep them cool. Companies operating data centres have taken various steps to reduce temperatures such as evaporative and liquid cooling and even locating centres in countries with colder climates. However evidence suggests that energy efficiency can only go so far in older data centres. Power usage effectiveness (PUE) is used to measure the energy efficiency of a data centre. PUE is the ratio of the total energy used by a data centre to the energy delivered to the equipment. A PUE value near 1.0 would indicate high energy efficiency. Uptime Institute, an organization that certifies data centres, finds that reductions in PUE have slowed with the global average standing at 1.57 in 2021 (Figure 3.2, left).[45] Just as with telecommunication infrastructure, deploying greenfield data centres with the latest energy efficiency features built in may be the only way to achieve significant PUE reductions. Size of the data centre also has an impact with hyperscale data centres operated by companies such as Alphabet and Facebook having low PUEs (Figure 3.2, right). At the same time, PUE and energy efficiency needs to be balanced towards embodied emissions to identify the best way forward.

Figure 3.2: PUEs



Source: Uptime Institute and company reports.

[42] Nokia and Elisa see sustainability leap in world-first 5G liquid cooling deployment. Nokia Press Release, 3 June 2020. https://www.nokia.com/about-us/news/releases/2020/06/03/nokia-and-elisa-see-sustainability-leap-in-world-first-5g-liquid-cooling-deployment/

[43] Qualcomm. n.d. Environmental sustainability and a greener economy: The transformative role of 5G. https://www.qualcomm.com/media/documents/files/5g-and-sustainability-report.pdf

[44] ITU. 2020. Recommendation ITU-T L.1470. Greenhouse gas emissions trajectories for the information and communication technology sector compatible with the UNFCCC Paris Agreement https://www.itu.int/rec/T-REC-L.1470

[45] Uptime Institute. 2021. Global Data Center Survey 2021. https://uptimeinstitute.com/2021-data-center-industry-survey-results

International standards also offer a wide range of guidance and solutions for boosting energy efficiency of ICT operations. ITU standards are providing methodologies to assess the energy efficiency level of data centres, telecommunication sites[46], equipment[47], networks[48], and base stations[49]. The ITU standard Recommendation ITU-T L.1371 also provides a methodology for assessing and scoring the sustainability performance of building in 10 key areas: energy; water; air; comfort; health and wellness; purchasing; custodial; waste; site; and stakeholders.[50] It provides a set of concrete and measurable steps that building managers can follow to reduce the environmental impacts, specifically GHG emissions, of existing buildings.

Box 3.1: Green bonds

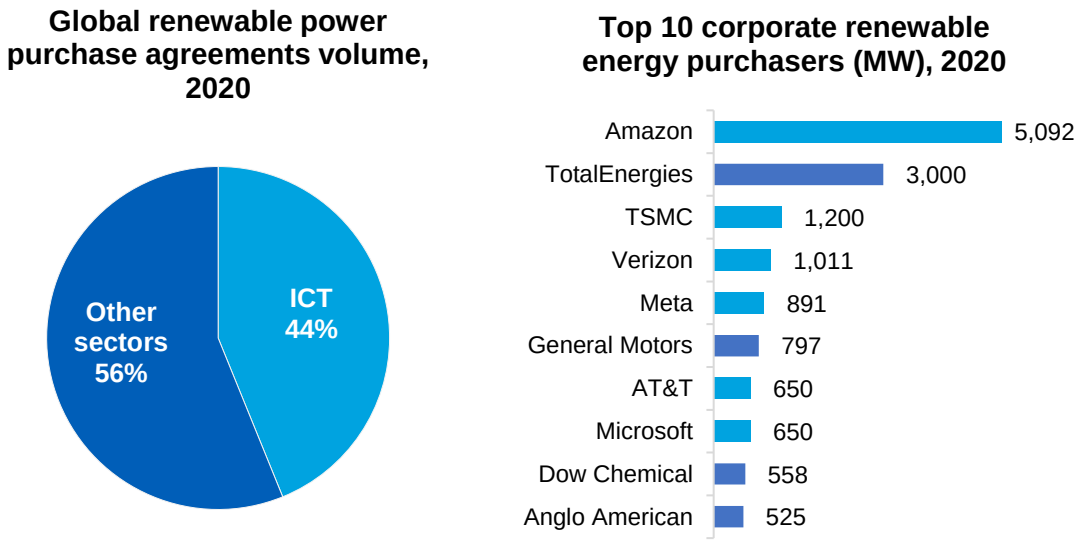
Green bonds are growing in popularity among investors desiring to support environmentally sound projects. These bonds provide a low interest rate tied to the company meeting environmental targets such as greater energy efficiency and higher use of renewables. Proceeds from the bonds are often used to accomplish these targets. A growing number of digital companies are issuing green bonds. For instance Singtel has created a Sustainability-Linked Bond Framework and in April 2021 issued a green bond for SGD 750 million, at the time, the largest ever Singapore-dollar denominated sustainability-linked loan.[51] Data centre operator Digital Reality Trust has been issuing green bonds since 2015. In January 2021, it issued a green bond for EUR 451 million for projects receiving LEED or BREEAM sustainable rating standards as well as for various energy efficiency projects.[52] Apple has issued three Green Bonds since 2016 totalling USD 4.7 billion for low-carbon manufacturing and recycling technologies, renewable power projects, carbon removal and supporting suppliers to decarbonize.[53]

3.3 Renewable energy

Using renewable energy is the most important step to reduce GHG emissions and eventually eliminate them. Digital companies are leaders in green energy procurement as well as innovative initiatives for tools and mechanisms to drive renewable energy markets. The ICT sector accounted for about half of global corporate renewable energy procurement in 2020. Amazon is the world's largest corporate purchaser of renewable energy and one of six digital companies among the top ten corporate renewable energy purchasers in 2020 (Figure 3.3).

[46] ITU. 2015. Recommendation ITU-T L.1302. Assessment of energy efficiency on infrastructure in data centres and telecom centres. https://www.itu.int/ITU-T/recommendations/rec.aspx?rec=12630
[47] ITU. 2020. Recommendation ITU-T L.1310. Energy efficiency metrics and measurement methods for telecommunication equipment. https://www.itu.int/ITU-T/recommendations/rec.aspx?rec=14302
[48] ITU. 2015. Recommendation ITU-T L.1330. Energy efficiency measurement and metrics for telecommunication networks. https://www.itu.int/ITU-T/recommendations/rec.aspx?rec=12430
[49] ITU. 2016. Recommendation ITU-T L.1350. Energy efficiency metrics of a base station site. https://www.itu.int/ITU-T/recommendations/rec.aspx?rec=12883
[50] ITU. 2020. Recommendation ITU-T L.1371. A methodology for assessing and scoring the sustainability performance of office buildings. https://www.itu.int/ITU-T/recommendations/rec.aspx?rec=14304
[51] See "Sustainability-Linked Bond Framework" at: https://www.singtel.com/about-us/investor-relations/debt-investors/sustainability-linked-bond-framework
[52] See "Green Bonds" at: https://www.digitalrealty.com/about/sustainability/green-bond
[53] Apple. 2022. Annual Green Bond Impact Report. https://s2.q4cdn.com/470004039/files/doc_downloads/additional_reports/2022/Apple_GreenBond_Report.pdf

Figure 3.3: Global renewable power purchase agreements volumes by sector and top ten corporate purchasers of renewable energy, 2020



Source: IEA and BloombergNEF.

Companies use a number of tools for contracting renewable energy. Power purchase agreements (PPAs) are used to acquire energy from renewable energy companies generally at a fixed price and period. Another option is a renewable energy certificate (REC) equivalent to 1 MWh and used when companies cannot get the renewable electricity they pay for because it is not available on the grid they are using. A REC certifies that the purchased renewables are being injected into an electricity grid. That way, instead of using the average grid factor for determining their emissions (i.e., scope 2 location-based), companies can report zero emissions with a REC (i.e., scope 2 market-based).

However, it is important to note that there are still a number of markets with restrictions on the supply and procurement of renewable energy. According to the World Bank, progress in developing renewable energy policies has slowed and by 2019, only a third of countries around the world had developed legal frameworks for renewable energy and regulatory policies.[54]

[54] Energy Sector Management Assistance Program (ESMAP). 2020. Regulatory Indicators for Sustainable Energy (RISE) Sustaining the Momentum. Washington, DC: World Bank. https://rise.esmap.org/data/files/reports/rise-renewableenergy.pdf

Box 3.2: Ørsted and digital companies

Danish company Ørsted is one of the world's largest providers of renewable energy with offshore and onshore wind and solar farms, energy storage facilities, renewable hydrogen and green fuels facilities, and bioenergy plants. The multinational is not only the biggest energy provider in Denmark but also the world's largest developer of offshore wind power. Ørsted projects are a popular source of renewable energy for power purchases from ICT companies. The company ranked first out of 50 energy companies assessed in the 2021 WBA Electric Utilities Benchmark.[55]

Ørsted renewable power purchase agreements with digital companies

Company	Project location	Amount of energy purchased (MW)	Type of renewable	Remarks
Amazon	Europe	16	Wind	Long-term power purchase agreement announced in January 2022.
Meta	North America	175	Wind	Announced in December 2021.
Alphabet	North Sea	50	Wind	The 12-year contract was announced in November 2021.
Amazon	North Sea	250 + 100	Wind	The 10-year contract is Europe's largest offshore wind corporate power purchase agreement. The first 250 MW was announced in October 2020 and amended 100 MW volume announced in December 2021.
Microsoft	Texas	Not publicly disclosed	Solar	Announced in October 2021, power is from a solar farm in Texas.
Meta	Europe	29	Wind	Long-term power purchase agreement announced in August 2020.
TSMC	Changhua County	920	Wind	The 20-year contract is one of the world's largest renewable corporate power purchase agreements. Announced in July 2020.
Amazon	North America	228	Wind	Announced in October 2016.
Meta	Europe	Long-term supply deal for 100 per cent of Meta's consumption. MW is not publicly disclosed	Wind	Long-term supply deal announced in 2016, which provides 100% renewable wind energy for Meta's international headquarters in Dublin and its data centre in Clonee, Co Meath.
Iron Mountain	North America	25	Wind	Announced in October 2016.

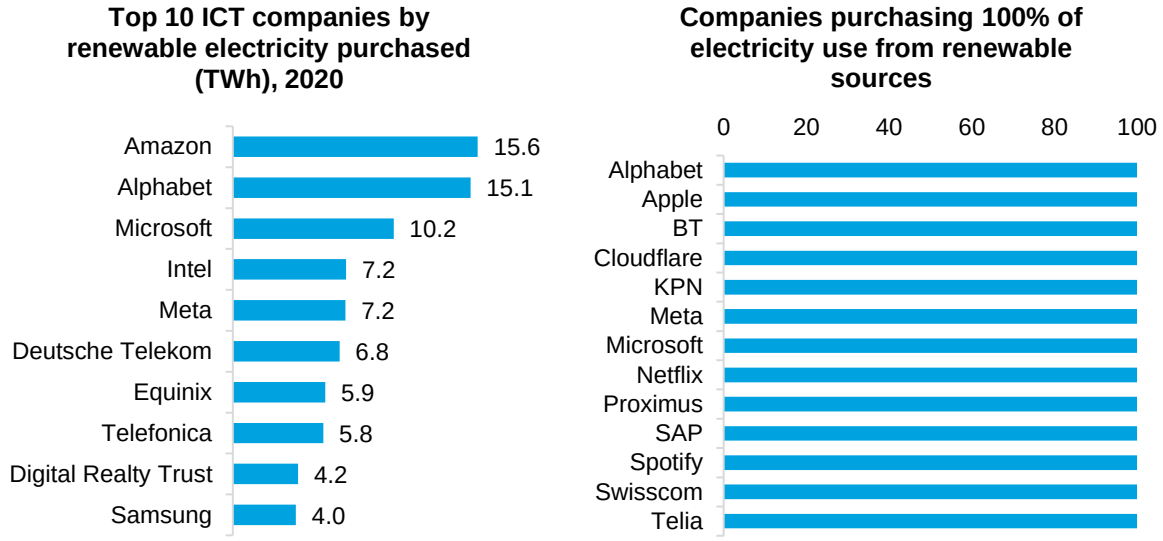
Source: Ørsted press releases, Available from: https://orsted.com/en/media/newsroom/news

The digital companies in the benchmark contracted a total of 115 TWh of renewable electricity in 2020 or 28 per cent of their total consumption. The figure rises to 34 per cent if companies from China are not counted. Companies in the benchmark from China have extremely low proportions of renewable energy but consume almost a quarter of the electricity among the group. Of the total renewable energy used, 10 companies account for 71 per cent of the total (Figure 3.4, left). Thirteen companies purchased 100 per cent of their electricity needs from renewable sources (Figure 3.4, right). Commitments to 100 per cent renewable energy have been made by a number of digital companies.

[55] https://electricutilities.worldbenchmarkingalliance.org/companies/orsted

Over thirty are members of RE100, a corporate group committed to 100 per cent renewable energy use;[56] of those, ten have already met the target while another 21 have committed to a 2030 target.

Figure 3.4: Top ten ICT companies by amount of renewable electricity used and ICT companies purchasing 100% renewable electricity, 2020

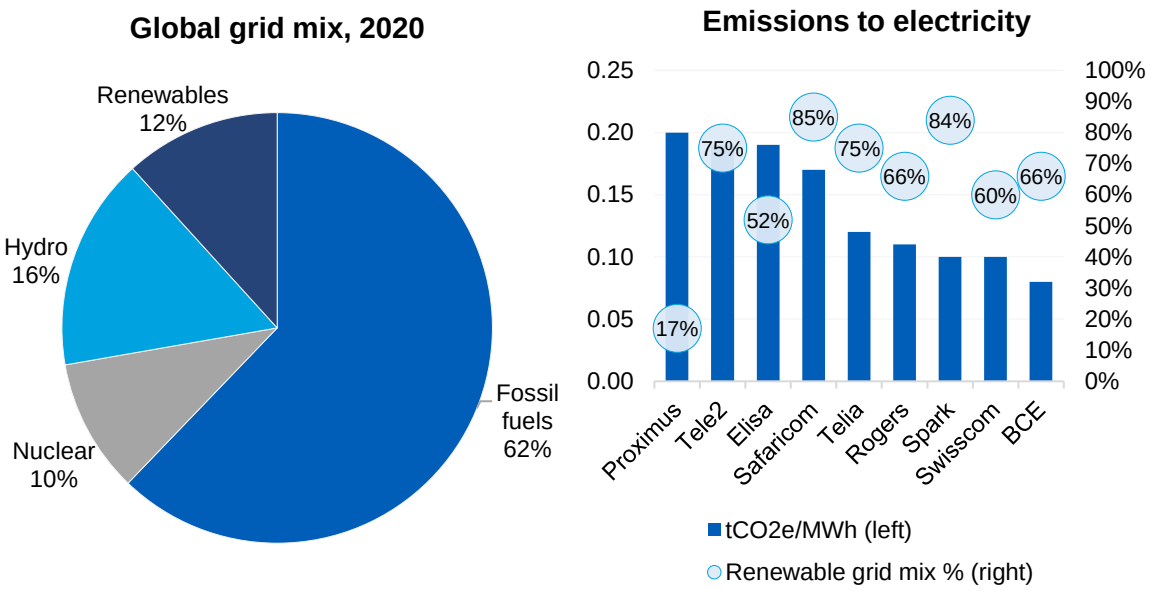


Source: Digital Inclusion Benchmark 2021.

Digital companies face the challenge that although they pay for renewables, they are not always getting green energy from the grid. In 2020, the global grid mix stood at 12 per cent renewable (as well as 16 per cent hydro and 10 per cent nuclear which emit no or low emissions) (Figure 3.5, left). Digital companies with the lowest ratio of emissions to electricity consumption predominantly operate in one market and where the grid has a large share of renewables or nuclear energy (Figure 3.4, left). Canadian companies BCE and Rogers have low emissions to electricity since hydro accounts for around 60 per cent of the grid mix; Proximus with headquarters in Belgium has relatively low emissions to electricity since nuclear accounts for over half the grid composition. Companies whose operations are primarily carried out in Finland, Kenya, New Zealand, Sweden and Switzerland also have relatively low electricity emissions due to the high level of renewables (and in some cases, nuclear) in the grid.

[56] https://www.there100.org/re100-members

Figure 3.5: Energy source of electrical grids, world average, and lowest GHG emissions to electricity among digital companies, 2020

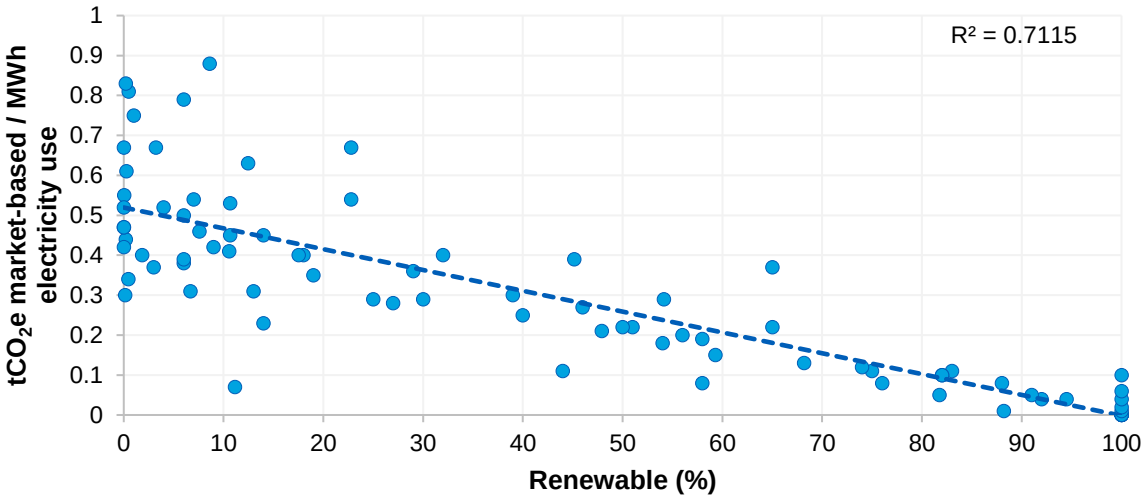


Note: The right chart refers to market-based scope 2 emissions.
Source: bp Statistical Review of World Energy and Digital Inclusion Benchmark 2021.

Scope 2 market-based emissions were introduced to account for the fact that even though companies pay for renewable electricity it is not always available to them on the grid. Renewable energy certificates (RECs) are used by companies to report lower grid emissions factors. As the renewables replace electricity that otherwise would have been generated elsewhere by fossil fuels, scope 2 emissions are reduced. Companies that have procured high amounts of renewables relative to their electricity consumption have lower scope 2 emissions. Despite the GHG Protocol recognizing market-based scope 2 reporting, some argue that it should not be used claiming it does not increase the amount of renewable electricity generation.[57] Whether current market-based solutions support the transition to renewables or not, these are key to decarbonizing the ICT sector as the majority of its emissions are associated with the use of electricity.

[57] Matthew Brander, Michael Gillenwater, Francisco Ascui2018. Creative accounting: A critical perspective on the market-based method for reporting purchased electricity (scope 2) emissions. Energy Policy. https://www.sciencedirect.com/science/article/pii/S0301421517306213?via%3Dihub

Figure 3.6: Relationship between market-based scope 2 emissions and renewable electricity use



Note: Each circle represents a company.

Four digital companies report zero scope 2 emissions using the market-based approach (Apple, Cloudflare, KPN and Swisscom). Companies will never be able to eliminate their location-based emissions from electricity unless the grid is 100 per cent renewable or all company sites are directly powered by renewables without going through the grid (but even then there are still the embodied emissions of the electricity supply (accounted for as scope 3). Apple is notable for its direct procurement of renewable energy for several of its sites. The company headquarters in California is operated using 100 per cent renewable energy. One of Apple's largest data centres is in Arizona where despite the sunny climate, the grid mix is only 5 per cent renewable. Apple uses an onsite solar plant for continuous renewable power generating 227 MWh a year and avoiding 107 000 tCO_2e.

The inability to get 100 per cent renewable energy from the grid is a major barrier to reducing GHG emissions for most digital companies. Google has been a pioneer in trying to solve this problem. While it procures 100 per cent renewable electricity for its operations, it finds that only 67 per cent was delivered to its data centres on an hourly basis in 2020. The company is committed to achieving 24/7 carbon free energy, where every kWh of power consumption is matched by carbon-free electricity production on the grid where the electricity is consumed.[58] Both Google and Ørsted are founding members of the 24/7 Carbon-Free Energy Compact[59], an initiative coordinated by Sustainable Energy for All and the United Nations. Google and Microsoft target using zero-carbon electricity on a 24/7 basis by 2030. Artificial intelligence and other digital technologies can help achieve this goal by shifting intensive computing tasks to times and regions for which low-carbon sources are plentiful. Baseload renewable power (e.g., biomass or geothermal) and storage is also required. If renewable electricity can be made available 24/7 on the grid, it will be a climate change milestone, resulting in dramatic emissions reductions not only for digital companies but the whole world.

3.4 Supply chain

Supply chains account for a notable portion of the emissions footprint for some companies. Supply chain emissions are accounted for in the GHG Protocol under scope 3 (Category 1: Purchased goods and services). Of the digital companies reporting their purchased goods and services emissions, the top 15 by the amount of such emissions are shown in Table 4.1. Among these 15 companies,

[58] Google. 2018. Moving toward 24x7 Carbon-Free Energy at Google Data Centers: Progress and Insights. https://www.gstatic.com/gumdrop/sustainability/24x7-carbon-free-energy-data-centers.pdf
[59] https://gocarbonfree247.com/

purchased goods and services account for 25 per cent of scope 3 emissions and 23 per cent of their emissions footprint (i.e., scope 1, 2 and 3). Apple and HP are notable with their supply chain accounting for 71 per cent and 59 per cent of their footprint.

Table 3.1: Highest reported supply chain emissions by company, 2020*

	Company	Industry	Scope 3			
				Category 1: Purchased goods and services		
			Total (tCO_2e)	Total (tCO_2e)	Share of total Scope 3	Share of total footprint
1	HP	Hardware	44.7	26.4	59%	59%
2	Apple	Hardware	22.6	16.1	71%	71%
3	Samsung	Hardware	65.6	8.0	12%	10%
4	NTT	Telecom services	22.2	6.2	28%	23%
5	Cisco	Hardware	24.9	5.4	22%	22%
6	Intel	Hardware	29.9	4.5	15%	14%
7	Microsoft	IT services	11.2	4.1	36%	35%
8	Vodafone	Telecom services	9.4	4.0	43%	37%
9	Sony	Hardware	17.1	3.8	22%	21%
10	Dell	Hardware	15.1	3.8	25%	24%
11	Deutsche Telekom	Telecom services	13.9	3.6	26%	22%
12	Nokia	Hardware	35.6	2.5	7%	7%
13	Lenovo	Hardware	20.0	2.3	11%	11%
14	Ericsson	Hardware	36.6	2.3	6%	6%
15	AMD	Hardware	5.6	1.3	23%	23%
	Total		**374**	**94**	**25%**	**23%**

* Includes only digital companies that have reported scope 3, category 1; there are likely other companies that have large supply chain emissions but did not disclose them. In addition, some are suppliers to other digital companies and some of the purchased goods and services emissions shown here would be captured in scope 1 and scope 2 emissions of other digital companies.

