Received: 12 December 2023 | Revised: 27 February 2024 | Accepted: 17 June 2024 | Published online: 26 June 2024

RESEARCH ARTICLE

Green and Low-Carbon Economy
2024, Vol. 00(00) 1–12
DOI: 10.47852/bonviewGLCE42022291

BON VIEW PUBLISHING

Analyzing Greenhouse Gas Emission Trends of Indian Companies Through Their Disclosures

Manvi Jain[1] **and Bhaskar Sinha**[1,*]

[1]*Indian Institute of Forest Management, India*

Abstract: With the increasing trend of greenhouse gas (GHG) emissions worldwide and the subsequent evolution of new national and international commitments related to climate change, corporates have started to limit and disclose their emissions. This paper analyzes the comprehensiveness of disclosures on Scopes 1, 2, and 3 emissions of the top 100 Indian companies by market capitalization and their trend compared to the previous reporting year through their publicly available reports/websites. The analysis revealed that 66 of these companies reported their Scopes 1 & 2 emissions, whereas 48 reported on all three scopes, with 35 companies making emission reduction targets voluntarily. This shows that Indian companies are increasingly becoming self-aware of their responsibilities. The analysis of emission targets showed that companies with carbon reduction targets scored better in disclosures than those without foreseeable targets, suggesting that these targets motivate corporates to calculate emissions and report more transparently. Additionally, a rating score of 1 to 5 was assigned to all the National Stock Exchange Fifty 100 companies to assess their GHG emission disclosure performance, which could be important for setting the benchmark for different sectors/industries on emission reduction targets in India. Furthermore, the study discusses the significance of such analysis in anticipation of India's regulation on domestic and voluntary carbon markets.

Keywords: NIFTY, greenhouse gas, corporate disclosures, climate change, voluntary carbon market, Scopes 1, 2 & 3, carbon neutral

1. Introduction

Climate change has emerged as a significant worldwide concern, impacting humanity. There have been several national and international responses in the form of policies and regulations to reduce greenhouse gas (GHG) emissions. As a result, it is vital to define the GHG emission management pathways of countries that are subject to international commitments and national laws [1, 2]. This, in turn, has led to the trickling down of the responsibilities of target setting for emission reductions to the corporate in major world economies. There is an alignment between the targets that corporates set for their operational emissions and those set in policy [3].

Recently, there has been an increasing trend among corporate publishing their environmental and sustainability reports [4]. One of the most significant goals of preparing these reports is teaching major stakeholder groups about non-financial issues to ensure the legitimacy of company actions, the supply of critical resources, and positioning their brand equity on overall sustainability. This leads to public acceptance of the corporates in general and acceptance of specific management decisions and activities that may be compromising at times. A specific goal may also be acceptance from key stakeholders (e.g., the government, the media, or employees) and pressure groups (e.g., environmental groups and human rights organizations). Therefore, the reporting must be reliable to instill trust in the organization and its corporate activities [5]. Additionally, in the context of growing concern for climate change and sustainability, governments are issuing guidelines for reporting on different aspects of sustainability. Multiple guidelines, regulations, and standards for sustainability reporting are dynamic and keep evolving with the disclosure requirements. Transparency, inclusion, completeness, relevance, sustainable context, accuracy, neutrality, comparability, clarity, and timeliness are examples of attributes which are essential for every sustainability report [6]. Climate-related proactive initiatives, carbon disclosures, and the production of environment-friendly products can also help a company's brand image. There appears to be a reporting bias based on the firm's environmental performance wherein the high-performers disclose more environmental information in their annual reports as well as sustainability reports [7].

Corporate GHG emissions' data are of core importance for two reasons—first, to identify the main sources of climatic changes and investigate causal mechanisms, and second, to monitor progress toward achieving agreed targets. Companies that record and disclose their GHG emissions have multiple advantages [8]. Such companies exhibit higher valuations [9]. In a meta-analysis, Albertini [10] confirmed a positive association between environmental disclosure and corporate financial success. As per the laws and regulations of various countries, corporates are increasingly being obliged to report their carbon emissions. This

*Corresponding author: Bhaskar Sinha, Indian Institute of Forest Management, India. Email: bsinha@iifm.ac.in

will lead to better carbon management and, as a result, lower energy use and expenses. Improved carbon management can assist businesses in dealing with natural calamities like drought, flood, etc., and regulatory hazards associated with climate change, making the operations more efficient. GHG emission data of companies are of key importance for two reasons—firstly, it helps identify the main sources of climatic changes and investigate causes behind the mechanisms, and secondly, it helps monitor progress toward achieving the set targets. Furthermore, carbon disclosure assists investors in estimating a company's regulatory and natural risks associated with climate change. Nonfinancial transparency, in general, is connected with excellent stock performance and lower cost of capital. Companies have an opportunity to position themselves as an appealing avenue for responsible investors based on how they address and mitigate these risks. GHG calculation is thus the first required step towards enhanced GHG emission control, and disclosure of the same increases transparency [11].

Although businesses frequently highlight their sustainability initiatives in promotional materials, formal reporting was typically not required in the US, and many other countries, and only a small number of businesses published sustainability reports. This is starting to change as a trend towards fusing financial and sustainability reporting emerges [12]. India is the fifth largest economy and globally amongst the top four emitters [13]. Furthermore, India made a pledge of achieving net zero emissions by 2070 at COP26 