Given that supply chains make up a large portion of overall emissions for some digital companies, it is critical that these emissions be reduced. The CDP supply chain project provides support for members to request their suppliers to report environmental data through CDP in order to more accurately account for their scope 3, Category 1 emissions.[60] Cisco has been asking its suppliers to report to the CDP since 2009 in order to enhance the accuracy of its scope 3 calculations.[61] Samsung Electronics asks key suppliers to disclose through CDP and received responses from 163 suppliers, with a response rate at 71 per cent.[62] They also provide incentives to suppliers to participate in CDP disclosure and set carbon reduction targets, as well as operating education seminars with CDP.

BT, Ericsson and Telia are among the founders of the 1.5C Supply Chain Leaders initiative that takes a collaborative approach to suppress supply chain emissions.[63] This initiative is also closely related to the SME Climate Hub, which aims to support SMEs with emissions disclosure and target setting.

The Supplier Clean Energy Program was launched by Apple in 2015 to encourage its supply chain to move to renewable energy. In 2020, over 100 suppliers had introduced four GWh of renewable energy, contributing to the Apple target of carbon neutrality in its supply chain by 2030.[64] Nokia has supply chain targets as part of its 1.5°C climate commitment. It has agreed with key final assembly suppliers that they should achieve net zero emissions by 2030 for the portion of their manufacturing

[60] https://www.cdp.net/en/research/global-reports/engaging-the-chain
[61] https://www.cisco.com/c/dam/en_us/about/supplier/cisco-cdp-supplier-reference-deck.pdf
[62] https://www.cdp.net/en/research/global-reports/transparency-to-transformation
[63] https://smeclimatehub.org/supply-chain-leaders/
[64] See "Supplier Clean Energy 2021 Program Update" at:
https://www.apple.com/environment/pdf/Apple_Supplier_Clean_Energy_Program_Update_2021.pdf

allocated to Nokia.[65] Similarly, Ericsson joined the 1.5°C Supply Chain Leaders initiative and the Race to Zero 'SME Climate Hub' to support companies across its global SME supply chain. By 2025, Ericsson suppliers responsible for 90 per cent of the company supply chain carbon emissions will have a 1.5°C target.[66]

Some companies have established targets for reducing their supply chain emissions. Both Apple and Microsoft aim for carbon neutrality across their entire footprint, including supply chain, by 2030. The Science Based Targets initiative calls for companies to establish scope 3 targets when they exceed 40 per cent of their emissions footprint.[67] HP has committed to reducing emissions among first-tier production and product transportation suppliers 10 per cent by 2025 (emissions per million USD revenue, 2015 base year). Vodafone commits to reduce its total scope 3 GHG emissions 50 per cent by 2030 from a 2020 base year.

Some companies are ambitious about reducing their supply chain emissions, and there is scope for others to follow. More digital companies need to calculate their supply chain emissions, which is essential to have a more complete understanding of their total GHG footprint. Identification of supply chain relationships and emissions flows among the benchmarked digital companies would also be very useful. Double counting would be avoided and a more accurate picture of the total ICT sector footprint could be calculated.

The CDP Supply Chain module asks suppliers to breakout their missionns by customer. However, participation among digital companies is incomplete and thousands of small suppliers do not participate. Moreover, such allocation is always model-based which brings an uncertainty. The most important step would be accurate scope 1 and 2 reporting by all companies as scope 3 would always be model-based rather than measured both for purchased goods and services and use of sold products.[68] .

3.5 Offsets and carbon neutrality

Compensating unavoidable emissions through voluntary offsets are recognized under the GHG Protocol – however this is considered separate from the company footprint. A number of digital companies are deploying offsets to compensate for their emissions.[69] This step is usually taken after they have addressed all other steps deemed feasible at a certain point in time to eliminate emissions, including procuring 100 per cent renewable electricity. Many of the offset projects are in developing countries (see section 4.4).

By the end of 2020, sixteen digital companies reported being carbon neutral including 11 in 2020 alone (Table 3.2). Most purchase their electricity from renewable sources allowing them to report much lower emissions and two companies have zero scope 2 emissions using the market-based calculation. Offsets are used by the others by investing in forest conservation or clean energy projects often in developing countries. Some 9.6 million tonnes of GHG were offset by these 16 companies in 2020 with Alphabet and Telstra accounting for over 80 per cent.

Methods used to calculate emissions that need to be offset are not always comparable among the carbon neutral companies. For instance, half offset only their market-based operational emissions.

[65] See "Supply chain" at: https://www.nokia.com/about-us/sustainability/climate/#supply-chain
[66] Ericsson. 2020. Ericsson partners to drive a net-zero supply chain. https://www.ericsson.com/en/news/2020/9/ericsson-partners-in-1.5c-supply-chain-drive
[67] See "SBTi Criteria and Recommendations" at: https://sciencebasedtargets.org/resources/files/SBTi-criteria.pdf
[68] These complexities are further described in Recommendation ITU-T L.1410. Methodology for environmental life cycle assessments of information and communication technology goods, networks and services at: https://www.itu.int/rec/T-REC-L.1410
[69] Google. 2011. Google's Carbon Offsets: Collaboration and Due Diligence. https://static.googleusercontent.com/media/www.google.com/en//green/pdfs/google-carbon-offsets.pdf

Unlike the others, Alphabet offsets its location-based scope 2 emissions rather than the smaller market-based figure as well as business travel and employee commuting and teleworking in scope 3. Guidance is needed to refine the term "carbon neutrality" by specifying whether it includes only offsetting market-based scope 1 and 2 emissions or also should include parts of scope 3. Greater clarity is also needed about the offsets used. Only a few of the companies clearly list the various projects and emissions offset per project; none report the amount paid for the offset.[70] There is a need for a global registry listing all offsets including the company investing in them to enhance transparency. It is also essential to ensure the additionality principle so that any credit is only counted once. Given the essentialness of environmental data to verify carbon neutrality, company emissions disclosure should include external assurance and the verification statement according to the GHG Protocol.[71] For instance, IT software and service company Infosys has its carbon neutrality assured by KPMG[72] according to the UK PAS 2060 carbon neutrality standard.[73] Telstra carbon neutrality is verified by the Australia Government.[74] Most of the other companies provide some level of independent assurance about their emissions but for several stating a claim of carbon neutrality is difficult to assess.

Table 3.2: Digital companies reporting carbon neutrality, 2020

	Company	Year became carbon neutral	Total offset in 2020 tCO_2e	Statement
1	Alphabet	2007	6 116 789	"...in 2007, we were the first major company to be carbon neutral in our operations."
2	Apple	2020	47 430	"Apple is carbon neutral for corporate emissions as of April 2020."
3	Booking Holdings	2020	55 923	"In 2020, Booking Holdings achieved ... becoming carbon neutral."
4	Cloudflare	2020	0	"Cloudflare's… emissions are zero for 2020"
5	Elisa	2020	5 770	"Elisa become carbon neutral in 2020 as the first Nordic telco."
6	Facebook	2020	145 000	"Facebook's operations produce net zero emissions"
7	Infosys	2019	170 113	"We achieved Carbon Neutrality in fiscal 2020 [2019]…"
8	KPN	2015	0	"... we've been completely climate neutral since 2015."
9	Microsoft	2012	612 927	"... we at Microsoft have worked hard to be "carbon neutral" since 2012"
10	Proximus	2016	27 400	"Since 2016, we are CO_2 neutral for our own operations."
11	Salesforce	2020	85 000	"Net Zero company across its full value chain"
12	Spotify	2020	168 900	"Spotify is from 2020 committing to offsetting our total impact"
13	Swisscom	2020	39 107	"The remaining, unavoidable operational emissions ... completely offset"
14	Tele2	2020	11 036	"In April 2020, became first telco in the Nordics and Baltics to be climate neutral"
15	Telia	2020	13 000	"In 2020, became climate neutral within our own operations"
16	Telstra	2020	2 075 614	"We ... achieved carbon neutral certification for our operations"
	TOTAL		**9 574 009**	

Note: Total offset includes scope 1 and scope 2 (usually market based) and sometimes some categories in scope 3.

While certified offset projects result in a quantified reduction of emissions somewhere, lowering overall global emissions, they are subject to debate. Some argue that offsets reduce incentives for organizations to reduce their operational emissions at their source. Instead, according to SBTi, to truly be considered "net zero" a company should invest in matching carbon removal projects after reducing

[70] One is example is Microsoft which provides a number of attributes about its offset projects. See: Microsoft. 2021. Microsoft carbon removal: Lessons from an early corporate purchase. https://query.prod.cms.rt.microsoft.com/cms/api/am/binary/RE4MDlc

[71] World Business Council for Sustainable Development and World Resources Institute. 2004. A Corporate Accounting and Reporting Standard. p. 63. https://ghgprotocol.org/corporate-standard

[72] Infosys. 2021. "PAS2060 Qualifying Explanatory Statement." https://www.infosys.com/global-resource/18/carbon-neutrality-declaration.pdf

[73] https://www.bsigroup.com/en-GB/pas-2060-carbon-neutrality/

[74] Australian Government Climate Active. 2021. Public Disclosure Statement: Telstra Corporation Limited. https://www.climateactive.org.au/sites/default/files/2021-05/Telstra_Initial%20Certification_CY2020_PDS_True%20up.pdf

all emissions, leaving only a limited residual share technically unfeasible to suppress.[75] Several digital companies have announced a shift from offsets to carbon removal and are making huge investments in natural and industrial carbon removal projects (see section 5.3).

3.6 Targets

To limit the worst impacts of climate change, the increase in temperature from global warming needs to be well below 2.0°C above pre-industrial levels with global efforts aimed at limiting the temperature increase to 1.5°C. GHG emissions need to be halved by 2030 (compared to 2020), another 50 per cent by 2040 and net zero emissions achieved by 2050 to reach the 1.5°C goal.

Targets provide a roadmap for emissions reductions over time. Among the digital companies, 86 have established some kind of emissions reduction target. Some are based on the Science Based Targets initiative (SBTi) which works with companies to establish targets consistent with limiting global warming of 1.5°C to 2°C and achieving net zero no later than 2050. ITU, GeSI, GSMA and SBTi have published a target-setting guideline for telecommunication operators and data centre operators.[76] In addition, ITU and the same partners have developed the international standard Recommendation ITU-T L.1470 to provide ICT companies with an emissions trajectory to reach the 1.5°C scenario set out in the Paris Agreement.[77] To further support the implementation of L.1470, two supplements were developed to provide guidance to decarbonize following a 1.5°C pathway, specifically to operators of mobile networks, fixed networks, and data centres (this document is equal to the SBTi guidance) as well as to manufacturers.[78,79] Moreover, ITU has developed net zero guidance specifically for ICT companies (Recommendation ITU-T L.1471) that builds on net zero approaches by initiatives such as the SBTi, the UNFCCC Race to Zero and others.[80] Note that some companies have targets that are not part of SBTi and are based on national policy or their own goals that can be more ambitious than SBTi.

Digital company targets vary widely in ambition, scope and measurement. Some companies go beyond SBTi by aiming to eliminate their entire footprint by 2030 while others plan to eradicate their operational emissions by 2030. Other companies are less ambitious with longer term targets. Intensity-based targets (e.g., emissions per revenue, emissions per data traffic, etc.) are used by some companies making forecasting their future impact impossible and possibly resulting in higher emissions. While SBTi calls for scope 3 targets to be established if they account for at least 40 per cent of a company's total footprint, not all have. Some that do, only target specific scope 3 categories rather than their entire upstream-downstream value chain.

Among the 41 companies with non-intensity targets and a 2030 or earlier target, it is forecast that operational emissions will drop at least by 60 per cent, from 46 million tCO_2e to 18 million by 2030.

[75] SBTi. 2021. SBTi Corporate Net-Zero Standard. https://sciencebasedtargets.org/resources/files/Net-Zero-Standard.pdf

[76] ITU, GeSI, GSMA and the Science Based Targets Initiative. 2020. Guidance for ICT companies setting science based targets. https://www.itu.int/en/action/environment-and-climate-change/Documents/20200227-Guidance-ICT-companies-report.PDF

[77] ITU. 2020. Recommendation ITU-T L.1470. Greenhouse gas emissions trajectories for the information and communication technology sector compatible with the UNFCCC Paris Agreement. https://www.itu.int/rec/T-REC-L.1470

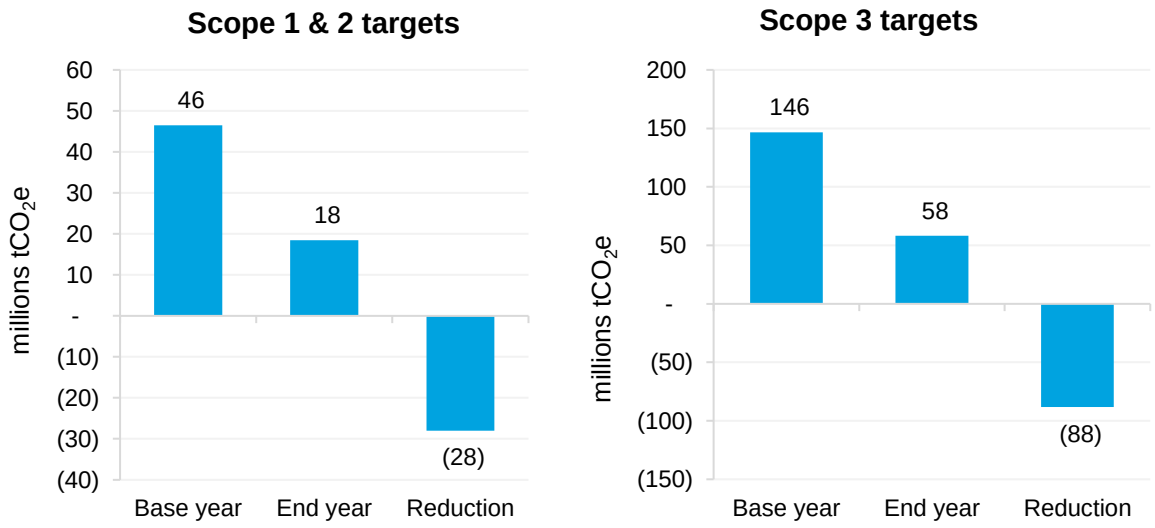
[78] ITU. 2020. Supplement ITU-T L Suppl. 37. Guidance to operators of mobile networks, fixed networks and data centres on setting 1.5°C aligned targets compliant with Recommendation ITU-T L.1470. https://www.itu.int/ITU-T/recommendations/rec.aspx?rec=14318

[79] ITU. 2020. Supplement ITU-T L Suppl. 38. Guidance for information and communication technology manufactures on setting 1.5°C aligned targets compliant with Recommendation ITU-T L.1470. https://www.itu.int/rec/T-REC-L.Sup38/_page.print

[80] ITU. 2021. Recommendation ITU-T L.1471. Guidance and criteria for information and communication technology organizations on setting Net Zero targets and strategies. https://www.itu.int/rec/T-REC-L.1471

Those with scope 3 targets for 2030 or earlier would see such emissions also drop by 60 per cent from 146 to 58 million.

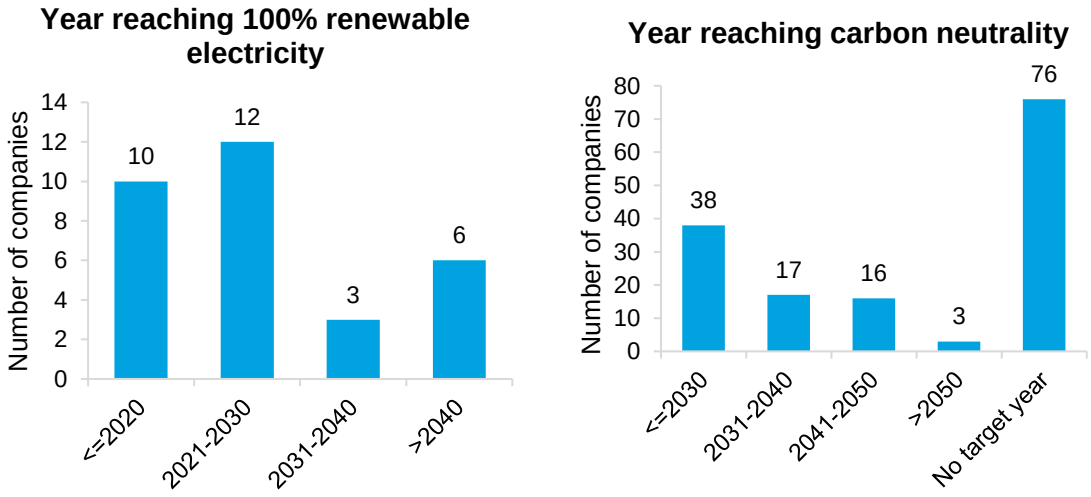
Figure 3.7: Measurable emissions target reductions by 2030, millions tCO_2e



Note: Only companies with non-intensity targets and where the end year is 2030 or earlier. Figures shown are the minimal reductions since companies with a target end year earlier than 2030 are likely to adopt new targets. Also companies with an end year after 2030 are also likely to begin making reductions in the period up to 2030.

In addition to carbon reduction targets, some companies have set dates by which they will be procuring 100 per cent renewable electricity. Of the 31 benchmarked digital companies that are members of RE100, 10 already purchased 100 per cent renewable electricity in 2020, with twelve more committing to achieve this by 2030. Six companies will only reach 100 per cent after 2040. There are 71 companies that have announced a year by which they expect to be carbon neutral. By 2030, 38 companies plan to be carbon neutral (including those that already were in 2020). Another 33 expect to reach carbon neutrality between 2031 and 2050, while three Chinese companies state it will not be until 2060, in line with national policy. The majority of companies have either not announced a target or a carbon neutrality year.

Figure 3.8: Number of companies by year of reaching 100 per cent renewable electricity and carbon neutrality



Note: The left chart refers only to the 31 ICT companies that are members of RE100.
Source: RE100 and Digital Inclusion Benchmark 2021.

4 Digital companies in low- and middle-income economies

This chapter looks at climate issues for digital companies in low- and middle-income economies. This includes 46 companies assessed with headquarters in a low- or middle-income economy (almost one third of the 150 companies, Table 4.1) as well as subsidiaries of companies in low- and middle-income countries with headquarters in high-income countries. Low- and middle-income countries differ from high-income countries in respect to the types of energy challenges they face, their capacity to deal with those challenges and government policies and strategies. Low- and middle-income countries are also used to offset emissions, and besides positive environmental impacts for middle-income countries, these offsets can also benefit local communities.

4.1 Companies with headquarters in middle-income economies

The 46 digital companies with headquarters in lower (15 companies) and upper (31 companies) middle income economies vary greatly in the availability and quality of their environmental data as well as their overall emissions impact data. A dozen mainly privately-held or government-owned companies do not disclose emissions data.[81] Just nine companies in middle-income countries verify emission data using third parties, none make a distinction between scope 2 location- and market-based emissions (suggesting a lack of renewable energy options) and most either do not report scope 3 emissions or report just some categories.

Table 4.1: Assessed companies headquartered in middle-income economies

Lower middle income	Upper middle income	
Bharti Airtel (India)	AIS (Thailand)	Meituan (China)
Globe (Philippines)	Alibaba (China)	Mercado Libre (Argentina)
Gojek (Indonesia)	América Móvil (Mexico)	MTN (South Africa)
HCL (India)	Ant (China)	MTS (Russian Federation)
Infosys (India)	Axiata (Malaysia)	Naspers (South Africa)
Jio (India)	Baidu (China)	NetEase (China)
Jumia (Nigeria)	ByteDance (China)	Pinduoduo (China)
Ola (India)	China Mobile (China)	Sina (China)
PLDT (Philippines)	China Satellite (China)	Telkom (South Africa)
Safaricom (Kenya)	China Telecom (China)	Tencent (China)
Sonatel (Senegal)	China Unicom (China)	Türk Telekom (Turkey)
Tata Communications (India)	Digicel (Jamaica)	Xiaomi (China)
Telecom Egypt (Egypt)	Huawei (China)	Yandex (Russian Federation)
Telkom Indonesia (Indonesia)	iFlytek (China)	Yunji (China)
Viettel (Viet Nam)	JD.com (China)	ZTE (China)
	MegaFon (Russian Federation)	

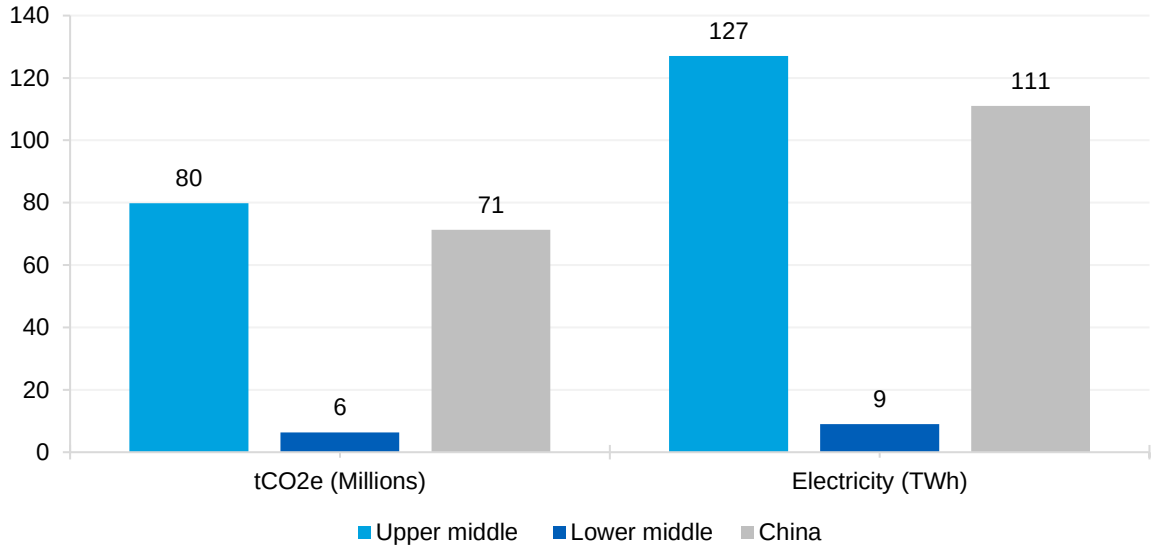
Note: Income classification based on World Bank Country and Lending Groups (https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups).

Companies based in China account for 41 per cent of companies in middle-income countries and have by far the highest operational emissions in this group of 46 companies at 82 per cent (Figure 4.1). The 15 companies with headquarters in lower-middle income countries account for just 7 per cent of emissions largely due to a lower level of ICT adoption.[82]

[81] Ant, ByteDance, China Satellite, IFlytek, Pinduoduo, Sina, Yunji (all China based), Digicel (Jamaica), Jumia (Nigeria), Ola (India), Telecom Egypt and Viettel (Viet Nam).

[82] Désiré Avom et. al. 2020. ICT and environmental quality in Sub-Saharan Africa: Effects and transmission channels. Technological Forecasting and Social Change. https://www.sciencedirect.com/science/article/abs/pii/S0040162519316257

Figure 4.1: Emissions and electricity use, digital companies with headquarters in middle-income countries, 2020



In respect to carbon reduction targets, only five companies commit to carbon neutrality before 2030, in addition to Infosys, which is carbon neutral. Six more have committed to carbon neutrality by 2050, while 32 have not established any date for reaching carbon neutrality. At the other extreme, of the 46 companies, the three majority state-owned Chinese telecommunication operators account for over 70 per cent of the operational emissions, follow government policy which aims to peak emissions as late as 2030 and reach carbon neutrality by 2060. In contrast, some of the other companies with headquarters in China have far more ambitious goals: Alibaba, Ant and Baidu aim to be carbon neutral by 2030. Eleven companies have committed to the Science Based Targets Initiative (SBTi) to set goals while three have established targets (América Móvil, Bharti Airtel and Infosys).

4.2 Green energy and electricity usage

Low- and middle-income countries face difficult energy environments compared to high-income countries. Electricity access is far from universal, and grids often use dirty energy for the bulk of the mix. For mobile operators, this has typically resulted in having to use diesel powered base stations in rural areas. Companies with headquarters in middle income countries have low rates of renewable electricity at just six per cent overall for the companies reporting this metric. However, the lack of electricity and dirty grid mixes provide an incentive to leapfrog into renewable energy, yet the ability to do so is largely determined by how the energy sector is regulated.

The MTN Group with headquarters in South Africa is a mobile operator with a portfolio in 22 countries in Africa and the Middle East. Most of the markets MTN operates in have enormous potential for sustainable growth and environmental conservation, despite facing challenges of land degradation, deforestation, biodiversity loss and vulnerability to climate change. MTN has set science-based targets to achieve a 47 per cent average reduction in operational emissions by 2030 (from a 2019 baseline) and has pledged to achieve net zero emissions by 2040. MTN also aims to have 1 330 rural sites powered by solar. MTN is a member of the GSMA Climate Action Taskforce which has a goal of moving mobile operators to zero emissions before 2050.[83] Approximately 80 per cent of the MTN carbon footprint comes from operations in South Africa, Nigeria, Ghana, Sudan, Cameroon and Iran. Energy sources in these countries are predominantly diesel, and national grids are mainly powered by fossil

[83] See "Climate Action Taskforce" at: https://www.gsma.com/betterfuture/climate-action/climate-action-taskforce

fuel sources. The MTN Project Zero initiative includes energy management solutions, monitoring, measurements and focuses on carbon emission reduction.[84]

Unlike many middle-income countries, Kenya is fortunate in its energy mix with hydro, geothermal, solar and wind playing a significant role in power generation. As a result, Kenya's largest telecommunication operator, Safaricom, reports using 90 per cent renewable electricity in 2020, the highest of any company with headquarters in middle-income economies. Nevertheless, Safaricom faces the challenge of powering its base stations in off-grid rural areas and also faces power outages for those on the grid. Because of this, Safaricom has almost as much scope 1 emissions related to fuel usage for energy as scope 2 electricity emissions. In order to meet its SBTi goal of reducing operational emissions 43 per cent by 2030 (from a 2017 starting point), Safaricom is putting emphasis on renewables and energy efficiency. As of 2020, 97 per cent of its sites were either on the grid or powered by renewable energy. The company is converting backup power from diesel to deep cycle batteries for use during outages. Safaricom also invests in emissions reductions offsets for reforestation projects in Kenya benefitting many local communities.

Companies with headquarters in high-income countries but with substantial subsidiaries in middle-income countries are also working to increase renewable energy options. Orange Middle East and Africa (OMEA) subsidiaries have several renewable energy production programmes being rolled out in the 18 countries where they operate. many sites are not connected to the electricity grid, and when they are, the quality of the grid requires alternative back-up solutions such as generators consuming fossil fuels. To reduce GHG emissions, OMEA is equipping telecommunication sites with photovoltaic solar panels and 5 400 base stations were equipped as of 2021.[85] In addition, Orange joined forces with Engie, an independent renewable energy provider in west Africa, to convert their main data centre, located in the Côte d'Ivoire, to solar power. Upon completion the project will supply the data centre with 527 MWh/year of clean energy, supporting Côte d'Ivoire Government plans to use renewables for at least 4 per cent of the energy mix by 2030.[86] Sonatel, an Orange subsidiary in Senegal, has also established renewable energy sector policies and instruments including tax-based mechanisms, producer frameworks, and national financing schemes (Box 4.1).

Telenor, a telecommunication operator in Norway, has subsidiaries in four middle-income countries in Asia: Bangladesh, Malaysia, Pakistan and Thailand. The company is transitioning diesel-powered mobile base stations to solar renewable energy, in line with its goal of a 50 per cent reduction in carbon emissions for subsidiary operations by 2030. The company has already invested in more than 3 000 solar-based base stations and anticipates spending around USD 100 million converting diesel to solar to reach its goal.

Box 4.1: Sonatel and renewable energy

Access to energy in Senegal poses a challenge. Much of the population does not have access to electricity (35 per cent), while those on the grid are using electricity that is mostly powered by oil and coal (90 per cent).[87] In May 2020, the Government of Senegal granted a VAT exemption for 22

[84] See "Project Zero" at: https://mtn-investor.com/mtn-road-to-zero/project-zero.php

[85] Orange. 2021. Alioune Ndiaye: 5,400 telecom sites are already equipped with solar panels in MEA. News, 17 June. https://www.orange.com/en/newsroom/news/2021/alioune-ndiaye-5400-telecom-sites-are-already-equipped-solar-panels-mea

[86] Orange and Engie Join Forces to Convert the GOS, Orange's Main Data Center in Africa, to Solar Power, Helping to Reduce the Carbon Footprint in Côte d'Ivoire. News, 17 January 2022. https://orange.africa-newsroom.com/press/orange-and-engie-join-forces-to-convert-the-gos-oranges-main-data-center-in-africa-to-solar-power-helping-to-reduce-the-carbon-footprint-in-cote-divoire?lang=en

[87] https://www.iea.org/countries/senegal

different renewable energy products.[88] The move was driven by the goal of facilitating access to energy, particularly in rural areas.

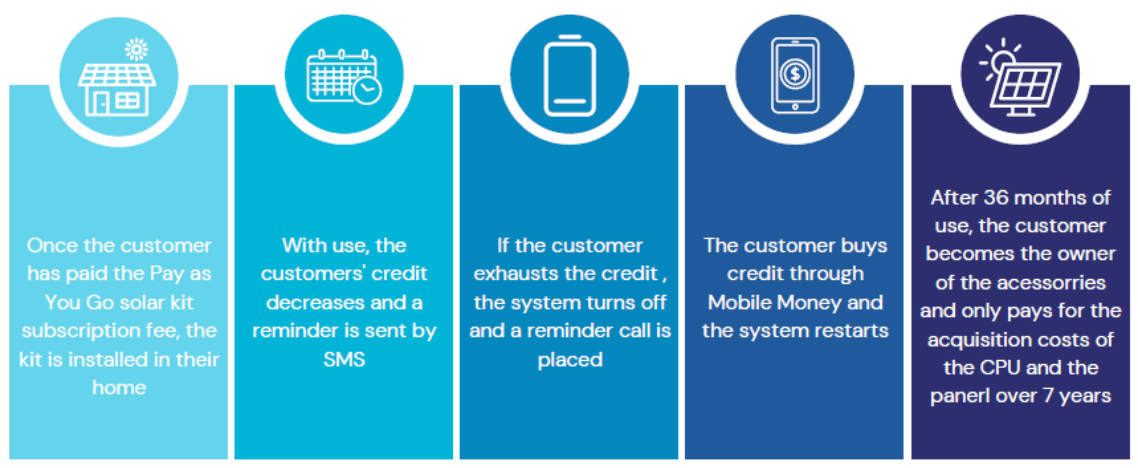
Sonatel (a member of the Orange Group) has subsidiaries in Mali, Guinea, Guinea Bissau and Sierra Leone. It is the only telecommunication company with headquarters in a least developed country (LDC) from those assessed (some of other companies assessed have subsidiaries in other LDCs).

Optimizing electricity consumption is becoming an increasingly important issue for Sonatel. ISO 50001[89] certification was established based on energy efficiency and the management of a sound energy policy. A data centre in Rufisque was opened to boost local IT infrastructure and labelled by the company as a crucial asset for the Senegal Governmental plans to become an African digital hub by 2025. The data centre reduces consumption by using modular equipment to adapt to demand. As part of its policy to reduce GHGs and energy-related costs, the company is planning to install solar panels at its headquarters.

Sonatel also deploys solar energy solutions to provide power to sites in off-grid areas. The use of solar energy for the power supply of base stations in rural areas has reduced CO_2 emissions with 721 sites, or almost a third of the total using solar. Twenty-eight sites are hybrid solar/on-grid reducing dependence on the national energy company.

In August 2018, Sonatel launched pay-as-you-go (PAYG) solar kits to off-grid rural households and small shops in Senegal. Users receive a loan to purchase a solar panel and use mobile money to make small daily payments. If they do not pay, the panel is automatically disabled over the mobile network. Not only does the PAYG model widen green energy access, it also reduces product-use emissions to zero.

Figure 4.2: Pay as You Go system



Adapted from: Sonatel 2019 Corporate Social Responsibility Report.

4.3 Data centres

Data demand is growing rapidly in emerging economies requiring new data centres, especially in Africa and parts of Asia. As of 2021, Africa accounted for less than 1 per cent of global colocation data centre

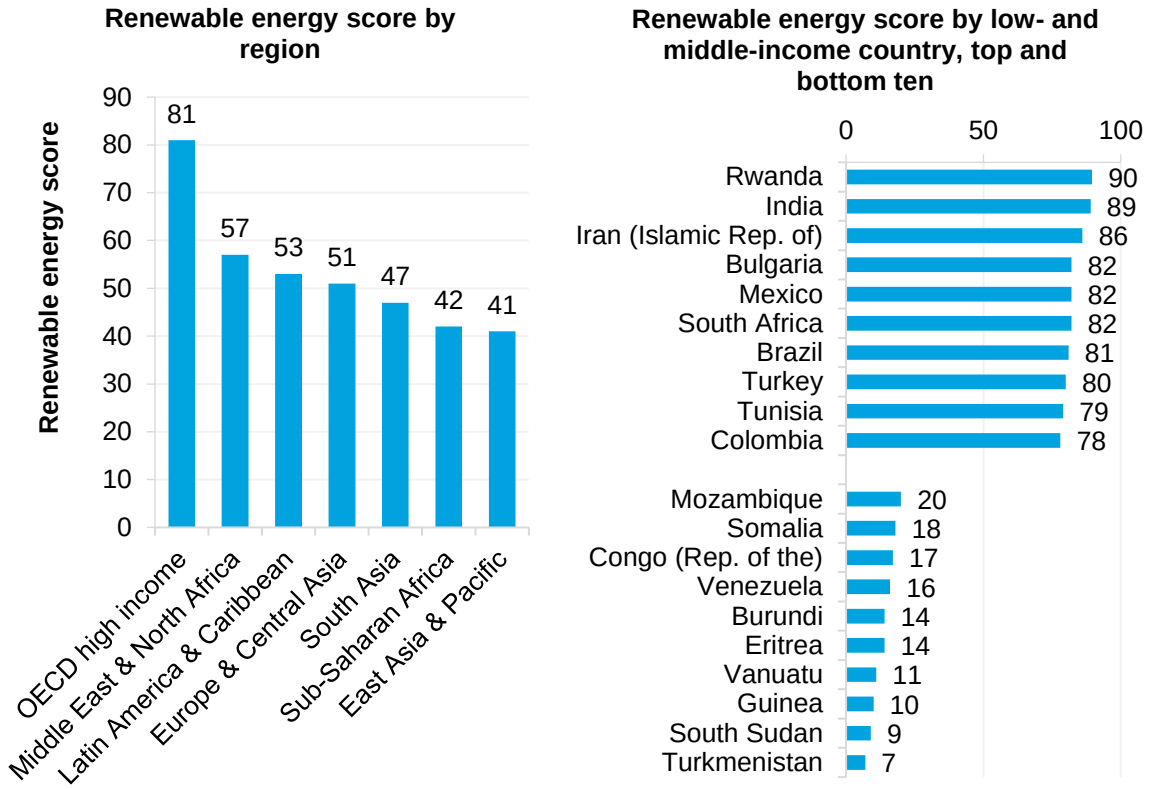
[88] See "L'État Du Sénégal A Posé Un Acte Fort Pour Booster Le Secteur Des Énergies Renouvelables" at: https://www.aner.sn/letat-du-senegal-a-pose-un-acte-fort-pour-booster-le-secteur-des-energies-renouvelables/

[89] https://www.iso.org/iso-50001-energy-management.html

supply, but that is forecast to grow by 25 per cent by 2023.[90] Rather than having to retrofit existing data centres to green energy, developing countries could leapfrog to greenfield data centres powered by renewable energy.

Governments have a leading role to play in liberalizing the environment for clean energy. Considerable effort is needed in this area as low- and middle-income regions lag developed ones in respect to clean energy policies and regulation. OECD countries have a score of 81 out of 100 on the Renewable Energy pillar of the Regulatory Indicators for Sustainable Energy (RISE) compared to 57 in the Middle East and North Africa and 41 in East Asia and the Pacific (Figure 4.3, left). There are also huge gaps in renewable energy performance among low- and middle-income countries. For instance, Rwanda scores 90 out of 100 on the Renewable Energy pillar while Turkmenistan scores 7 (Figure 4.3, right).

Figure 4.3: RISE renewable energy pillar scores, 2019



Note: Seven indicators are assessed for the RISE renewable energy pillar: 1) Legal framework for renewable energy; 2) Planning for renewable energy expansion; 3) Incentives and regulatory support for renewable energy; 4) Attributes of financial and regulatory incentives; 5) Network connection and use; 6) Counterparty risk; and 7) Carbon Pricing and Monitoring.
Source: RISE (https://rise.esmap.org/indicators).

South Africa is an example of how government policy can influence green energy markets. It ranks 6th among low- and middle-income countries in the RISE renewable energy indicator. In June 2021, the government announced new regulations exempting power projects up to 100 MW from having to apply for a licence from the energy regulator.[91] Independent power producers will also be able to upload their surplus energy onto the grid. This is linked to the requirement that Eskom, the national

[90] Oxford Business Group. 2021. Focus Report: How is Africa positioned as a destination for data centres? https://oxfordbusinessgroup.com/news/focus-report-how-africa-positioned-destination-data-centres
[91] Marianne Merten. 2021. Increase to 100 MW embedded generation threshold will give 'oomph' to South African economy, says Ramaphosa. Daily Maverick, 10 June. https://www.dailymaverick.co.za/article/2021-06-10-increase-to-100mw-embedded-generation-threshold-will-give-oomph-to-south-african-economy-says-ramaphosa/

energy utility, unbundle the grid.[92] These steps are expected to help green the grid (in 2019 over 80 per cent of the mix was coal[93]) as well as mitigate recurring electricity outages.

The private sector can be a force for sustainable data centres in low- and middle-income countries. Large data centre operators with headquarters in high-income countries have sustainability goals that subsidiaries will need to follow. Such companies are not likely to invest in low- and middle-income countries unless there are clean grids or deregulated energy markets allowing for independent renewable power suppliers. Recent moves by governments to create more favourable environments for clean energy seem to be bearing fruit. Digital Realty Trust the world's largest multitenant data centre operator recently took a majority stake in Teraco, South Africa's largest data centre operator.[94] Digital Realty is committed to reducing group operational emissions by area (i.e., m^2) 68 per cent by 2030. Similarly, Equinix, the second largest global multitenant data centre provider, announced plans to purchase MainOne, which has data centres in Cote d'Ivoire, Ghana and Nigeria, for USD 320 million in April 2022.[95] Similar to Digital Realty, Equinix also has established a target to reduce operational GHG emissions by 50 per cent by 2030 (from 2019) and achieve 100 per cent renewable energy in its operations by 2025.

In Southeast Asia, hot tropical climates and high humidity are typical and not the ideal environment for data centres to operate. Servers and IT equipment typically need to function within specific recommended temperature and humidity ranges, otherwise they can degrade or are at higher risk of breaking down. Indonesia is a hot spot for data centre activity, and Amazon, Google and Microsoft and others have announced plans to deploy cloud data centres there. While Indonesia's electricity profile remains fossil fuel-heavy (coal, natural gas and palm oil), the government ratified the Paris Climate Agreement and committed to reducing GHG emissions by 29 per cent in 2030. Indonesia wants to achieve a 23 per cent renewable energy mix by 2025 and 31 per cent by 2030. However policies favouring traditional fuels are slowing the switch to cleaner energy sources. Under the Domestic Market Obligation, 25 per cent of coal output needs to be supplied to the local market, which includes supplying coal at fixed lower prices to state-owned electricity company, Perusahaan Listrik Negara (PLN), one of the country's biggest energy purchasers. Despite government policies not being ideal for near term sustainable data centre growth, Indonesia has the potential to become a major renewable energy producer from geothermal and off-shore wind and tidal energy. In its press release announcing its plans for a cloud data centre in Indonesia, Microsoft reaffirmed its commitment to 100 per cent supply of renewable energy by 2025.[96]

International standards can provide low-cost, effective solutions and guidance for monitoring and improving data centre energy efficiency performance in low- and middle-income countries. Recommendation ITU-T L.1300 provides best practices for green data centres, including resilient planning, selecting and deploying ICT equipment and services, maximizing energy management of cooling, managing power equipment, monitoring energy use and more[97]. Recommendation ITU-T

[92] Eskom. 2022. Update on the unbundling of Eskom's Transmission division. Media Statement, 3 February. https://www.eskom.co.za/update-on-the-unbundling-of-eskoms-transmission-division

[93] Department of Energy. 2022. The South African Energy Sector Report 2021. http://www.energy.gov.za/files/media/explained/2021-South-African-Energy-Sector-Report.pdf

[94] Digital Realty to Acquire Teraco. News, 3 January 2022. https://investor.digitalrealty.com/news-and-events/news/press-release-details/2022/Digital-Realty-to-Acquire-Teraco/default.aspx

[95] Equinix Enters Africa, Closing the US$320 Million Acquisition of MainOne. Press Release, 5 April 2022 https://www.equinix.com/newsroom/press-releases/2022/04/equinix-enters-africa-closing-the-us-320-million-acquisition-of-mainone

[96] Microsoft to establish first datacenter region in Indonesia as part of Berdayakan Ekonomi Digital Indonesia initiative. Microsoft Stories Asia, 25 February 2021. https://news.microsoft.com/apac/2021/02/25/microsoft-to-establish-first-datacenter-region-in-indonesia-as-part-of-berdayakan-digital-economy-indonesia-initiative/

[97] ITU. 2014. Recommendation ITU-T L.1300. Best practices for green data centres. https://www.itu.int/rec/T-REC-L.1300-201406-I

L.1305 provides technical specifications of a data centre infrastructure management (DCIM) system based on big data and AI with key energy saving and efficiency features[98]. Others include standards that detail the procurement criteria for sustainable data centres, energy efficiency metrics and measurement for power and cooling equipment for telecommunications and data centres[99].

4.4 Carbon offsetting projects in low- and middle-income countries

Carbon offsetting is an environmental accounting method that enables companies to purchase credits for projects such as tree planting or forest restoration, which are intended to offset the purchaser's own emissions. Low- and middle-income countries are often beneficiaries of carbon offset projects. The Kyoto Protocol recognized offsets that benefit developing countries through the Clean Development Mechanism (CDM).[100] Offset projects earn Certified Emission Reduction (CER) credits, equivalent to one tonne of CO_2, and the emissions reduction must be additional to what would otherwise have occurred. The Gold Standard certifies non-governmental emission reductions projects in the CDM, the Voluntary Carbon Market and other climate and development interventions.

Offsets are benefitting low- and middle-income countries in various ways. Solar and wind projects are helping to develop renewable energy sources. Reforestation could enhance climate resiliency and often has spill over benefits for local communities. For instance, mangroves protect shorelines and support livelihoods as well as storing up to ten times more carbon than forests on land.[101] One popular type of offset project is reducing the use of firewood through the supply of biomass powered cookstoves; apart from reducing emissions they also mitigate against deforestation.[102] The Thermo Electric Generator (TEG) Stove is estimated to avoid three tons of CO_2e per household per year in Benin and can also provide energy for charging phones (Figure 4.4).

[98] ITU. 2019. Recommendation ITU-T L.1305. Data centre infrastructure management system based on big data and artificial intelligence technology. https://www.itu.int/ITU-T/recommendations/rec.aspx?rec=14080

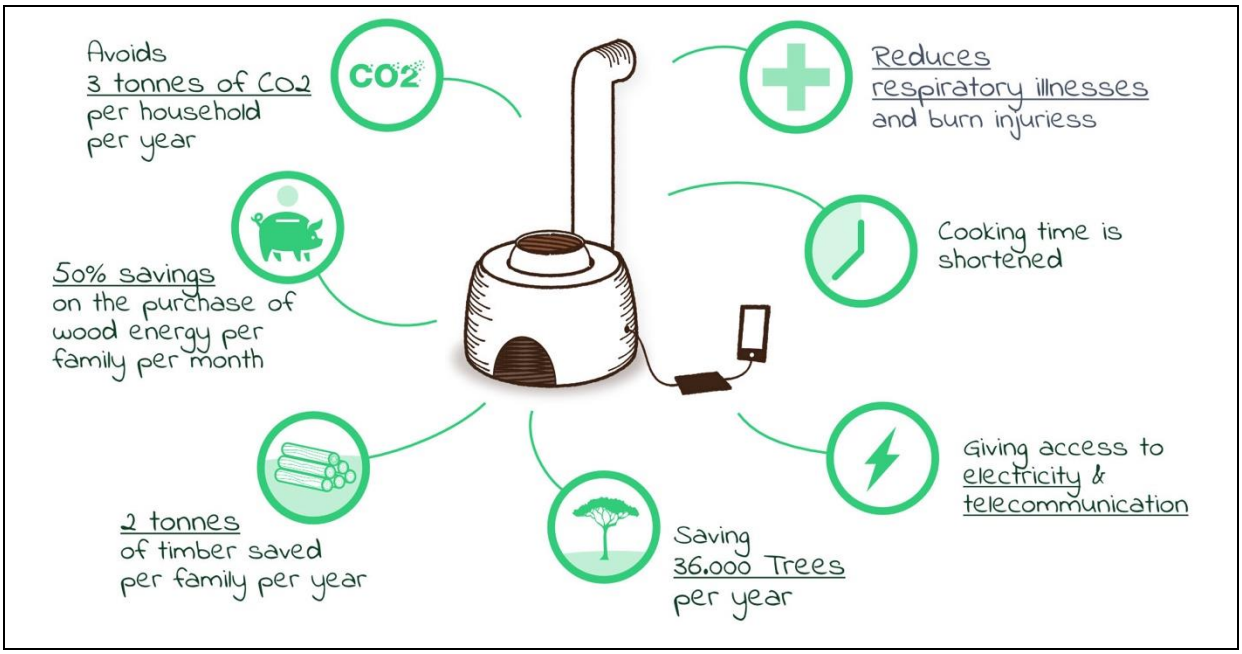
[99] ITU. 2014. Recommendation ITU-T L.1320. Energy efficiency metrics and measurement for power and cooling equipment for telecommunications and data centres. https://www.itu.int/ITU-T/recommendations/rec.aspx?rec=12136

[100] See "The Clean Development Mechanism" at: https://unfccc.int/process-and-meetings/the-kyoto-protocol/mechanisms-under-the-kyoto-protocol/the-clean-development-mechanism

[101] Apple. 2020. From farm to sea: Conserving mangroves to protect local livelihoods and the planet. News, 21 April. https://www.apple.com/newsroom/2022/04/conserving-mangroves-to-protect-local-livelihoods-and-the-planet/

[102] D.L. Wilson et. al. 2016. Avoided emissions of a fuel-efficient biomass cookstove dwarf embodied emissions. Development Engineering, June. https://www.sciencedirect.com/science/article/pii/S2352728515300464

Figure 4.4: Benefits of TEG stove in Benin



Source: http://www.tegstove.org

Digital companies are offsetting carbon emissions through projects in low- and middle-income countries from Benin to Zimbabwe (Table 4.2).

Table 4.2: Digital companies with carbon offsetting projects, 2020

Company	Remarks	Crediting scheme	Location
Apple	Offsets its remaining operational emissions through various projects. See Environmental Progress Report, p. 3	VCS	• China - solar energy. • Colombia - preserve mangrove forests • Kenya - sustainable tree farming and preserving savannas
Booking Holdings	Scope 1 and 2 emissions have been offset, along with scope 3 business travel flight emissions (55 ,923 tCO_2e). See 2020 Sustainability Report, p. 32.	VCS, Gold Standard	• Cambodia - rainforest protection • Ecuador - waste energy • Honduras - hydropower • India - solar energy • Namibia - solar energy • Thailand - waste energy
Elisa	Uses emissions compensation to offset operational and some value chain emissions amounting to 13 200 tonnes in 2020. See "Emissions Compensations"	Gold Standard	• Uganda - biomass cookstoves (5 770 tCO_2) • Colombia - reforestation and forest protection project.
Logitech	Neutralising all remaining scope 1,2, and 3 emissions by investing in certified projects. See carbon neutrality certification	VCS, Gold Standard, CER	• China - cookstoves and wind farm (80 094 tCO_2e) • Brazil - tropical rainforest conservation project (21 844 tCO_2e) • Indonesia - geothermal power and biodiversity reserve (21 844 tCO_2e)
Microsoft	The company's 1.3 million tons of offset credits included forestry and soil carbon sequestration projects. See Microsoft carbon removal: Lessons from an early corporate purchase, p. 12.	VCS	• India – Restoration of forests (9 000 tCO_2e) • Peru- Agroforestry and reforestation (100 000 tCO_2e)
Proximus	Offsets through Gold Standard projects and supporter of the TEG cookstove. See Integrated Annual Report 2020, p. 154.	Gold Standard	• Benin, China, Malawi, Uganda – Biomass cookstoves (274 000 tCO_2e)
Salesforce	Achieved net zero greenhouse gas emissions by purchasing carbon credits for operational emissions as well as some upstream/downstream	Gold Standard, VCS	• Honduras: Biomass cookstoves

Company	Remarks	Crediting scheme	Location
	emissions. See "Explore Salesforce's Climate Action Strategy"		
Swisscom	To offset emissions buys CERs according to the Gold Standard. Also offers customers the opportunity to offset emissions of products for a small surcharge. See: 2020 Swisscom climate report in accordance with ISO 14064, p. 17	CER	• India – biogas plant
Tele2	Offsetting remaining emissions by investing in projects for renewable energy in India. See "Tele2's Climate Efforts"	Gold Standard	• India – solar and wind power
Telia	Carbon offsetting was used to cover remaining emissions in the form of industrial and biological removal credits. See "Climate Neutral in own operations"	VCS	• Peru – forest conservation • Zimbabwe – forest conservation

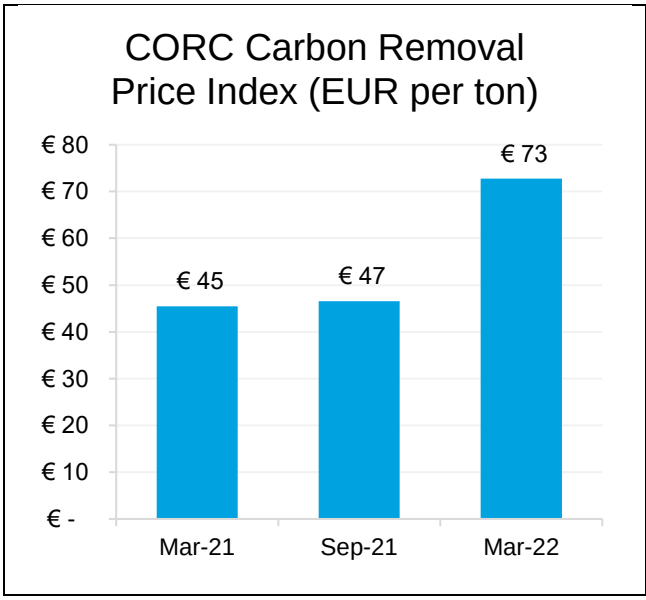
Note: VCS = Verified Carbon Standard. CER = Certified Emission Reduction. Excluding offsets used by companies headquartered in middle-income countries.

There is a degree of opaqueness surrounding the carbon offset market. While the CDM has a registry it is not easy to navigate and only has projects within its domain.[103] Similarly, the Gold Standard has a registry but the ultimate company sponsoring projects is not clearly disclosed.[104] The Verified Carbon Standard, the world's largest voluntary GHG offset programme, also has a registry.[105] However, none of these registries clearly link corporate purchasers with the project they claim offsets for, the amount of the offset and the amount of money paid for the offset. A unified registry of all offsets would provide insight into the total funding digital companies are providing to low- and middle-income countries in respect to environmental assistance for projects offsetting emissions.

The Puro Registry tracks carbon removals including the amount removed and the name of the company.[106] Puro has also created a carbon price index in conjunction with Nasdaq.[107] The Carbon Removal Price Index (CORCX) tracks the price of one tonne of carbon removal (Figure 4.5, left). It stood at EUR 73 (USD 80) in March 2022, up 60 per cent in one year. This is significantly higher than the price of a ton of voluntary carbon offset, which stood at USD 3.37 in November 2021 (Figure 4.5, right).

[103] https://cdm.unfccc.int/Registry/index.html
[104] https://registry.goldstandard.org/projects?q=&page=1
[105] https://verra.org/registry-system/
[106] Both Microsoft and Telia are documented as having purchased carbon removals in the registry. See: https://registry.puro.earth/carbon-sequestration
[107] Nasdaq Acquires Emerging Carbon Removal Market Puro.earth. Press Release, 1 June 2021. https://www.nasdaq.com/press-release/nasdaq-acquires-emerging-carbon-removal-market-puro.earth-2021-06-14

Figure 4.5: Price per tonne of carbon removal and voluntary offsets



Voluntary carbon market (January - November 2021)	
Volume (tCO_2e millions)	298.4
Value (USD millions)	USD 1 006
Weighted average price (USD)	USD 3.37

Source Puro Earth (https://puro.earth/carbon-removal-index-price) and Ecosystem Marketplace (https://www.ecosystemmarketplace.com/articles/voluntary-carbon-markets-top-1-billion-in-2021-with-newly-reported-trades-special-ecosystem-marketplace-cop26-bulletin/)

4.5 Looking forward

Governments need to create a favourable environment for clean energy (e.g., allowing renewable energy providers, eliminating taxes on renewable products, unbundling grids, allowing onsite use of renewables). While in the past factors such as low cost was key to attracting foreign investment, environmental policies are increasingly an influential investment factor for technology multinationals. Global ICT companies can provide a positive contribution since they often have considerable expertise with emissions reduction and their subsidiaries in low- and middle-income countries would fall under the umbrella of the parent company emissions reduction targets. Governments might also consider participating in offset markets to encourage investment in renewables, reforestation and related initiatives such as clean cookstoves and PAYG solar.

5 Digitalization as an emission reduction driver

Digitalization has considerable potential to drive carbon reductions. Digital companies can trigger carbon reductions throughout their footprint, enable organizations and individuals to avoid emissions, and support innovative carbon removal technologies. At the very least, digitalization increases circular and environmentally friendly products, improves supply chain transparency and traceability, optimizes production processes for resource use, reduces environmental pollution, facilitates hybrid work models, increases energy, water or fuel efficiency, and improves data gathering that helps target setting and monitoring compliance. At the same time, as a general-purpose technology, ICT technologies could also be used to maintain a fossil fuel-based economy.

Digital companies are deploying a variety of technologies to achieve reductions across their value chain emissions. Companies are facing increasing costs and environmental risks associated with their upstream and downstream value chains (i.e., scope 3). Emissions can be avoided through the application of digitalization across different sectors. For example, the GeSI SMARTer2030 report suggested that ICT has the potential to enable a 20 per cent reduction in global carbon emissions by 2030, holding emissions at 2015 levels.[108] Focusing on mobile networks, a comparison of the GHG emissions caused by each generation of mobile networks per unit of data transmitted showed that previous mobile networks caused 30.3 g CO_2e/GB, while mobile networks in 2030 are expected to cause 4.5g CO_2e/GB, or 85 per cent less emissions.[109]

Some digital companies are now beginning to concretely measure this. Large scale engineering technologies, such as carbon capture and storage, can decrease global carbon emissions by removing GHGs from the atmosphere. Moving beyond carbon reduction and avoidance, digital companies can also contribute to funding and carbon removal expertise.

5.1 Digital technology applications to reduce digital company value chain emissions

The following section showcases how digital companies are using digital technology solutions – artificial intelligence (AI), robotics, blockchain, big data analytics, cloud computing, Internet of Things (IoT), and sensors - to reduce carbon footprints across their value chains.

5.1.1 Internet of Things and big data applications

The application of the Internet of Things (IoT) on electricity networks could enable operators to understand electricity flows more precisely, allowing them to expand transmission capacity without increasing the physical footprint.[110] The use of IoT technologies and smart sensors in manufacturing and transportation can improve efficiency and provide greater supplier transparency, while also enabling digital companies to produce more accurate scope 3 emissions inventories and track progress toward goals. IoT solutions are also being used by digital companies to optimize facility efficiency and reduce unnecessary consumption of energy. Smart energy and smart grids enable real-time data collection, monitoring and controlling capabilities to support outages, manage increasingly decentralized energy production, and the integration of renewable sources and energy storage to reduce CO_2 emissions.[111] Sensors can be used to monitor energy usage and generate -real-time data

[108] Global e-Sustainability Initiative (GeSI) and Accenture Strategy. 2015. #SMARTer2030 – ICT Solutions for 21st Century Challenges. https://smarter2030.gesi.org/downloads/Full_report.pdf
[109] Bieser, J. et al., (2020). Next generation mobile networks. Problem or opportunity for climate protection? https://plus.empa.ch/images/5G%20climate%20protection_University%20of%20Zurich_Empa.pdf
[110] IEA (2021). 5 ways Big Tech could have big impacts on clean energy transitions. https://www.iea.org/commentaries/5-ways-big-tech-could-have-big-impacts-on-clean-energy-transitions
[111] International Electrotechnical Commission. Smart energy and smart grids. https://www.iec.ch/energies/smart-energy

to improve energy efficiency and optimal building management.[112] Using algorithms, building management systems can analyse the data and automate the use of different facilities such as air conditioning, lighting, heating, and ventilation.

Many heating, ventilation, and air conditioning (HVAC) systems must be managed manually on-site, making it difficult to generate live data insights for monitoring and optimising their energy use. Hark Systems has partnered with Dell to deploy the Hark Platform, an all-in-one, cloud-based IoT monitoring system, which aggregates data on energy use from existing infrastructures, including HVAC, power, and lighting.[113] Companies use the platform to reduce energy costs and alert them when it is more economical to switch from grid electricity to solar powered microgrids.

Similarly, Samsung Electronics uses IoT in the HVAC systems of the Yeongdeok Training Center in the Republic of Korea and its worksite in Ho Chi Minh City, Viet Nam. The company has developed an energy-saving algorithm that factors in outdoor climate conditions, HVAC load, and device capacity, enabling optimum operational control of the infrastructure equipment. As a result, Samsung was able to reduce energy consumption at its Ho Chi Minh City site by 12.4 per cent.[114] The technology is planned to be applied at all worksites in the Republic of Korea, the United States, and Southeast Asia.

Other examples include Amazon, which uses building control system technology and real-time data analytics to optimize heating and cooling systems for occupant comfort while operating as efficiently as possible. AT&T created an Energy and Building Management Solution that uses IoT and sensors to monitor their energy usage from nearly 250 000 managed locations.[115]

5.1.2 Blockchain

Many companies and organizations are supporting the development of blockchain business applications. Blockchain supports verification of sustainable supply and value chains and can provide documentation of manufacturer data. A number of digital companies are members of the Responsible Minerals Initiative, which has announced voluntary guidelines to drive the application of blockchain solutions to support mineral supply chain due diligence.[116] Apple has been using blockchain technology to trace tin, tantalum, tungsten, gold and other minerals in its supply chain, which will help to transition it to using recycled and renewable materials.[117] Similarly, the Microsoft Cloud supply chain blockchain initiative aims to increase visibility and allow for mine-to-data centre traceability.[118] The ICT industry can also facilitate the development of distributed energy resources, such as solar PV panels and storage, by creating better incentives and making it easier for producers to store and sell electricity to the grid. In addition, Blockchain could help to facilitate electricity trade within local energy communities.

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[112] Petrosanu, D. et al., 2019. A Review of the Recent Developments in Integrating Machine Learning Models with Sensor Devices in the Smart Buildings Sector with a View to Attaining Enhanced Sensing, Energy Efficiency, and Optimal Building Management. Energies, 12. https://www.mdpi.com/1996-1073/12/24/4745

[113] Dell Technologies. 2021. Helping global organizations reduce their carbon footprints. https://www.delltechnologies.com/asset/en-us/solutions/oem-solutions/customer-stories-case-studies/dell-technologies-hark-customer-story.pdf

[114] Samsung (2022). Climate Action: Acting now for a sustainable, low-carbon future. https://www.samsung.com/latin_en/sustainability/environment/climate-action/

[115] AT&T Business. 2018. Optimize your energy and building management systems throughout your facilities. https://www.business.att.com/content/dam/attbusiness/briefs/att-energy-management-brief.pdf

[116] Responsible Minerals Initiative. 2018. Responsible Minerals Initiative Releases Blockchain Guidelines to Drive Alignment in Mineral Supply Chain Due Diligence. https://www.responsiblebusiness.org/news/blockchain-guidelines-mineral-supply-chain/

[117] Apple. 2022. Conflict Minerals Report 2021. https://www.apple.com/supplier-responsibility/pdf/Apple-Conflict-Minerals-Report.pdf

[118] Microsoft Industry Blogs. 2020. Improve supply chain resiliency, traceability, and predictability with blockchain. https://cloudblogs.microsoft.com/industry-blog/manufacturing/2020/12/17/improve-supply-chain-resiliency-traceability-and-predictability-with-blockchain/

Box 5.1: Example of digital technologies in nature-based solution credits

Digital technology innovations can be used when generating and marketing carbon credits to create efficiencies, improve access to better quality data and analytics and help create well-functioning, liquid markets.

At the project level, innovative technologies are emerging that help to address challenges in ensuring accurately and efficiently measuring, reporting, and verifying emissions from forestry and land-use projects. Data from satellites and aerial sensors from drones and low flying aircraft can be triangulated to provide more data at scale, while machine learning can train this data to improve the way projects are monitored and verified. These models are being used by companies such as Global Mangrove Trust, Pachama, or Regen Network to address monitoring challenges in large nature-based projects. Meanwhile, in Chile, the OpenSurface pilot project uses similar technologies to help the government prioritize where to place resources.

When it comes to trading and retiring credits, blockchain technology can be one way to provide the traceability and immutability needed to verify that credits are not double counted and can facilitate linkages between national registry systems consistent with the bottom-up ethos of the Paris Agreement. Existing and developing blockchain-based solutions include tradable carbon credit tokens and token standardization, such as the Microsoft-backed Interwork Alliance initiative or the CBL Nature-based Global Emissions Offset contract for agriculture, forestry, and other land-use projects. There are also climate marketplaces such as those offered by AirCarbon and ClimateTrade, and meta-registries such as the one to be launched soon by IHS Markit. Another example is the World Bank Climate Warehouse prototype, which seeks to offer a transparent public data layer that can provide real-time data to connected registry systems.

Artificial intelligence (AI) is also being used to help bring transparency to crediting markets. S&P Global Platts is developing a series of AI-driven carbon indices to enhance transparency in the benefits that carbon credits deliver, providing market participants with a greater understanding of their market value.

Source: The World Bank. 2021. State and Trends of Carbon Pricing 2021.
https://elibrary.worldbank.org/doi/abs/10.1596/978-1-4648-1728-1

5.1.3 Artificial intelligence and cloud-based platforms

AI-based techniques can lead to more precise forecasting of wind and solar production, enabling greater shares of renewables being used without jeopardising energy security. An example is the Google system for Carbon-Intelligent Compute Management that reduces grid carbon emissions from data centre electricity use by temporally shifting internal workloads.[119] AI technology can also improve energy efficiency, for example, Huawei launched an iCooling@AI solution powered by AI to reduce the energy consumption of data centres while enabling smart cooling. In a data centre in Ningxia, China, the solution helped reduce energy consumption by up to 15 per cent, lowering costs and carbon emissions.[120] Similarly, Google used the DeepMind AI framework to reduce energy used for cooling in data centres by 40 per cent. Substation and Edge-of-the-Grid Automation has been developed by Intel and Capgemini to address the limitations of a one-way grid by helping utilities monitor and manage load and flow, prioritize production and consumption of clean energy sources, simplify the energy

[119] Radovanovic, A. et al., 2021. Carbon-Aware Computing for Datacentres. arXiv:2106.11750
https://arxiv.org/pdf/2106.11750.pdf

[120] Zhenfu, F. and Xiaoxin, S. 2020. iCooling@AI: Smart cooling for data centers. Huawei.
https://www.huawei.com/en/technology-insights/publications/huawei-tech/90/smart-cooling-data-centers

ecosystem, extend asset life duration, and reduce IT infrastructure footprint within a substation. [121] Here, Intel AI and machine learning capabilities enable real-time decision-making for predictive maintenance.

The virtualization of infrastructures reduces the number of physical servers and networking devices, as well as related costs of power consumption and cooling. Software is used to virtualize the hardware layers to reduce the carbon emission of computing, storage, and networking infrastructure. AIS expanded the use of Virtual Machine Servers in Thailand - an operating system enabling the use of cloud software via a simulated server - which enhanced resource efficiency and lowered power usage for servers and their cooling systems and cut annual GHG emissions by 12 421 tCO_2e.[122] Microsoft Cloud for Sustainability is an Azure-based platform that allows organizations to combine disparate data sources into one place and help provide insights into how to improve their sustainability approaches.[123] The Nokia Digital Automation Cloud platform offers unmetered private wireless connectivity and edge computing capabilities. In collaboration with nCentric, this 5G ready Nokia solution has been installed at several offshore wind farms, improving connectivity, and decreasing costs.[124] According to nCentric, a private LTE network can offer 30 times more bandwidth than VSAT, enabling live HD video streaming, video conferencing, file synchronisation, and seamless communication between offshore platforms and teams on land.

Amazon is developing fully autonomous delivery innovations using AI technologies that can be powered by clean electricity as part of their Shipment Zero initiative.[125] Amazon Scout and Prime Air drones are electrically powered autonomous devices that can deliver packages to customers without the need for a delivery vehicle. These devices are currently being designed and tested to be able to transport small packages quickly, safely, and sustainably. By increasing delivery efficiency across their network, Amazon can put fewer vehicles and planes into service, reducing the carbon intensity of shipments. Pinduoduo is investing in machine learning technology to optimize delivery route planning by working with their logistics partners to make deliveries greener and more efficient.[126]

5.1.4 Robotics

Innovative robotics solutions can support resource optimisation and minimisation of waste across digital company value chains, as well as reducing energy consumption and GHG emissions. Robots can assist assembly line monitoring, predictive maintenance and production monitoring.

The Apple robot 'Dave' disassembles used iPhones to recover key materials such as rare earth magnets, tungsten, and steel. Another robot, 'Daisy' disassembles iPhone devices so recyclers can recover more material inside. Just one metric ton of iPhone main logic boards, flexes, and camera modules disassembled by Daisy contain the same amount of gold and copper as an estimated 150 metric tonnes of mined earth. These materials make it back to the general market, so that Apple and

[121] Intel. 2020. Smart Substations Transform the Grid. insight.tech. Technology Brief. https://www.intel.com/content/dam/www/central-libraries/us/en/documents/otsi-insight-tech-business-brief-capgemini-smart-substations-transform.pdf

[122] Belanger, S. and Casemore, B. 2019. Exploring the Impact of Infrastructure Virtualization on Digital Transformation Strategies and Carbon Emissions. IDC White Paper. https://www.vmware.com/content/dam/digitalmarketing/vmware/en/pdf/company/vmware-exploring-impact-of-infrastructure-virtualization-on-digital-transformation-strategies-and-carbon-emissions-whitepaper.pdf

[123] Microsoft. 2022. Microsoft Cloud for Sustainability. https://www.microsoft.com/sustainability/cloud

[124] Nokia. 2022. Nokia Digital Automation Cloud. https://dac.nokia.com/

[125] Wilke, J. 2019. A drone program taking flight. Amazon. https://www.aboutamazon.com/news/transportation/a-drone-program-taking-flight

[126] Pinduoduo. 2020. Rethinking the agricultural and manufacturing supply chains. https://stories.pinduoduo-global.com/articles/rethinking-the-supply-chain

others can use recycled materials for the next generation of products.[127] Logitech also uses robotic technology and automation in their facilities to deliver accurate, timesaving, and waste-eliminating production of products.[128]

Robotics can also help keep the supply chain moving by improving warehouse operating efficiency and lowering GHG emissions through autonomous mobile robots and rack-climbing picking-and-put-away robots.[129] Amazon has hundreds of thousands of robots used in warehouses across the globe to help reach its carbon neutral goals. Exotex, a leader in warehouse robotics, recently received investment from Dell Technologies, and its Skypod Systems available in 10 countries and has an 80 per cent lower energy footprint compared to traditional automated solutions.[130]

5.1.5 Mobile apps, online and collaborative platforms

Several digital companies are moving to make some degree of remote working permanent following quarantine restrictions imposed by COVID-19, reducing their net emissions and for staff that need to go to the office, they are supporting green travel options. This is enabled by adopting the use of remote collaboration technologies in business processes, management practices and culture. Cisco employees (and clients) use several remote collaboration technologies such as TelePresence rooms (more than 5 800 multipurpose rooms are available in Cisco offices globally), and Webex Meetings Cisco Virtual Office hardware that help to reduce emissions.[131] Swisscom launched a 'Work Smart initiative' based on digital solutions and has 33 virtual conferencing sites for employees equipped with TelePresence virtual videoconferencing.[132] Similarly, Telefonica uses collaborative digital solutions to allow suppliers and people inside the organization to connect and work remotely, reducing journeys, fuel consumption and office air-conditioning.[133]

While the pandemic significantly impacted the number of employees commuting to Apple facilities and retail stores—temporarily reducing the carbon footprint—the company's strategy to reduce commuting-related emissions looks beyond this to the long term. The Apple At Home Advisor programme allows specialists providing customer support to work remotely. Apple also encourages employees to transition away from single-occupancy vehicles through mass transit, coach services, and campus bicycles. More than 2 300 electric vehicle charging stations are available across the company campuses based in the United States. In total, these initiatives have helped reduce CO_2e emissions by more than 16 000 metric tonnes in 2020.[134]

[127] Apple. 2021. Environmental Progress Report 2020. https://www.apple.com/environment/pdf/Apple_Environmental_Progress_Report_2021.pdf
[128] Logitech. 2022. Sustainability Report FY21. https://www.logitech.com/content/dam/logitech/en/sustainability/pdf/resources/sustainability-report-fy21-aw-spreads.pdf
[129] Graham, M. 2022. The role of robotics in carbon-neutral warehouses. GreenBiz. https://www.greenbiz.com/article/role-robotics-carbon-neutral-warehouses
[130] Exotec. 2022. What is the Skypod System? https://www.exotec.com/en/skypod-system/
[131] Cisco. 2020. Cisco 2020 Environment Technical Review. https://www.cisco.com/c/dam/m/en_us/about/csr/esg-hub/_pdf/2020_Environment_Technical_Review.pdf
[132] Swisscom. 2019. Sustainability Report 2018. https://sustainserv.com/wp-content/uploads/2020/03/swisscom_sustainability_report_2018_ENGL.pdf
[133] Telefonica. 2022. Green Digitalisation. https://www.telefonica.com/en/sustainability-innovation/environment/green-digitalisation/#:~:text=The%20Eco%20Smart%20seal%20shows,helping%20to%20protect%20the%20environment
[134] Apple. 2021. Environmental Progress Report 2020. https://www.apple.com/environment/pdf/Apple_Environmental_Progress_Report_2021.pdf

Salesforce estimates that it can reduce its emissions a net 5 per cent between 2020 and 2030 from making permanent adaptable work arrangements in the aftermath of COVID-19.[135] Staff can choose to work "flex" (i.e., in the office 1-3 days per week) or fully remote for those who do not live near an office or whose role does not require an office. A growing number of digital companies are continuing the use of telecommuting and videoconferencing on a permanent basis after COVID-19 to allow for a more flexible work arrangement, as well as to reduce emissions generated by travel. This includes Twitter where employees who do not need to come to the office can work from home when they wish.[136]

Smartphone apps with carbon calculators can inform users about the environmental cost of different transport modes (e.g., taking public transport or car) possibly triggering behavioural changes.[137] Apps from ride sharing companies facilitate shared mobility reducing emissions and providers of such apps are greening their fleets. Ride sharing companies such as Grab, Gojek and Uber are converting their fleets to electric and providing customers with the option of selecting a green ride. Gojek and Grab are targeting a fully electric fleet by 2030 with Uber expecting to reach this by 2040.

E-procurement technologies have risen in popularity in recent years. For example, e-informing, e-ordering, e-sourcing and e-reverse auctioning can lead to operational proficiency and green supply chain performance. With digital procurement, companies have the option to purchase more sustainable products. For example, Amazon Business offers more than 200 000 products that are Climate Pledge Friendly and certified.[138] Telefonica offers sustainable purchasing criteria such as the Eco Smart seal, which rates the sustainability of mobiles and encourages manufactures to improve them.[139]

Box 5.2: Emissions and videoconferencing

An increasing number of studies have demonstrated that physical meetings and conferences generate a much larger amount of greenhouse gas emissions compared to virtual conferences, which has become the alternative communication method for people during the COVID-19 pandemic. A 2021 study showed an online conference produced 66 times fewer emissions than an in-person meeting would have (based on 164 participants gathering in San Francisco).[140]

Calculating emissions savings from videoconferencing is not straightforward. The basic premise is that videoconferencing emissions need to be balanced against the emissions travel emits. Both depend on various assumptions such as the type of travel (e.g., car, public transport, plane), the distance travelled and as well as videoconferencing attributes (e.g., length of call, network speed,

[135] The net figure incorporates less emissions from commuting plus additional emissions workers generate from working at home. See "Salesforce Climate Action Plan" at https://www.salesforce.com/content/dam/web/en_us/www/assets/pdf/reports/salesforce-climate-action-plan-2021.pdf

[136] Christie, J. 2020. Keeping our employees and partners safe during #coronavirus. Twitter Blog. https://blog.twitter.com/en_us/topics/company/2020/keeping-our-employees-and-partners-safe-during-coronavirus

[137] Cellina, Francesca, Dominik Bucher, Francesca Mangili, José Veiga Simão, Roman Rudel, and Martin Raubal. 2019. A Large Scale, App-Based Behaviour Change Experiment Persuading Sustainable Mobility Patterns: Methods, Results and Lessons Learnt. Sustainability 11, no. 9: 2674. https://www.mdpi.com/2071-1050/11/9/2674#cite

[138] Amazon Business. 2022. Sustainability. https://business.amazon.com/en/social-responsibility/sustainability

[139] Telefonica. 2022. Consolidated Annual Report 2021. Building a greener future. https://www.telefonica.com/en/wp-content/uploads/sites/5/2022/03/building-greener-future-2021.pdf

[140] Grant Faber. 2021. A framework to estimate emissions from virtual conferences. International Journal of Environmental Studies. https://www.tandfonline.com/doi/abs/10.1080/00207233.2020.1864190

type of background, etc.). One hour of streaming or videoconferencing can emit between 0.15 and 1 kg of carbon dioxide, depending on the service.[141]

Elisa, the telecommunication operator in Finland, calculates the impact of virtual meetings compared to its employees driving to work. Based on employee travel pattern surveys, the company calculated an average emission reduction from virtual meetings of 3.58 kg of CO_2e per participant.[142]

Companies providing video conferencing services have calculated the level of emissions their products have avoided. Zoom estimates that it enabled millions of users to work from home during the COVID-19 pandemic, reducing CO2 emissions by more than 55 million tonnes in 2020.[143] Similarly Alibaba notes that its videoconferencing software DingTalk has resulted in avoided emissions although it has not calculated the amount.[144] While these companies provide the videoconferencing software, the enablement of working remotely is only made possible by the telecommunication operators networks. Similar to other areas of environmental accounting, if enablement is not attributed correctly it can result in double counting.

5.2 Scope 4: Enablement?

ICT technologies play an important enablement role in decarbonization. Use of digital services contribute to avoided emissions that goes beyond their upstream and downstream emissions and is sometimes referred to as scope 4.[145] While all types of digital companies help to enable emissions reductions through their products and services, arguably telecommunication operators have the largest enablement impact by providing the underlying network connectivity.[146]

Table 6.1 illustrates telecommunication operators that calculate their enablement emissions alongside operational emissions. Some companies derive an "enablement factor" showing the ratio of avoided enablement emissions to operational or total footprint. Deutsche Telekom uses all three of its scopes to calculate an enablement factor[147] whereas Vodafone uses just scopes 1 and 2. Among this group, total emission avoidance enabled in 2020 came to 100 million tonnes, almost seven times larger than their operational emissions and more than 1.5 times their total footprint. Such claims are

[141] Kelley Travers. 2021. How to reduce the environmental impact of your next virtual meeting. MIT News, 4 March. https://news.mit.edu/2021/how-to-reduce-environmental-impact-next-virtual-meeting-0304
[142] Elisa. 2021. Elisa Energy and CO_2 Emission Disclosure 2020. https://static.elisa.com/v2/image/2tqybbhjs47b/2zPLRmgLXG1ox93ufK479t/Elisa_Energy-Emission_Disclosure_2020.pdf?w=800&_ga=2.43693921.595549146.1616402162-1934489418.1585554167
[143] Zoom. 2022. Environmental Social Governance Report Fiscal Year 2022. https://explore.zoom.us/docs/en-us/zoom-esg-framework.html
[144] Alibaba Group. 2021. Alibaba Group Carbon Neutrality Action Report. https://sustainability.alibabagroup.com/download/Alibaba%20Group%20Carbon%20Neutrality%20Action%20Report_20211217_ENG_Final.pdf
[145] STL Partners. 2022. How telcos can help their customers reach net-zero. https://stlpartners.com/wp-content/documents/reports/Telco%20net-zero%20enablement%20use%20case%20directory%20-%20How%20telcos%20can%20help%20their%20customers%20reach%20net-zero%20-%20February%202022.pdf
[146] GSMA. 2018. The Enablement Effect: The impact of mobile communications technologies on carbon emission reductions. https://www.gsma.com/betterfuture/enablement-effect
[147] See "Enablement factor" at: Telecom. 2021. Corporate Responsibility Report 2021. https://www.cr-report.telekom.com/site20/management-facts/environment/enablement-factor#atn-16754-16755

hard to interpret due to lack of standards. To overcome this, ITU aims to prepare detailed guidance to be published in 2022.

Table 5.1: Digital companies reporting enablement emissions, 2020

	tCO_2e (Millions)				Enablement factor	
Company	**Enablement**	**Scope 1 and 2**	**Scope 3**	**Total footprint**	**Scope 1 and 2**	**Total footprint**
AT&T	31.30	5.78	2.83	8.61	5.4	3.6
Deutsche Telekom	38.00	2.52	13.88	16.4	15.1	2.3
KPN	0.57	0.02	0.89	0.91	28.5	0.6
Proximus	0.47	0.03	0.65	0.68	15.7	0.7
Swisscom	0.90	0.01	0.3	0.31	90.0	2.9
Telefonica	9.10	0.74	1.91	2.65	12.3	3.4
Telia	0.49	0.02	1.15	1.17	24.5	0.4
Verizon	12.00	3.97	15.64	19.61	3.0	0.6
Vodafone	7.10	1.37	9.4	10.77	5.2	0.7
Total	**100**	**14**	**47**	**61**	**6.9**	**1.6**

Note: Enablement refers to emissions that been avoided due to products and services of a company. The enablement factor is derived from dividing the enablement emissions by both the company operational emissions (i.e., scope 1 and 2) as well as by its total footprint (scope 1, 2 and 3).

Several digital companies have been identifying their own enablement impact, in addition to their carbon footprint reduction initiatives, as shown in Table 6.2. The bulk of the enablement effect is from homeworking, video conferencing and smart sensors in buildings and for transportation.

Table 5.2: Examples of enablement activities from digital companies

Company	**Description**
AT&T	AT&T-enabled customer GHG emissions reductions between 2018 and 2021 total 110.3 million metric tonnes of CO_2e – approximately 11% attainment toward their 2035 Gigaton Goal: Deliver connectivity solutions that enable business customers to reduce a gigaton (1 billion metric tonnes) of GHG emissions between 2018 and 2035.[148]
KPN	KPN services are helping customers to consume less energy and raw materials. Such as interactive television, where customers no longer record their favourite series on a hard drive at home, but instead save it in the cloud. That means less equipment and less energy consumption: in 2020 alone, their customers saved 330 million euros on their energy costs.
Swisscom	Savings by customers (enabling effects through the portfolio), including: • Savings through services that help customers to replace some of their travel. • Savings through services that enable customers to control devices or vehicles intelligently via the Internet of Things (IoT). • Savings through services that enable customers to give up their own data centres and servers and outsource them to highly efficient data centres with a considerable level of server virtualisation. • Savings through services that help to reduce paper consumption. These include electronic billing and the electronic trading platform Conextrade. • Savings through 'dematerialisation' services. This refers to customers replacing previously physical items with data transmitted via a broadband connection. • Savings through services that target reductions in shopping trips due to online ordering and in retail space as physical shops are replaced by virtual ones (e-commerce). • Savings through services that extend the life of mobile phones.
Tele2	During 2021, Tele2 mapped the GSMA themes in the report "The Enablement Effect" against their connectivity and IoT services and developed a framework of key impact areas that encompass the Tele2 enablement effect. To test the framework, measures have been done for 2 pilot projects, in the form of IoT customer cases, which has resulted in measurable social and environmental impact.
Telia	Since 2020, Telia tracks "enablement effects" for some of its products and services: remote meetings and IoT for buildings, transports and utilities. Based on products and services delivered during and before 2021, they estimate that these categories enabled GHG emission reductions by approximately 590 000 tonnes in 2021, the equivalent of over 4.3 million return trips by air between Stockholm and Helsinki. Many of the markets Telia operates in have domestic electricity production with a high share of renewables. Hence, for some applications the carbon enablement effect may be lower than in other geographies. They estimate that in 2021, enabled electricity savings of approximately 800 GWh through IoT solutions for smart buildings and utilities, equivalent to the annual consumption of 90 000 average Swedish households. In addition to the above, the underlying connectivity they provide enables further reductions that are indirect

[148] https://about.att.com/csr/home/reporting/issue-brief/climate-change.html

Company	Description
	or more distant and thus more difficult to capture. For example, as a connectivity provider they enable various digital solutions provided by other digital players, including new sharing economy business models that significantly reduces both GHG emissions and resource use.
Vodafone	Vodafone enables its customers to reduce their emissions (which include both businesses and governments) and environmental footprint using Vodafone digital technologies and services. In July 2020, they committed to help business customers to reduce their own carbon emissions by a cumulative total of 350 million tonnes globally over 10 years between 2020 and 2030 – the equivalent to Italy's total annual carbon emissions for 2019. Their IoT service offer, including logistics and fleet management, smart metering and manufacturing activities, will be central in delivering this target. Other savings are expected to be made through healthcare services, cloud hosting and home working. They work with the Carbon Trust to calculate the total GHG emissions avoided as a consequence of their IoT technologies and services. They estimate that over 54% of their 123 million IoT connections directly enabled customers to reduce their emissions in the past year. During the year, they estimate an avoidance of 7.1 million tonnes CO_2e, which is 5.2 times the emissions generated from Vodafone's own operations (scope 1 and 2). In March 2021, Vodafone became a founding member of the European Green Digital Coalition which aims to drive investment in, and implementation of, digital solutions in action against climate change.

5.3 Funding climate innovation

Several digital companies have recently launched funds to finance start-ups developing products for reducing and removing carbon emissions. Over USD 3 billion in decarbonization funding has been made available through these initiatives.

Amazon launched The Climate Pledge Fund in 2020 to support the development of sustainable and decarbonizing technologies and services.[149] The USD 2 billion venture capital fund invests in companies whose products and solutions will facilitate the transition to a low-carbon economy. Since launching, the fund has made investments in several companies. For example, Ion Energy uses software to provide advanced battery management solutions to owners and operators of battery fleets used in stationary and mobile applications. Pachama uses satellite imaging with artificial intelligence to verify the impact of carbon capture in nature-based offset projects around the world.

French-headquartered telecommunication group Orange has launched a EUR 50 million Nature fund to finance reforestation and ecological restoration projects.[150] Focused on carbon removal projects, Orange's investment is Europe's first single-investor carbon fund. Launched in partnership with sustainable finance firm Mirova, the Orange Nature fund will directly or indirectly invest in carbon sequestration projects around the world: afforestation, reforestation, and restoration of natural ecosystems. The project is part of the Orange target for a net zero carbon emissions footprint by 2040. Returns from the Orange Nature fund will be in the form of carbon credits to capture the residual CO_2 emissions of the whole Group leading up to the 2040 goal. The fund is in addition to other carbon removal projects Orange has already financed: reforestation of forests in France and Spain, and planting mangrove forests in Senegal.

The Apple USD 200 million Restore Fund is aimed at carbon removal.[151] Launched in 2021 in partnership with Conservation International and Goldman Sachs, it plans to invest in forestry projects with the goal of removing at least 1 million metric tonnes of carbon dioxide every year.

[149] See "The Climate Pledge Fund" at: https://sustainability.aboutamazon.com/about/the-climate-pledge/the-climate-pledge-fund

[150] Orange. 2021. Orange Nature to fund natural ecosystem restoration. News, 8 December 2021. https://www.orange.com/en/newsroom/news/2021/orange-nature-fund-natural-ecosystem-restoration

[151] Apple. 2021. Apple and partners launch first-ever $200 million Restore Fund to accelerate natural solutions to climate change. Press Release, 15 April 2021. https://www.apple.com/newsroom/2021/04/apple-and-partners-launch-first-ever-200-million-restore-fund/

The Microsoft Carbon Innovation Fund will invest USD 1 billion in companies developing products to reduce emissions.[152] Microsoft partners with nine venture capital firms to invest in areas such as direct carbon removal as well as advanced energy systems and sustainable agriculture. Launched in 2020, the fund portfolio stood at 17 companies in May 2022. Investments include Aclima, which provides greenhouse gas measurement and analysis for improving air quality; Climeworks, which is using direct air capture technology in plants in Iceland to remove carbon; and Utilidata, whose AI-driven software optimizes electric grids as well as integrating distributed energy resources such as solar onto the grid.

[152] See "Climate Innovation Fund" at: Microsoft. n.d. https://www.microsoft.com/en-us/corporate-responsibility/sustainability/climate-innovation-fund?activetab=pivot1:primaryr6

6 Conclusions

Digital companies have a notable impact on various dimensions of climate change. Companies assessed for this report account for 0.7 per cent per cent of location-based global emissions and 1.6 per cent of electricity use. The list of the largest corporate purchasers of renewable electricity is dominated by digital companies and the ICT sector on its own accounted for 44 per cent of all global renewable energy purchases in 2020. Some digital companies that have been early adopters of mechanisms such as renewable power purchase agreements and energy credits are driving changes in renewable energy markets through experience and advocacy and are at the forefront of current initiatives for carbon removal and 24x7 green grids. Digital companies have a significant impact on reducing emissions in other sectors, and several of the digital companies assessed for this report consistently outperform peers in other sectors in company climate performance rankings (Box 6.1).

At the same time, there are noticeable differences among the digital companies in their approach to decarbonization. Some are committed to eliminating their entire carbon footprint before 2030 while others, especially some of the biggest emitters, are moving slowly, with operational carbon neutrality targeted for 2050 or even later. The existence of a geographical divide is evident from the company assessments, with companies leading the emissions reporting performance all hailing from North America and Europe.

Table 6.1: Top performing digital companies in climate reporting assessment, 2020

Company	Region of headquarters	Industry	Overall	Data	Target	Performance
Elisa	Europe	Telecom services	A	A	A	B
Cisco	North America	Hardware	A	A	A	B
Apple	North America	Hardware	A	A	A	A
Akamai	North America	IT Services	A	A	A	C
Ericsson	Europe	Hardware	A	A	A	B
IBM	North America	IT Services	A	A	A	B
Microsoft	Europe	IT Services	A	A	A	B
Proximus	Europe	Telecom services	A	A	A	B
Facebook	North America	IT Services	A	A	A	B
Swisscom	Europe	Telecom services	A	B	A	A
Adobe	North America	IT Services	A	A	B	B
Alphabet	North America	IT Services	A	A	A	B
Telefonica	Europe	Telecom services	A	A	B	B
Vodafone	Europe	Telecom services	A	A	B	C
Tele2	Europe	Telecom services	A	B	A	B
SAP	Europe	IT Services	A	B	A	B

Note: Shown in order of climate assessment results.

It is inevitable that as the world becomes more digitized, a process accelerated by the COVID-19, pandemic, electricity use among digital companies will rise. According to Swedish hardware company Ericsson, mobile data traffic grew by 48 per cent in 2020 to 58 443 exabytes per month; data traffic per smartphone has grown from 1.9 GB per month in 2016, to 9 GB per month in 2020 and is forecast to reach over 40 GB per month by 2027.[153] Growth in data traffic is resulting to rising product use as well as growing data centre use.

Energy efficiency can play a part in reducing electricity consumption as evidenced by more energy efficient devices and improving power use effectiveness (PUE) of data centres. However, these efficiencies can only go so far and cannot keep pace with the growth of electricity triggered by digitization. If digital companies were getting all the renewable energy they pay for, emissions would

[153] See "Ericsson Mobility Visualizer" at https://www.ericsson.com/en/reports-and-papers/mobility-report/mobility-visualizer

be far less. The solution therefore is to get more renewable energy onto the power grids — driven by leading digital companies through large purchases of green power — and to reengineer those grids so that 100 per cent of renewable energy purchases are delivered to the buyer — another area where digital companies are leading the way. The most ambitious of the digital companies are hoping this can happen by 2030.

Box 6.1: Digital companies climate performance in context

This report covers the emissions and energy use of the 150 companies assessed by the World Benchmarking Alliance for the Digital Inclusion Benchmark (DIB). The "DIB150" companies encompass the largest technology companies in the world accounting for the majority of the ICT sector company revenue. They include the top six personal computer manufacturers, the top three smartphone vendors, the top five network equipment suppliers, telecommunication operators representing 85 per cent of worldwide mobile subscriptions and 71 per cent of fixed-broadband subscriptions, the top two multitenant data centre operators and all of the leading cloud providers. They account for 83 per cent of the revenue of ICT companies included in the Fortune Global 500 (Table 6.2). [154]

The forty DIB150 companies in the Fortune Global 500 have a higher level of near-term climate commitments and targets than other Global 500 companies. While 11 per cent of the Global 500 are already or plan to be carbon neutral by 2030, the corresponding figure for the 40 technology companies is 25 per cent.[155] Just 9 per cent of the Global 500 use or plan to use 100 per cent renewable electricity by 2030 compared to 30 per cent for ICT companies. And while less than a quarter of the Global 500 have a Science Based Target initiative to be achieved by 2030, almost 60 per cent of the technology companies have one. Another index measuring the climate action and reporting performance of the top 180 publicly listed firms had five of the ICT companies in the top 10.[156]

Twenty-seven of the benchmarked technology companies feature in the Fortune 500 list of the top companies headquartered in the United States.[157] These 27 companies accounted for 15 per cent of Fortune 500 revenue but just 2 per cent of emissions.[158] A climate performance ranking of over 800 companies in the United States placed technology companies in nine of the top ten positions.[159]

Table 6.2: Assessed digital companies and the Fortune Global 500

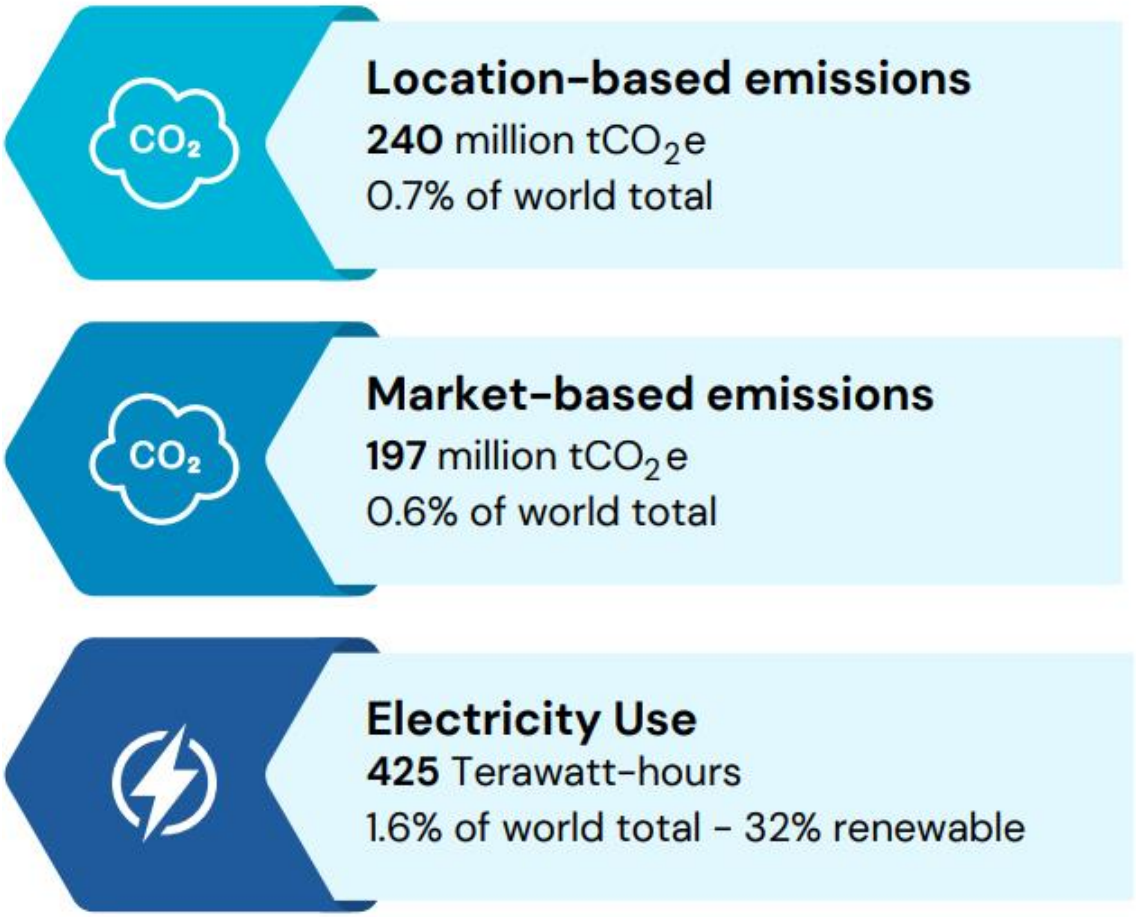
	Number of companies			Revenue (USD millions)		
	Global 500	Assessed companies	%	Global 500	Assessed companies	%
Computers, Office Equipment	9	4	44%	644 058	486 120	75%
Computer Software	3	3	100%	213 233	213 233	100%
Electronics, Electrical Equip.	15	4	27%	964 544	521 198	54%

[154] https://fortune.com/global500/2020/search/
[155] Natural Capital Partners. 2021. Reality Check: The third annual study to assess how Fortune Global 500 companies have increased their climate actions and commitments. https://assets.naturalcapitalpartners.com/downloads/Reality-Check-Study-of-Fortune-Global-500-climate-actions-and-commitments.pdf
[156] Ecoact. 2021. The Climate Reporting and Performance of the DOW 30, EURO STOXX 50 and FTSE 100. https://info.eco-act.com/hubfs/0%20-%20Downloads/SRP%20research%202021/Climate-reporting-performance-research-2021.pdf?hsLang=en
[157] https://fortune.com/fortune500/
[158] Recapture. 2021. Fortune 500 Companies Greenhouse Gas Emissions. https://www.recapturecarbon.com/f500/F500_Report.pdf
[159] https://justcapital.com/rankings/

	Number of companies			Revenue (USD millions)		
	Global 500	Assessed companies	%	Global 500	Assessed companies	%
Information Technology Services	4	2	50%	180 053	101 863	57%
Internet Services and Retailing	7	7	100%	974 006	974 006	100%
Network and Other Communications Equipment	4	4	100%	228 621	228 621	100%
Semiconductors and Other Electronic Components	4	3	75%	177 652	150 386	85%
Telecommunications	15	14	93%	1 186 432	1 138 335	96%
	61	**41**	**67%**	**4 568 598**	**3 813 762**	**83%**

Note: The table refers to technology companies in the Fortune Global 500 and the share of companies and revenue of the 41 assessed digital companies in the list. Industries are those used by the Fortune Global 500.

Figure 6.1: Emissions and electricity use of digital companies assessed, 2020



6.1 Mixed ambitions

A few companies account for the majority of sector emissions and those in East Asia are largely lagging in commitments to reduce emissions in a timely manner. Twenty companies emit 75 per cent of the assessed digital companies emissions. Many of those with their headquarters outside East Asia have strong emission reduction and renewable energy targets and some are already carbon neutral through the use of voluntary offsets. Within East Asia, either there is no time bound commitment — for instance Samsung, the second largest emitter among the companies has not announced a target year to reach carbon neutrality — or commitments are unambitious and often far into the future. In some cases, particularly the three state-owned telecommunication operators with headquarters in China, commitments are based on government targets, which only call for them to reach carbon neutrality by 2060.

There are signs that this is beginning to change. Some of the companies in the region have recently adopted more ambitious goals and several have made renewable energy commitments through the RE100. The largest ever corporate renewable energy procurement contract for offshore wind power recently signed by Taiwan Semiconductor Manufacturing Company (TSMC). Other companies are lobbying governments to improve their climate goals and remove barriers to renewable energy procurement. This needs to accelerate if companies are to meet the 2030 Agenda for Sustainable Development[160] calling to substantially increase the share of renewable energy in the global energy mix[161] and clean and environmentally sound technologies.[162]

6.2 Impacting non-ICT sectors

Studies are emerging that show the significant impact ICTs are having on reducing emissions in other sectors. Enablement is now a calculated metric for some digital companies showing how use of their products and services are avoiding emissions.[163] Activities such as broadband enabled homeworking, online conferencing and smart metering are helping to avoid and reduce emissions. COVID-19 accelerated the use of videoconferencing, lowering travel-induced emissions. As the world becomes more digitized, emissions avoidance from ICT products and services will grow. Importantly, a new ITU Recommendation to be published in 2022 will aim to establish a global method for calculating enablement.

6.3 Developing countries

Almost a third of digital companies are headquartered in middle-income countries while others have operations in those countries. Developing countries face particular challenges including lack of access to the grid in rural areas, dirty grids and frequent outages. Governments need to create a favourable environment for clean energy (e.g., allowing renewable energy providers, eliminating taxes on renewable products, unbundling grids, allowing onsite use of renewables). While in the past factors such as low cost was key to attracting foreign investment, environmental policies are increasingly an influential investment factor for technology multinationals. These companies often have considerable expertise with emissions reduction and their subsidiaries in low- and middle-income countries would fall under the umbrella of the parent company emissions reduction targets. While there is debate about the use of offsets to report lower emissions, they are having an impact in low- and middle-income countries through investment in renewables, reforestation and related initiatives such as clean cookstoves and PAYG solar, contributing to sustainable development. Developing country governments might consider participating in voluntary offset markets to encourage investment in green projects.

6.4 Better accounting and clear goals needed

Most of the digital companies covered in the benchmark publish the basic metrics needed to analyse their operational climate performance. However, there is a wide gap in quality and quantity. Some disclosures are opaque and deviate from the GHG Protocol terminology. Not all companies report both scope 2 metrics (location and market-based) and few compile all relevant categories of scope 3 upstream and downstream emissions. Transparency is lacking in the disclosure of offsets and the verification of carbon neutrality. The ICT industry should also agree on what the term carbon neutrality means and make sure to refer to the standardized definitions of net zero while clarifying whether they refer to location-based or market-based emissions, the role of offsets and carbon removal in achieving them, as well as whether they should include all relevant upstream and downstream emissions.

Targets reported outside the SBTi framework are sometime vague, such as not mentioning the base year or even any emissions data to track the target. Intensity-based targets are challenging because it

[160] https://sdgs.un.org/2030agenda
[161] https://sdg-tracker.org/energy
[162] https://sdg-tracker.org/infrastructure-industrialization
[163] https://ghgprotocol.org/blog/do-we-need-standard-calculate-avoided-emissions

is not possible to make a long-term forecast of what their impact will be and they can result in the intensity metric improving but GHG emissions continuing to rise. While a number of companies provide evidence of the climate data being reviewed by an outside party, very few have statements attesting to a reasonable level of assurance based on GHG verification standards. While GHG accounting is complex and time consuming, digital companies have the responsibility and resources for such an important task. Better verification is also needed to enhance trust in the reported data.

Efforts should be boosted to enhance upstream and downstream scope 3 data. This includes more companies reporting all categories. In addition, identifying supplier emissions by the source company would minimize double counting and eventually allow for the full footprint emissions of digital companies expanding knowledge about the ICTs sector impact on global emissions. Similarly while some of the digital companies disclose disaggregated emissions data by country, this practice should extend to all. More complete country emissions data would allow for deeper geographical analysis of digital company emissions.

Annexes

Information on the companies covered in this report, including emissions, energy use and climate targets, are shown in the tables below. The annex also includes company assessments and the sources of company emissions and energy data used for this report.

Annex A: Benchmarked companies

Company	Region of headquarters	Income group	Industry
Acer	East Asia and Pacific	High income	Hardware
Adobe	North America	High income	IT services
Airbnb	North America	High income	IT services
AIS	East Asia and Pacific	Upper middle income	Telecom services
Akamai	North America	High income	IT services
Alibaba	East Asia and Pacific	Upper middle income	IT services
Alphabet	North America	High income	IT services
Altice	Europe and Central Asia	High income	Telecom services
Amazon	North America	High income	IT services
AMD	North America	High income	Hardware
América Móvil	Latin America and Caribbean	Upper middle income	Telecom services
Ant	East Asia and Pacific	Upper middle income	IT services
Apple	North America	High income	Hardware
Asus	East Asia and Pacific	High income	Hardware
AT&T	North America	High income	Telecom services
Axiata	East Asia and Pacific	Upper middle income	Telecom services
Baidu	East Asia and Pacific	Upper middle income	IT services
BCE	North America	High income	Telecom services
Bharti Airtel	South Asia	Lower middle income	Telecom services
Booking Holdings	North America	High income	IT services
Broadcom	North America	High income	Hardware
BT	Europe and Central Asia	High income	Telecom services
ByteDance	East Asia and Pacific	Upper middle income	IT services
China Mobile	East Asia and Pacific	Upper middle income	Telecom services
China Satellite	East Asia and Pacific	Upper middle income	Telecom services
China Telecom	East Asia and Pacific	Upper middle income	Telecom services
China Unicom	East Asia and Pacific	Upper middle income	Telecom services
Chunghwa Telecom	East Asia and Pacific	High income	Telecom services
Cisco	North America	High income	Hardware
Citrix	North America	High income	IT services
Cloudflare	North America	High income	IT services
Cogent	North America	High income	Telecom services
Comcast	North America	High income	Telecom services
Delivery Hero	Europe and Central Asia	High income	IT services
Dell	North America	High income	Hardware
Deutsche Telekom	Europe and Central Asia	High income	Telecom services
Digicel	Latin America and Caribbean	Upper middle income	Telecom services
Digital Realty Trust	North America	High income	IT services
eBay	North America	High income	IT services
EchoStar	North America	High income	Hardware
Elisa	Europe and Central Asia	High income	Telecom services
Equinix	North America	High income	IT services
Ericsson	Europe and Central Asia	High income	Hardware
Etisalat	Middle East and North Africa	High income	Telecom services
Eutelsat	Europe and Central Asia	High income	Telecom services
Facebook*	North America	High income	IT services
Foxconn	East Asia and Pacific	High income	Hardware
GlobalFoundries	North America	High income	Hardware
Globe	East Asia and Pacific	Lower middle income	Telecom services
Gojek	East Asia and Pacific	Lower middle income	IT services
Grab	East Asia and Pacific	High income	IT services
GTT	North America	High income	Telecom services
HCL	South Asia	Lower middle income	IT services
HP	North America	High income	Hardware
Huawei	East Asia and Pacific	Upper middle income	Hardware
IBM	North America	High income	IT services
iFlytek	East Asia and Pacific	Upper middle income	IT services
Iliad	Europe and Central Asia	High income	Telecom services
Infosys	South Asia	Lower middle income	IT services
Inmarsat	Europe and Central Asia	High income	Telecom services
Intel	North America	High income	Hardware
JD.com	East Asia and Pacific	Upper middle income	IT services
Jio	South Asia	Lower middle income	Telecom services
Jumia	Sub-Saharan Africa	Lower middle income	IT services

Company	Region of headquarters	Income group	Industry
KDDI	East Asia and Pacific	High income	Telecom services
KPN	Europe and Central Asia	High income	Telecom services
KT	East Asia and Pacific	High income	Telecom services
Lenovo	East Asia and Pacific	Upper middle income	Hardware
LG	East Asia and Pacific	High income	Hardware
Liberty Global	Europe and Central Asia	High income	Telecom services
Logitech	Europe and Central Asia	High income	Hardware
Lumen	North America	High income	Telecom services
MegaFon	Europe and Central Asia	Upper middle income	Telecom services
Meituan	East Asia and Pacific	Upper middle income	IT services
Mercado Libre	Latin America and Caribbean	Upper middle income	IT services
Microsoft	North America	High income	IT services
Millicom	Europe and Central Asia	High income	Telecom services
MTN	Sub-Saharan Africa	Upper middle income	Telecom services
MTS	Europe and Central Asia	Upper middle income	Telecom services
Naspers	Sub-Saharan Africa	Upper middle income	IT services
NAVER	East Asia and Pacific	High income	IT services
NEC	East Asia and Pacific	High income	IT services
NetEase	East Asia and Pacific	Upper middle income	IT services
Netflix	North America	High income	IT services
Nintendo	East Asia and Pacific	High income	Hardware
Nokia	Europe and Central Asia	High income	Hardware
NTT	East Asia and Pacific	High income	Telecom services
NVIDIA	North America	High income	Hardware
Ola	South Asia	Lower middle income	IT services
Omantel	Middle East and North Africa	High income	Telecom services
Ooredoo	Middle East and North Africa	High income	Telecom services
Oracle	North America	High income	IT services
Orange	Europe and Central Asia	High income	Telecom services
OTE	Europe and Central Asia	High income	Telecom services
Palantir	North America	High income	IT services
Paypal	North America	High income	IT services
PCCW	East Asia and Pacific	High income	Telecom services
Pinduoduo	East Asia and Pacific	Upper middle income	IT services
PLDT	East Asia and Pacific	Lower middle income	Telecom services
Proximus	Europe and Central Asia	High income	Telecom services
Qualcomm	North America	High income	Hardware
Rakuten	East Asia and Pacific	High income	IT services
Rogers	North America	High income	Telecom services
Safaricom	Sub-Saharan Africa	Lower middle income	Telecom services
Salesforce	North America	High income	IT services
Samsung	East Asia and Pacific	High income	Hardware
SAP	Europe and Central Asia	High income	IT services
Seagate	Europe and Central Asia	High income	Hardware
ServiceNow	North America	High income	IT services
SES	Europe and Central Asia	High income	Telecom services
Sina	East Asia and Pacific	Upper middle income	IT services
Singtel	East Asia and Pacific	High income	Telecom services
SK hynix	East Asia and Pacific	High income	Hardware
SK Telecom	East Asia and Pacific	High income	Telecom services
SoftBank	East Asia and Pacific	High income	Telecom services
Sonatel	Sub-Saharan Africa	Lower middle income	Telecom services
SONY	East Asia and Pacific	High income	Hardware
SpaceX	North America	High income	Hardware
Spark	East Asia and Pacific	High income	Telecom services
Spotify	Europe and Central Asia	High income	IT services
stc	Middle East and North Africa	High income	Telecom services
Swisscom	Europe and Central Asia	High income	Telecom services
Tata Communications	South Asia	Lower middle income	Telecom services
Tele2	Europe and Central Asia	High income	Telecom services
Telecom Egypt	Middle East and North Africa	Lower middle income	Telecom services
Telecom Italia	Europe and Central Asia	High income	Telecom services
Telefonica	Europe and Central Asia	High income	Telecom services
Telenor	Europe and Central Asia	High income	Telecom services
Telia	Europe and Central Asia	High income	Telecom services
Telkom	Sub-Saharan Africa	Upper middle income	Telecom services

Company	Region of headquarters	Income group	Industry
Telkom Indonesia	East Asia and Pacific	Lower middle income	Telecom services
Telstra	East Asia and Pacific	High income	Telecom services
Tencent	East Asia and Pacific	Upper middle income	IT services
Texas Instruments	North America	High income	Hardware
TSMC	East Asia and Pacific	High income	Hardware
Türk Telekom	Europe and Central Asia	Upper middle income	Telecom services
Twilio	North America	High income	IT services
Twitter	North America	High income	IT services
Uber	North America	High income	IT services
VEON	Europe and Central Asia	High income	Telecom services
Verizon	North America	High income	Telecom services
Viettel	East Asia and Pacific	Lower middle income	Telecom services
Vodafone	Europe and Central Asia	High income	Telecom services
Western Digital	North America	High income	Hardware
Xiaomi	East Asia and Pacific	Upper middle income	Hardware
Yandex	Europe and Central Asia	Upper middle income	IT services
Yunji	East Asia and Pacific	Upper middle income	IT services
Zain	Middle East and North Africa	High income	Telecom services
Zoom	North America	High income	IT services
ZTE	East Asia and Pacific	Upper middle income	Hardware

Note: * Rebranded as Meta Platforms in October 2021.

Annex B: GHG inventory (tCO_2e), 2020

Company	3rd party verification statement	Scope 1	Scope 2 Location Based	Scope 2 Market based	Scope 3	Scope 3 Note
Acer	✓	3 004	15 114	9 195	1 693 341	All relevant categories
Adobe	✓	9 842	51 176	34 540	438 210	6 categories
Airbnb						
AIS	✓	11 196	685 687	685 687		Not calculated
Akamai	✓	38	190 800	105 100	41 100	Akamai Global Platform only
Alibaba	✓	510 026	3 709 747	3 709 747	5 294 457	All relevant categories
Alphabet	✓	38 694	5 865 095	911 415	9 376 000	All relevant categories; no breakdown
Altice		8 341	52 158	52 158		Not calculated
Amazon	✓	9 620 000	5 270 000	5 270 000	45 750 000	All relevant categories
AMD	✓	2 335	29 916	29 916	5 554 692	All relevant categories
América Móvil	✓	288 688	2 453 963	2 453 963	6 412 754	Some categories
Ant						
Apple	✓	47 430	890 189	0	22 550 000	All relevant categories
ASUS		51	20 379	20 379	1 200 925	Supply Chain, product use, transportation
AT&T	✓	1 040 000	5 635 263	4 740 000	2 830 000	All relevant categories
Axiata	✓	102 548	1 276 641	1 276 641		Not calculated
Baidu		5 974	468 246	468 246	16 622	Sewage, business travels & buildings
BCE	✓	142 996	160 548	160 548	1 947 578	12 categories
Bharti Airtel		42 955	880 859	880 859		Not calculated
Booking Holdings		2 373	41 994	9 117	109 885	All relevant categories
Broadcom		112 646	128 076	128 076		Not calculated
BT	✓	171 422	633 091	261 806	3 454 525	All relevant categories
ByteDance						
China Mobile		240 000	33 910 000	33 910 000	496 400	Business travel & employee commuting
China Satellite						
China Telecom		210 000	13 550 000	13 550 000		Not calculated
China Unicom		200 000	14 030 000	14 030 000		Not calculated
Chunghwa Telecom	✓	22 193	768 128		244 865	Category 3, 4 & 5
Cisco	✓	39 223	607 969	163 636	24 867 512	All relevant categories
Citrix	✓	3 336	18 082	12 618	260 043	All relevant categories
Cloudflare	✓	0	13 955	0		Not calculated
Cogent						
Comcast		547 084	1 743 564	1 675 509		Not calculated
Delivery Hero	✓	1 274	1 710	3 103	278 361	Categories 1, 5, 6 and 9
Dell	✓	44 900	360 800	174 900	15 134 600	All relevant categories
Deutsche Telekom	✓	235 261	4 815 423	2 276 607	13 881 000	All relevant categories
Digicel						
Digital Realty Trust	✓	32 798	2 964 619	1 833 390	2 521 356	Categories 3, 6 and 7
eBay	✓	18 847	139 389	47 715	1 468 100	8 categories
EchoStar						
Elisa	✓	660	59 760	1 662	171 263	All categories
Equinix	✓	55 100	2 280 200	327 700	1 633 000	All relevant categories
Ericsson	✓	40 000	156 000	74 000	36 605 000	4 categories including use of sold products
Etisalat	✓	7 366	561 085	561 085	14 756	Fuel consumption in operations
Eutelsat		58	5 626	5 475	1 610	Business travel
Facebook	✓	29 000	7 555 000	9 000	4 029 000	Categories 1-3 and 6-7
Foxconn		152 602	5 265 000	5 265 000	102 140	Category 4
GlobalFoundries		1 552 766	795 507	795 507		Not calculated
Globe		38 758	424 753	424 753		Not calculated
GoJek	✓	0	617	617	1 042 734	6 categories including use of sold products
Grab	✓	0	5 030	5 030	1 506 045	Use of sold products and business travel
GTT						
HCL		20 744	131 125	131 125	10 254	Business travel
HP	✓	50 600	203 600	120 400	44 720 000	All relevant categories
Huawei		41 736	2 243 722	2 243 722		Not calculated
IBM	✓	90 906	828 794	530 365	706 387	All relevant categories
iFlytek						
Iliad		16 000	65 000	65 000	372 000	Electricity use by devices
Infosys	✓	8 678	68 673	68 673	213 514	7 categories

Company	3rd party verification statement	Scope 1	Scope 2 Location Based	Scope 2 Market based	Scope 3	Scope 3 Note
Inmarsat		868	11 381	7 452	223 784	All relevant categories
Intel	✓	1 973 000	3 700 000	909 000	29 866 000	All relevant categories
JD.com		355 585	646 827	646 827	1 273 523	No breakdown
Jio		493 761	3 106 924	3 106 924	521 876	Some relevant categories
Jumia						
KDDI	✓	25 338	1 476 961	1 297 520	5 390 054	All relevant categories but non-consolidated
KPN	✓	16 800	273 600	0	885 400	All relevant categories
KT	✓	36 059	1 185 659	1 185 659	464 378	Some categories
Lenovo	✓	7 269	177 678	21 519	19 976 020	All relevant categories
LG	✓	440 000	854 000	854 000	59 001 759	Categories 1 (domestic), 6 and 11
Liberty Global	✓	47 029	199 116	38 257	23 618	No breakdown
Logitech		801	15 703	1 088	1 299 592	All relevant categories
Lumen		224 166	1 860 121	1 779 708	2 456 221	All relevant categories
MegaFon						Not calculated
Meituan*						Not calculated
Mercado Libre		188 745	12 610	12 610	590 720	No breakdown
Microsoft	✓	118 100	4 102 445	228 194	11 239 000	All relevant categories
Millicom	✓	27 339	165 197	165 197	1 585 057	No breakdown
MTN		272 695	953 351	953 351	912 471	No breakdown
MTS		31 246	631 575	631 575		Not calculated
Naspers	✓	11 282	18 402	18 402		Not calculated
Naver	✓	230	79 677	79 677		Not calculated
NEC	✓	26 000	347 000	347 000	6 158 000	No breakdown
NetEase		2 072	18 366	18 366	50 225	Employee travel and rented data centers
Netflix	✓	30 883	28 585	141	1 067 778	Categories 1-4, 6-7, and 13
Nintendo		461	4 809	4 809		Not calculated
Nokia	✓	116 300	380 200	263 600	35 595 100	All relevant categories
NTT		243 707	4 560 424	4 471 746	22 230 000	All relevant categories
NVIDIA	✓	2 692	105 621	89 048	2 074 450	8 Categories
Ola						
Omantel						
Ooredoo*						Not calculated
Oracle		10 300	602 329	419 277	1 577 176	All relevant categories
Orange		282 526	1 223 080	990 554	14 729	Business travel only
OTE		25 410	279 578	37 665		Not calculated
Palantir						Not calculated
PayPal	✓	3 000	22 100	22 100	13 600	Not all categories
PCCW	✓	7 359	229 092	229 092	1 252	Paper and water consumption and sewage
Pinduoduo						
PLDT	✓	43 248	439 703	439 703		Not calculated
Proximus	✓	26 600	70 400	800	647 000	8 relevant categories
Qualcomm	✓	112 479	245 077	203 047	2 705 344	All relevant categories
Rakuten	✓	2 705	93 192	66 494	1 045 127	All relevant categories
Rogers	✓	29 456	118 662	118 662		Not calculated
Safaricom		31 126	33 142	33 142	1 765	No breakdown
Salesforce	✓	1 000	292 000	84 000	946 400	All relevant categories
Samsung	✓	5 726 000	17 579 000	9 079 000	65 591 000	All relevant categories
SAP	✓	95 000	124 967	34 000	40 000	Some categories
Seagate	✓	311 120	879 032	887 960	8 670 300	All relevant categories
ServiceNow		1 018	28 458	19 392	3 928	Business travel
SES		2 510	25 850	30 800	4 250	Business travel, commuting, waste, water
Sina						
Singtel	✓	7 643	605 329	585 251	14 892	3 categories
SK hynix	✓	2 711 409	4 836 920	4 836 920	99 765	Limited categories
SK Telecom	✓	6 133	1 033 846	1 033 846	9 486 821	1-3, 5-8, 14 and 15
SoftBank	✓	12 141	590 438	590 438	3 121 487	All categories
Sonatel		6 546	82 894			Not calculated
Sony	✓	189 000	1 282 239	1 203 990	17 077 000	All relevant categories
SpaceX						
Spark	✓	2 500	15 855	15 855	6 277	C3, C6 and C13
Spotify		0	3 700	2 600	166 300	Categories 1, 6 and 11
stc		19 974	159 911	159 911		Not calculated

Company	3rd party verification statement	Scope 1	Scope 2 Location Based	Scope 2 Market based	Scope 3	Scope 3 Note
Swisscom	✓	14 420	47 104	0	295 921	All relevant categories
Tata Comm.	✓	5 561	98 453	98 453	1 305	Business travel, employee commute and waste
Tele2	✓	2 434	43 666	8 602	187 292	All relevant categories
Telecom Egypt						
Telecom Italia		153 829	559 629	641 541	8 391	Work-home commuting and business travel
Telefonica	✓	212 682	1 396 941	530 684	1 909 321	Categories 1-3, 6 and 11
Telenor	✓	167 396	847 892	1 039 796	2 096 000	No breakdown
Telia		7 000	132 000	6 000	1 151 000	All relevant categories
Telkom		50 695	578 225	578 225		Not calculated
Telkom Indonesia		34 454	800 310	800 310		Not calculated
Telstra	✓	36 905	1 210 145	1 210 145	3 456 996	All except 10, 13 and 14
Tencent		4 090	926 676	926 676		Not calculated
Texas Instruments	✓	938 506	1 195 111	978 237		Not calculated
TSMC	✓	2 450 354	8 282 509	7 459 856	5 511 486	All relevant categories
Türk Telekom		112 730	712 625	712 625	8 849	No breakdown
Twilio		65	4 619		12 744	Some categories
Twitter						
Uber	✓	1 121	131 701	131 701	3 102 101	Category 11 Use of sold products
VEON		140 000	1 180 000	1 180 000		Not calculated
Verizon	✓	336 831	3 753 660	3 627 972	15 640 414	All relevant categories
Viettel						
Vodafone	✓	271 626	2 040 000	1 096 240	9 400 000	7 main categories
Western Digital	✓	44 643	958 052	1 000 814	27 680	Business air travel
Xiaomi		624	30 723	30 723		Not calculated
Yandex		94 624	116 390			Not calculated
Yunji						
Zain	✓	401 370	730 328	730 328	44 644	Business travel and employee commuting
Zoom						
ZTE		18 676	432 398	432 398		Not calculated

Note: * Provides aggregated Scope 1 and 2 figure with no breakdown.

Annex C: Energy use and intensity metrics, 2020

Company	Energy use (MWh)	Renewable energy (%)	Electricity use (MWh)	Renewable electricity (%)	Revenue (USD m)	GHG* / Revenue	GHG** / Electricity
Acer	31 735		31 735	54	USD 9 367	1.61	0.29
Adobe	208 187	38	162 417	48	USD 12 868	3.98	0.21
Airbnb					USD 3 378		
AIS	1 220 024	0.5	1 177 954		USD 5 525	124.11	0.58
Akamai	477 800	51	477 800	51	USD 3 198	59.66	0.22
Alibaba	9 333 333		9 333 333	2	USD 103 943	35.69	0.40
Alphabet	15 439 538	85	15 138 543	100	USD 182 527	32.13	0.06
Altice	984 212				USD 17 149	3.04	
Amazon	24 000 000	65	24 000 000	65	USD 386 064	13.65	0.22
AMD	124 000	27	116 000		USD 9 763	3.06	0.26
América Móvil	6 365 209	14	5 474 080	14	USD 47 329	51.85	0.45
Ant							
Apple	2 933 870	92	2 580 000	100	USD 274 515	3.24	0.00
Asus	38 964		38 725	0	USD 13 953	1.46	0.53
AT&T	17 500 000		14 100 000	16	USD 171 760	32.81	0.34
Axiata	2 344 444	1	1 916 569	0	USD 5 758	221.72	0.67
Baidu	588 112	9	529 137	9	USD 15 516	30.18	0.88
BCE	2 553 153		1 936 097	58	USD 17 062	9.41	0.08
Bharti Airtel	1 393 090		1 115 011	6	USD 13 578	64.87	0.79
Booking Holdings	173 809	29	115 483	29	USD 6 796	6.18	0.08
Broadcom	407 093		292 466		USD 23 888	5.36	0.44
BT	3 315 000	90	2 577 000	100	USD 27 347	23.15	0.10
ByteDance							
China Mobile	31 212 915	6	54 919 000	7	USD 111 302	304.67	0.62
China Satellite							
China Telecom	23 993 689		22 833 000		USD 57 031	237.59	0.59
China Unicom	17 220 000		17 220 000		USD 44 030	318.65	0.81
Chunghwa Telecom	1 663 443	5	1 353 500		USD 7 018	109.45	
Cisco	1 718 000	76	1 556 000	83	USD 49 301	12.33	0.11
Citrix				75	USD 3 237	5.59	
Cloudflare	41 300		41 300	100	USD 431	32.37	0.00
Cogent					USD 568		
Comcast	6 504 762	4	4 436 006	6	USD 103 564	16.84	0.38
Delivery Hero	4 500		5 437	9	USD 2 823	0.61	0.57
Dell	1 106 000		958 000	54	USD 94 224	3.83	0.18
Deutsche Telekom	12 800 000		11 716 000	58	USD 115 361	41.74	0.19
Digicel							
Digital Realty Trust	8 589 399	48	8 318 712	50	USD 3 904	759.46	0.22
eBay	468 647	62	392 369	74	USD 10 271	13.57	0.12
EchoStar					USD 1 888		
Elisa	320 067	87	317 304	88	USD 2 164	27.61	0.01
Equinix	6 460 000	91	6 460 000	91	USD 5 999	380.13	0.05
Ericsson	756 000	52	572 000	68	USD 25 232	6.18	0.13
Etisalat	105 125		73 516		USD 14 080	39.85	7.63
Eutelsat	22 926				USD 1 460	3.85	
Facebook	7 170 000		7 170 000	100	USD 85 965	87.88	0.00
Foxconn	10 383 795	10	8 423 000	12	USD 181 116	29.07	0.63
GlobalFoundries	3 019 000	0	2 626 530	0.1	USD 4 851	163.99	0.30
Globe	567 214		590 555		USD 3 235	131.31	0.72
GoJek	793	0	793	0			0.78
Grab					USD 868	5.8	
GTT							
HCL	271 433	10	248 197	11	USD 10 173	12.89	0.53
HP	604 901	40	480 595	40	USD 56 639	3.59	0.25
Huawei	3 601 700		3 601 700		USD 129 169	17.37	0.62
IBM	4 118 636		3 513 000	59	USD 73 620	11.26	0.15
iFlytek							
Iliad	944 000		944 000	9	USD 6 706	9.69	0.07
Infosys	186 572		176 605	45	USD 13 561	5.06	0.39
Inmarsat	37 552			40	USD 1 272	8.95	
Intel	10 600 000	82	8 798 000	82	USD 77 867	47.52	0.10
JD.com	332 138		332 138		USD 108 075	5.98	1.95
Jio	4 186 928		3 749 479	0.2	USD 9 432	329.42	0.83

Company	Energy use (MWh)	Renewable energy (%)	Electricity use (MWh)	Renewable electricity (%)	Revenue (USD m)	GHG* / Revenue	GHG** / Electricity
Jumia					USD 159		
KDDI	3 201 028		3 201 028	11	USD 49 755	29.68	0.41
KPN	674 444	85	573 000	100	USD 6 057	45.17	0.00
KT	6 938 306	0.1	2 538 600	0	USD 20 264	58.51	0.47
Lenovo	346 683	3	292 751	11	USD 60 742	2.93	0.07
LG	2 420 972	3	1 633 888	4	USD 53 599	15.93	0.52
Liberty Global	930 320		818 020	82	USD 11 980	16.62	0.05
Logitech	30 375	86	28 580	92	USD 5 252	2.99	0.04
Lumen	5 571 233	5	4 605 413	6	USD 20 712	89.81	0.39
MegaFon	1 364 732		1 232 872		USD 4 607		
Meituan	56 407				USD 16 635		
Mercado Libre	27 590		27 585		USD 3 974		0.46
Microsoft	10 757 166	95	10 244 377	100	USD 143 015	28.69	0.02
Millicom	704 533		600 304		USD 4 171	39.61	0.28
MTN	5 717 836		1 816 851	0	USD 10 897	87.48	0.52
MTS	1 499 900		1 499 908	0	USD 6 864	92.02	0.42
Naspers					USD 5 934		
Naver	458 056	0.1	454 444		USD 4 494	17.73	0.18
NEC	853 536	6	2 027 778	8	USD 28 040	12.38	0.17
NetEase	94 722		94 722		USD 10 675	1.72	0.19
Netflix	94 285	100	94 285	100	USD 24 996	1.14	0.00
Nintendo	51 411	13	15 713	13	USD 16 473	0.29	0.31
Nokia	1 059 000	33	893 000	39	USD 24 959	15.23	0.30
NTT	10 459 578	3	6 670 000	3	USD 111 862	40.77	0.67
Nvidia	325 899		310 016	25	USD 16 675	6.33	0.29
Ola							
Omantel					USD 1 386		
Ooredoo	4 280 740		3 746 752		USD 7 930		
Oracle	1 631 246	45	1 566 666	46	USD 40 479	14.88	0.27
Orange	5 468 000		4 329 000	14	USD 48 281	25.33	0.23
OTE	620 000				USD 3 722	75.11	
Palantir					USD 1 093		
PayPal	264 100	66	264 100	76	USD 21 454	1.03	0.08
PCCW	371 068		371 068		USD 4 905	46.71	0.62
Pinduoduo					USD 8 621		
PLDT	735 411	37	735 411		USD 3 648	120.55	0.60
Proximus	458 889	77	352 000	100	USD 6 258	11.25	0.00
Qualcomm	483 532	10	451 768	11	USD 23 531	10.42	0.45
Rakuten	192 777		178 909	65	USD 13 632	6.84	0.37
Rogers	1 232 872		1 091 770	44	USD 10 376	11.44	0.11
Safaricom	285 771	60	196 746	90	USD 2 352	14.09	0.17
Salesforce	777 000		746 000	75	USD 21 252	13.74	0.11
Samsung	29 024 000	14	22 916 000	18	USD 200 637	87.62	0.40
SAP	693 000	70	816 000	100	USD 31 225	4	0.04
Seagate	1 696 968	0.1	1 626 187	0	USD 10 509	83.65	0.55
ServiceNow	85 975	27	69 396	27	USD 4 519	6.3	0.28
SES					USD 2 143	12.06	
Sina							
Singtel	445 194	1	961 295	0.3	USD 11 338	53.39	0.61
SK hynix	25 045 559	0	23 167 536	0	USD 27 028	178.96	0.21
SK Telecom	2 248 035	0.1	2 216 781	0	USD 15 780	65.52	0.47
SoftBank	1 680 530		1 680 530	19	USD 52 711	11.2	0.35
Sonatel	135 410	5	109 740	6	USD 2 095	39.56	
Sony	2 967 530	6	2 406 919	6	USD 84 284	15.21	0.50
SpaceX							
Spark	160 340		160 340	82	USD 2 349	6.75	0.10
Spotify		100		100	USD 9 001	0.41	
STC	331 360		244 513		USD 15 721	10.17	0.65
Swisscom	546 000		479 046	100	USD 11 823	3.98	0.00
Tata Communications	166 762	14	140 762		USD 2 308	42.66	0.70
Tele2	249 361	87	225 318	95	USD 2 883	15.15	0.04
Telecom Egypt					USD 2 025		
Telecom Italia	2 198 708	30	2 198 708	30	USD 18 052	31	0.29
Telefonica	6 863 728	72	6 543 977	88	USD 49 201	28.39	0.08
Telenor	3 275 000	7	2 473 000	9	USD 13 043	65.01	0.42

Company	Energy use (MWh)	Renewable energy (%)	Electricity use (MWh)	Renewable electricity (%)	Revenue (USD m)	GHG* / Revenue	GHG** / Electricity
Telia	1 216 000	93	1 135 250	100	USD 9 684	13.63	0.01
Telkom	657 840	0	555 986	0	USD 2 626	220.19	1.04
Telkom Indonesia	2 431 487		2 313 301		USD 9 357	85.53	0.35
Telstra	1 957 217	100	1 793 784	23	USD 18 004	67.22	0.67
Tencent	1 723 568		1 703 233	23	USD 69 857	13.27	0.54
Texas Instruments	2 888 724	15	2 461 723	18	USD 14 461	82.64	0.40
TSMC	16 919 000	7	16 058 000	8	USD 45 271	182.96	0.46
Türk Telekom	1 831 313		1 621 395	0.2	USD 4 036	176.55	0.44
Twilio					USD 1 762	2.62	
Twitter					USD 3 716		
Uber	329 893	32	329 893	32	USD 11 139	11.82	0.40
Veon	2 750 000		2 730 000		USD 7 980	147.87	0.43
Verizon	11 427 436	3	9 833 827	3	USD 128 292	29.26	0.37
Viettel					USD 6 383		
Vodafone	5 832 000	54	5 524 000	56	USD 56 165	36.32	0.20
Western Digital	2 033 778	7	1 865 600	7	USD 16 736	57.24	0.54
Xiaomi	48 608		45 416		USD 35 629	0.86	0.68
Yandex	418 577		398 477		USD 3 028	38.44	
Yunji					USD 801		
Zain	976 334	1	976 334	1	USD 5 313	137.47	0.75
Zoom					USD 2 651		
ZTE	593 093		534 178	1	USD 14 701	29.41	0.81

Note: Note that for companies not disclosing renewable electricity, the value would be equal to the grid mix. So non-disclosure does not necessarily imply low renewable use. Conversely, for some companies reporting high levels of renewable electricity it typically refers to their renewable purchases and is often not what they are getting on the grid.
* Scope 2 location based. ** Scope 2 market based.

Annex D: Targets

Company	Description	SBTi *	Carbon neutral **
Acer	Pledge to achieve 100 per cent renewable energy use by the year 2035.		
Adobe	SBTI approved science-based target to achieve a 35per cent reduction in our scope 1 and scope 2 GHG emissions by 2025 from a 2018 baseline.	✓	
Airbnb	Net zero by 2030.		2030
AIS	Reduce direct and indirect GHG emission intensity (tCO_2e per Terabit) in 2023 by 90 per cent compared to the baseline set in 2015.		
Akamai	50 per cent by 2030 from base year, 2020.	✓	2030
Alibaba	By 2030, achieve carbon neutrality in our own operations. [As well as others, see source].		2030
Alphabet	By 2030: *Achieve net-zero emissions across all of operations and value chain *Become the first major company to run on carbon-free energy 24 hours a day, seven days a week, 365 days a year.		2007
Altice	No evidence of target found.		
Amazon	Commitment to achieve netzero carbon emissions across business by 2040		2040
AMD	50 per cent reduction in absolute GHG emissions from AMD operations from 2020 to 2030.	✓	
América Móvil	América Móvil commits to reduce its scope 1 and 2 GHG emissions by 52 per cent, as well as our absolute scope 3 GHG emissions by 13.5 per cent by 2030, compared with 2019 levels.	✓	
Ant	By 2030, for all scopes 1, 2, and 3 achieve net zero emissions.		2030
Apple	Achieve carbon neutrality for our entire carbon footprint by 2030.		2020
Asus	Reduce 50 per cent of carbon emissions from ASUS global operations centers by 2030 [baseline 2020].		
AT&T	2030 TARGET: Reduce our absolute scope 1 and 2 GHG emissions 63 per cent by 2030 (against 2015 baseline) – aligning with a 1.5°C pathway. 2035 GOAL: Achieve carbon neutrality (net zero scope 1 and 2 emissions).	✓	2035
Axiata	We remain committed to the GSMA Zero by 2050 target which calls for GSMA members to commit to setting verifiable Science Based Targets (SBT) at 1.5°C, or a target that aligns and meets national commitments	✓	2050
Baidu	Achieve carbon neutrality by 2030 from 2020 base year		2030
BCE	Reduce our absolute scope 1 and scope 2 GHG emissions 57 per cent by 2030, from a 2020 base year. Reduce our absolute scope 3 GHG emissions from categories other than purchased goods and services 42 per cent by 2030, from a 2020 base year.	✓	2025
Bharti Airtel	Airtel has committed to set Science Based targets for emissions reduction and achieve net-zero carbon emissions by no later than 2050. (see STBi; also this seems to be India only).	✓	2050
Booking Holdings	No evidence of target found.		2020
Broadcom	No evidence of target found.		
BT	We're working to become a net zero carbon emissions business by 2045 and this year we expanded this target to include our supply chain as well as our operations.	✓	2045
ByteDance	No evidence of target found.		
China Mobile	Dedicated to achieve the national target of peaking carbon dioxide emissions by 2030 and reaching carbon neutrality by 2060.		2060
China Satellite	No evidence of target found.		
China Telecom	In response to the national requirements of "reaching a peak on carbon dioxide emissions and carbon neutrality" [… the company will] strive to achieve the carbon emission peak by 2030 and carbon neutrality by 2060.		2060
China Unicom	No evidence of target found.		2060
Chunghwa Telecom	No evidence of target found.		
Cisco	Cisco commits to reaching net zero across all scopes of emissions by 2040, which includes our product use, operations, and supply chain; company also commits to reaching net zero for all global scope 1 and scope 2 emissions by 2025.	✓	2025
Citrix	Set targets to reduce our total absolute GHG emissions by 30 percent and carbon intensity per unit of revenue by 50 percent by 2030, from a 2019 baseline level. These	✓	

Company	Description	SBTi *	Carbon neutral **
	targets cover scope 1 (direct), scope 2 (energy indirect), and scope 3 (other indirect) GHG emissions.		
Cloudflare	No evidence of target found		2020
Cogent	No evidence of target found		
Comcast	Commitment to be carbon neutral by 2035 in scopes 1 and 2 emissions across our entire global operations.		2035
Delivery Hero	As of January 1st, 2022 Delivery Hero is planning to become carbon neutral globally.		2021
Dell	Commits to reach net zero greenhouse gas (GHG) emissions across scopes 1, 2 and 3 by 2050. Goal of reducing scope 1 and 2 GHG emissions by 50 per cent by 2030 from 2020 baseline.		2050
Deutsche Telekom	By the end of 2025, wants to achieve climate neutrality in the company. Commits to reduce absolute scope 1 and 2 GHG emissions 90% by 2030 from a 2017 base-year. Commits to increase annual sourcing of renewable electricity from 41% in 2017 to 100 per cent by 2021. Commits to reduce scope 3 GHG emissions 25 per cent per customer by 2030 from a 2017 base-year.	✓	2025
Digicel	No evidence of target found.		
Digital Realty Trust	Committed to reducing scope 1 and 2 emissions (by area (i.e., m^2)) by 68 per cent and scope 3 emissions by area by 24% by 2030.		
eBay	Commits to reduce absolute scope 1 and scope 2 GHG emissions 90 per cent by 2030 from a 2019 base year. Also commits to reduce absolute scope 3 emissions from downstream transportation and distribution 20 per cent within the same timeframe.	✓	
EchoStar	No evidence of target found.		
Elisa	Carbon neutral by 2020 (achieved); by 2025 reduce scope 1 and 2 by 50 per cent compared to 2016 and scope 3 by 12 per cent.	✓	2020
Equinix	Equinix will reduce absolute scope 1 and 2 GHG emissions by 50 per cent by 2030, from a 2019 base year.	✓	
Ericsson	Net zero in own activities by 2030 and value chain by 2040. By 2030 committed to reduce emissions from portfolio and supply chain by 50 percent.	✓	2030
Etisalat	No evidence of target found.		
Eutelsat	No evidence of target found.		
Facebook	Committed to reaching net zero emissions across value chain in 2030.		2020
Foxconn	Net zero by 2050.	✓	2050
GlobalFoundries	Goal to reduce absolute scope 1 and scope 2 GHG emissions by 25% from 2020 to 2030.		
Globe	No evidence of target found.	✓	
Gojek	Net zero by 2030 of scope 1 and 2 emissions, compared to 2020 as baseline year.		2030
Grab	No evidence of target found.		
GTT	No evidence of target found.		
HCL	No evidence of target found.	✓	
HP	Commits to reduce scope 1 and 2 GHG emissions 60% by 2025, using a 2015 base year. Commits to reduce product use GHG emissions intensity (lifetime use emissions per unit shipped), including emissions resulting from both products' energy use and paper use, 30 per cent by 2025 from a 2015 base year. Further commits to reduce scope 3 emissions intensity from first-tier production and product transportation suppliers (emissions per million USD revenue) 10 per cent by 2025, using a 2015 base year.	✓	
Huawei	No evidence found of recent target.		
IBM	Reduce GHG emissions 65 percent by 2025, measured against 2010 and adjusted for acquisitions and divestitures. Procure 75 per cent of the electricity IBM consumes.		2030
	worldwide from renewable sources by 2025, and 90 per cent by 2030. Reach net zero greenhouse gas emissions by 2030.		
iFlytek	No evidence of target found.		
Iliad	95 per cent reduction in scopes 1 and 2 emissions by 2035 in France (baseline 2019) and 98 per cent in Italy (baseline 2020); 30 per cent and 98 per cent reductions, respectively, in significant scope 3 emissions (box and mobile equipment and consumption, roaming), excluding	✓	2035
Infosys	Commits to reduce absolute scope 1 and 2 GHG emissions 12.5 per cent by FY2025 and 37.5 per cent by FY2035 from a FY2020 base year. Infosys Limited also commits to reduce absolute scope 3 GHG emissions 12.5 per cent by FY2025 and 37.5 per cent by FY2035 from a FY2020 base year.	✓	2019

Company	Description	SBTi *	Carbon neutral **
Inmarsat	In 2019 we set and internally approved a scope 1 and 2 reduction target of 29 per cent by 2025, relative to our 2018 baseline.		
Intel	Ten percent reduction by 2030 from 2019 scope 1 and 2 emissions.		2040
JD.com	No evidence of target found.		
Jio	Reducing scope 1+2 100 per cent by 2035 from FY2021 baseline.	✓	2035
Jumia	No evidence of target found.		
KDDI	Reducing our CO_2 emissions by 50 per cent in the fiscal year ending March 31, 2030 compared to the fiscal year ended March 31, 2019.		2050
KPN	KPN commits to reduce scope 1 and scope 2 greenhouse gas emissions by 100 per cent by 2030 from a 2010 base year. The company's long-term target is to maintain yearly zero emissions from 2030 to 2050. In addition, KPN will reduce its scope 3 emissions by 20 per cent by 2.	✓	2015
KT	We aim to reduce GHGs emissions 35 per cent by 2030, 50 per cent by 2040, and 70 per cent by 2050 from the 2007 level under the vision net zero 2050.		2050
Lenovo	By 2030, reduce absolute scope 1 + scope 2 GHG emissions 50 per cent, Reduce scope 3 GHG emissions by 25 per cent [across 3 categories, baseline FY2018/19].	✓	2050
LG	LG Electronics Inc. commits to reduce absolute scope 1 and 2 GHG emissions 54.6 per cent by 2030 from a 2017 base year. Achieve carbon neutrality by expanding the areas of the CDM (Clean Development Mechanism) by 2030.	✓	2030
Liberty Global	Commits to reduce absolute scope 1 and 2 GHG emissions 50 per cent by 2030 and 80 per cent by 2050 from a 2019 base year. Liberty Global also commits to reduce absolute scope 3 GHG emissions from the manufacture and use of customer premises equipment 50 per cent by 2030 from a 2019 base year.		2030
Logitech	68% reduction by 2025, from a 2019 baseline.	✓	2021
Lumen	SBT-1 is to reduce the annualized absolute market-based scope 1 and scope 2 GHG emission by 18 percent. SBT-2 is to reduce annualized absolute upstream scope 3 GHG emissions by 10 percent. Both SBTs have a target year of 2025 compared to our 2018 baseline.		
MegaFon	No evidence of target found.		
Meituan	No evidence of target found.		
Mercado Libre	No evidence of target found.		
Microsoft	By 2030, Microsoft will be carbon negative, and by 2050, we will remove from the atmosphere all the carbon dioxide our company has emitted either directly or by our electricity consumption since we were founded in 1975.	✓	2012
Millicom	No evidence of target found.		2050
MTN	MTN has set science-based targets to achieve a 47 per cent average reduction in absolute emissions (tCO_2e) for scope 1, 2 and 3 by 2030 from a 2019 baseline.		2040
MTS	No evidence of target found.		
Naspers	To be carbon neutral in our own operations' (Naspers and Prosus core) scope 1 and scope 2 emissions by the end of FY22.		2022
Naver	2040 carbon negative.		2040
NEC	Commits to reduce absolute scope 1 and 2 GHG emissions 55 per cent by FY2030/31 from a FY2017/18 base year. NEC Corporation also commits to reduce absolute scope 3 GHG emissions from purchased goods and services, fuel and energy related activities and use of sold products 33 per cent by FY2030/31 from a FY2017/18 base year.		
NetEase	No evidence of target found		
Netflix	Achieve net zero emissions by the end of 2022, and every year thereafter...reduce scope 1 and 2 emissions by 45 per cent by 2030 from a 2019 base year.	✓	2021
Nintendo	No evidence of target found.		
Nokia	Committed to cutting emissions across business by 50 percent by 2030 compared to 2019.	✓	
NTT	Commits to reduce absolute scope 1 and 2 GHG emissions 80 per cent by FY2030/31 from a FY2018/19 base year. NTT Group also commits to reduce absolute scope 3 GHG emissions from purchased goods and services, capital goods, and use of sold products 15 per cent within the same timeframe.	✓	
Nvidia	Source 65 per cent of global electricity use from renewable energy by the end of FY25.		
Ola	No evidence of target found.		
Omantel	No evidence of target found.		

Company	Description	SBTi *	Carbon neutral **
Ooredoo	No evidence of target found.		
Oracle	Achieve net zero emissions by 2050, and to halve the greenhouse gas emissions across our operations and supply chain by 2030, relative to a 2020 baseline.		
Orange	"Net Zero Carbon in 2040" commitment with interim target of reducing CO_2 equivalent emissions by 30 per cent by 2025 compared with 2015.	✓	2040
OTE	Committed to achieve net zero carbon footprint by 2040.		2040
Palantir	Commits to Carbon-Neutrality by the end of 2021.	✓	2021
PayPal	Medium-term science-based targets focus on reducing company-wide greenhouse gas emissions across operations by 25 per cent by 2025 (from a 2019 baseline) and engaging with our supply chain so that 75 per cent of our vendors (by spend) set science-based targets by 2025.	✓	2040
PCCW	No evidence of target found.		
Pinduoduo	No evidence of target found.		
PLDT	Reduction of 382 tons (3 per cent total reduction using 2019 data as baseline) of greenhouse gases at the end of 2021.		
Proximus	A net positive contribution to the climate by 2030 [already carbon neutral].	✓	2016
Qualcomm	By 2025, reduce absolute scope 1 and scope 2 GHG emissions by 30 percent from global operations, compared to a 2014 baseline.		
Rakuten	Reduce greenhouse gas emissions originated from electricity consumption (scope 2) to zero by 2025.		2025
Rogers	Reduce scope 1 and 2 GHG emissions by 25 per cent by the year 2025, from our base year of 2011.		
Safaricom	Committed to becoming a net zero carbon emitting company by 2050. Commits to reduce absolute scope 1 and 2 GHG emissions 43 per cent by 2030 and 74 per cent by 2050 from a 2017 base year. Commits to reduce absolute scope 3 GHG emissions 41 per cent by 2030 and 72 per cent by 2050 from a 2017 base year.		2050
Salesforce	Commits to reduce absolute scope 1 and scope 2 GHG emissions by 50 per cent by 2030 from a 2018 base year. Commits to reduce absolute scope 3 GHG emissions from fuel and energy related activities by 50 per cent by 2030 from a 2018 base year.		
Samsung	No evidence of target found.		
SAP	Commits to reduce total scope 1, 2 and 3 GHG emissions 40 per cent by 2025, using a 2016 base year. Commits to achieve net-zero in value chain in 2030.	✓	2023
Seagate	Commits to reduce absolute scope 1 and scope 2 GHG emissions 20 per cent by 2025 and 60 per cent by 2040 from a 2017 base year. Also commits to reduce absolute scope 3 GHG emissions 20 per cent by 2025 and 60 per cent by 2040 from a 2017 base year.	✓	
ServiceNow	Commits to reduce absolute scope 1 and 2 GHG emissions 70 per cent by 2026 from a 2019 base year. Also commits to reduce scope 3 GHG emissions from business travel and employee commuting 40 per cent per unit of value added within the same timeframe.	✓	
SES	Commits to a net zero emissions target by no later than 2050.		2050
Sina	No evidence of target found.		
Singtel	Reduce absolute carbon emissions by 25 per cent for scope 1 and 2 by 2025, using 2015 as baseline, in line with 2050 net zero ambition.	✓	
SK hynix	Reduce greenhouse gas emissions intensity by 40 per cent from 2018 to 2022 (tCO_2e/100 million revenue).		
SK Telecom	47.4 per cent by 2030 (vs. 2020) (scope 1 and 2); Net zero by 2050	✓	2050
SoftBank	"Carbon-Neutral 2030 Declaration" as commitment to reducing greenhouse gas emissions to virtually zero by 2030.		
Sonatel	No evidence of target found.		
Sony	Goal of reducing environmental footprint to zero by 2050. Commits to reduce absolute scope 1 and 2 GHG emissions 72 per cent by FY2035 from a FY2018 base year. Commits to reduce absolute scope 3 GHG emissions covering use of sold products 45 per cent over the same target period.	✓	
SpaceX	No evidence of target found.		
Spark	Reduce scope 1 and 2 emissions 56 per cent by FY2030 from a FY2020 base year.	✓	
Spotify	No evidence of target found.		
STC	No evidence of target found.	✓	

Company	Description	SBTi *	Carbon neutral **
Swisscom	Operations climate-neutral since 2020. Reduce direct CO_2 emissions by over 90 per cent by 2025 compared to 1990.	✓	
Tata Communications	No evidence of target found		
Tele2	Commits to reduce absolute scope 1 and 2 GHG emissions by 90 per cent by 2025 and 100 per cent by 2029 from a 2019 base year. Commits to reduce scope 3 GHG emissions by 60% per subscription by 2029 from a 2019 base year.		2020
Telecom Egypt	No evidence of target found.		
Telecom Italia	Carbon neutral by 2030.		2030
Telefonica	Committed to achieving net zero emissions in value chain by 2040. Commits to reduce absolute scope 1 and 2 GHG emissions 70 per cent by 2025, and 80 per cent by 2030 from a 2015 base year. Commits to reduce absolute scope 3 GHG emissions from fuel and energy related activities 25 per cent by 2025 from a 2016 base year. Commits to reduce scope 3 GHG emissions from purchased goods and services and capital goods 30 per cent per euro purchased by 2025 from a 2016 base year.	✓	
Telenor	Commits to reduce absolute scope 1 and 2 GHG emissions 57 per cent by 2030 from a 2019 base year.	✓	
Telia	Commits to reduce absolute scope 1 and 2 GHG emission 50 per cent by 2025 from a 2018 base year. Commits to reduce absolute scope 3 GHG emissions from use of sold products 29 per cent by 2025 from a 2018 base year.	✓	2020
Telkom	No evidence of target found.		
Telkom Indonesia	No evidence of target found.		
Telstra	Reduce carbon emissions intensity (tCO_2 e per petabyte) by 50 per cent, from a baseline year of FY17 [by 2030].	✓	2020
Tencent	No evidence of target found.		
Texas Instruments	Reduce absolute scope 1 and 2 GHG emissions by 25% by 2025 using a 2015 baseline.		
TSMC	Peaking emissions growth by 2025 and reducing emissions to year 2020 levels by 2030.		
Türk Telekom	No evidence of target found.		
Twilio	No evidence of target found.		
Twitter	No evidence of target found.	✓	
Uber	Committing to become a fully zero-emission platform by 2040. In addition, committed to reaching net-zero emissions from corporate operations by 2030.		2030
Veon	No evidence of target found.		
Verizon	In addition to net zero goal, committed to reduce absolute scope 1 and 2 GHG emissions 53 per cent by 2030 over a 2019 baseline and to reduce absolute scope 3 emissions 40 per cent by 2035 from a 2019 base year.	✓	
Viettel	No evidence found of target		
Vodafone	2030 Target: Eliminate all carbon emissions (net zero) from our own activities and from energy we purchase and use (scope 1 and 2), Halve carbon emissions from our carbon footprint (against a 2020 baseline), including joint ventures, all supply chain pu	✓	
Western Digital	Commits to reduce absolute scope 1 and 2 GHG emissions 42 per cent by FY2030 from a FY2020 base year. Also commits to reduce scope 3 GHG emissions from use of sold products 50 per cent per petabyte capacity sold by FY2030 from a FY2020 base year.	✓	
Xiaomi	No evidence found of target.		
Yandex	No evidence found of target.		
Yunji	No evidence found of target.		
Zain	2017-2022 Emission Reduction Targets: Sudan 15 per cent, South Sudan 25 per cent, Iraq 20 per cent, Bahrain 5 per cent, Kuwait 7 per cent, Jordan 10 per cent, Saudi Arabia 8%.		
Zoom	No evidence found of target.		
ZTE	No evidence found of target.		

Note: Announced as of 1 November 2021. * Participates in Science Based Target initiative. ** Year of reaching carbon neutrality for at least operational emissions (scope 1 and 2); companies generally do not disclose definition (e.g., by using offsets/carbon removal, whether carbon neutrality refers to scope 2 location-based or market-based emissions).

Annex E: Assessment

Companies have been assessed on emissions reduction targets and the degree of target ambition; data availability, clarity and verification; and performance. Note that the assessment was made on information collected for the Digital Inclusion Benchmark with a cut-off date of 30 October 2021. Companies were provided the opportunity to review their data. Any subsequent data collected from reports issued after that date did not form part of the assessment but have been updated for this report including subsequent revisions.

Assessment methodology

Target (maximum 3 points)

Target: Company has a time bound commitment to reduce emissions (1 point)

Quality: The commitment is near-term and not intensity-based (i.e., by 2030) (1 point)

Ambition: The target aims for operational carbon neutrality by 2030 (1 point)

Data (maximum 7 points)

Data availability: Half point for each metric the company discloses: i) scope 1, ii) scope 2 location-based, iii) scope 2 market-based, iv) scope 3, v) energy use, vi) share of renewables in energy use, vi) electricity use, viii) share of renewables in electricity use (4 points)

The company has a dedicated environmental report (1 point).

Verification. Evidence of third-party verification of emissions data (1 point).

Evidence verification is informed by ISO 14064 (1 point).

Performance (maximum 3 points)

The share of renewables in electricity scaled to a maximum of 1 (Up to 1 point).

The proportion of GHG emissions (location based) to USD revenue normalized to a 1 point scale (up to 1 point).

The proportion of GHG emissions (market based) to electricity use normalized to a 1 point scale (up to 1 point).

Example

The example below shows how the assessment was calculated for Apple.

Annex E Table 1: Assessment calculation for Apple

	Max points	Score	Evidence
Target	**3**	**3**	
Target: Company has a time bound commitment to reduce emissions	1	1	"Achieve carbon neutrality for our entire carbon footprint, including products, by 2030. And reduce related emissions by 75% compared with fiscal year 2015" (Source: Environmental Performance Report 2021).
Quality: The commitment is near term (i.e., by 2030) and not intensity-based	1	1	Yes ("by 2030") and absolute reduction
Ambition: The target aims for carbon neutrality by 2030	1	1	Yes ("Achieve carbon neutrality...by 2030")
Data	**7**	**7**	
Data availability:	4	4	
Scope 1 (tCO_2e)	0.5	0.5	47 430
Scope 2 Location based	0.5	0.5	890 189
Scope 2 Market based	0.5	0.5	0

	Max points	Score	Evidence
Scope 3	0.5	0.5	22 550 000
Energy use (MWh)	0.5	0.5	2 933 870
Renewable energy (%)	0.5	0.5	92
Electricity (MWh)	0.5	0.5	2 580 000
Renewable electricity (%)	0.5	0.5	100
Reporting:	1	1	
The company has a dedicated climate report	1	1	2021 Environmental Progress Report
Verification:	2	1	
Evidence of third-party verification of emissions data	1	1	Apex verification statement included in Environmental Progress Report
Evidence verification is informed by ISO 14064	1	0	Not found
Performance	**3**	**3**	
The share of renewables in electricity scaled to a maximum of 1	1	1	Value 100 normalized to 100/100 = 1. Highest is best.
The proportion of GHG emissions (location based) to USD revenue normalized to a 1 point scale*	1	1	2020 revenues (millions): USD 274,514. scope 2 location based GHG / Revenue = 3.24. Lowest is best.
The proportion of scope 2 emissions (market based) to electricity use normalized to a 1 point scale*	1	1	Value 0. Lowest is best.
TOTAL POINTS	**13**	**12.0**	Assigned grade based on total points (>=10.5,"A";>7,"B";>3.5,"C";>0,"D";0,"F")

Note: * Normalized based on quartile that number falls in for the 150 companies. The highest quartile is scored 1, the next 0.66, the next 0.33 and the last 0.
Source: Apple. 2021. Environmental Progress Report (Covering fiscal year 2020).

Annex E Table 2: Climate assessment

Company	Overall	Data	Target	Performance
Elisa	**A**	A	A	B
Cisco	**A**	A	A	B
Apple	**A**	A	A	A
Akamai	**A**	A	A	C
Ericsson	**A**	A	A	B
IBM	**A**	A	A	B
Microsoft	**A**	A	A	B
Proximus	**A**	A	A	B
Facebook	**A**	A	A	B
Swisscom	**A**	B	A	A
Adobe	**A**	A	B	B
Alphabet	**A**	A	A	B
Telefonica	**A**	A	B	B
Vodafone	**A**	A	B	C
Tele2	**A**	B	A	B
SAP	**A**	B	A	B
eBay	**B**	A	B	B
BT	**B**	A	C	B
KPN	**B**	B	A	B
BCE	**B**	A	B	B
Salesforce	**B**	B	B	B
Telia	**B**	B	A	B
HP	**B**	B	B	B
Lenovo	**B**	B	B	B
Netflix	**B**	C	A	A
Deutsche Telekom	**B**	B	A	C
Texas Instruments	**B**	A	B	D
Oracle	**B**	B	B	B
AT&T	**B**	A	B	D
Acer	**B**	B	C	B
Logitech	**B**	B	C	B
Equinix	**B**	B	B	C
Cloudflare	**B**	B	C	B
Telecom Italia	**B**	B	B	C
Spark	**B**	B	B	B
Nokia	**B**	B	B	C
KDDI	**B**	B	B	C
Digital Realty Trust	**B**	B	B	C
Gojek	**B**	B	A	C
Infosys	**B**	B	C	B
Rogers	**B**	B	B	B
Dell	**B**	B	C	B
Verizon	**B**	B	B	C
AMD	**B**	B	C	B
Alibaba	**B**	A	C	D
LG	**B**	B	A	D
Amazon	**B**	B	C	C
Qualcomm	**B**	B	B	C
Telenor	**B**	B	B	D
NAVER	**B**	B	C	C
Intel	**B**	B	C	C
PayPal	**B**	C	B	B

Company	Overall	Data	Target	Performance
Singtel	**B**	B	B	C
NTT	**B**	B	B	D
Rakuten	**B**	B	C	C
KT	**B**	B	B	C
SK Telecom	**B**	B	C	C
Inmarsat	**B**	C	B	B
SK hynix	**C**	B	B	C
América Móvil	**C**	B	B	D
Comcast	**C**	C	B	C
Delivery Hero	**C**	B	C	C
Western Digital	**C**	B	C	D
Lumen	**C**	B	C	D
Liberty Global	**C**	B	C	C
Telstra	**C**	C	A	D
ServiceNow	**C**	C	C	B
Orange	**C**	C	B	C
Sony	**C**	B	C	C
Citrix	**C**	C	B	C
Iliad	**C**	C	B	C
NVIDIA	**C**	C	C	B
Uber	**C**	C	C	C
Naspers	**C**	C	A	C
NetEase	**C**	B	F	B
Samsung	**C**	B	F	D
AIS	**C**	C	B	D
JD.com	**C**	C	B	C
Sonatel	**C**	B	F	D
GlobalFoundries	**C**	C	B	D
Baidu	**C**	B	C	D
SoftBank	**C**	C	C	C
Booking Holdings	**C**	C	C	B
Mercado Libre	**C**	B	F	D
PLDT	**C**	C	C	D
ASUS	**C**	C	B	C
Axiata	**C**	B	C	D
Seagate	**C**	B	F	D
Foxconn	**C**	C	C	D
Türk Telekom	**C**	B	F	D
Safaricom	**C**	C	C	C
Nintendo	**C**	C	F	B
Spotify	**C**	C	F	B
Tencent	**C**	B	F	D
HCL	**C**	C	F	C
China Mobile	**C**	C	C	D
MTN	**C**	C	B	D
NEC	**C**	C	C	C
stc	**C**	C	F	C
Tata Communications	**C**	B	F	D
TSMC	**C**	C	C	D
Chunghwa Telecom	**C**	B	F	D
MTS	**C**	C	F	D
Etisalat	**C**	C	F	D
OTE	**C**	C	C	C

Company	Overall	Data	Target	Performance
Huawei	**C**	C	C	D
Bharti Airtel	**C**	C	C	D
Jio	**C**	C	F	D
China Telecom	**C**	C	C	D
Millicom	**C**	C	F	C
Zain	**C**	C	C	D
ZTE	**C**	C	F	D
Telkom Indonesia	**C**	C	F	D
VEON	**C**	C	F	D
Altice	**D**	D	F	B
Grab	**D**	C	F	C
Xiaomi	**D**	C	F	C
Broadcom	**D**	C	F	C
PCCW	**D**	C	F	D
Ant	**D**	F	A	F
Yandex	**D**	C	F	C
China Unicom	**D**	C	F	D
Telkom	**D**	C	F	D
Twilio	**D**	D	F	C
Globe	**D**	C	F	D
SES	**D**	D	F	D
Eutelsat	**D**	D	F	C
Palantir	**D**	D	C	F
Twitter	**D**	C	F	F
Airbnb	**D**	F	C	F
MegaFon	**D**	D	F	F
Ooredoo	**D**	D	F	F
Pinduoduo	**D**	D	F	F
Sina	**D**	D	F	F
SpaceX	**D**	D	F	F
Viettel	**D**	D	F	F
Yunji	**D**	D	F	F
Meituan	**D**	D	F	F
ByteDance	**F**	F	F	F
China Satellite	**F**	F	F	F
Cogent	**F**	F	F	F
Digicel	**F**	F	F	F
EchoStar	**F**	F	F	F
GTT	**F**	F	F	F
iFlytek	**F**	F	F	F
Jumia	**F**	F	F	F
Ola	**F**	F	F	F
Omantel	**F**	F	F	F
Telecom Egypt	**F**	F	F	F
Zoom	**F**	F	F	F

Note: Shown in order of points score. "E" not used.

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International Telecommunication Union
Telecommunication Development Bureau
Place des Nations
CH-1211 Geneva 20
Switzerland

https://www.itu.int/itu-d/sites/environment/

Contact ITU:
eetmail@itu.int

World Benchmarking Alliance
Rhijnspoorplein 10-38
1018 TX Amsterdam
The Netherlands

https://www.worldbenchmarkingalliance.org/

Contact WBA:
m.minges@worldbenchmarkingalliance.org

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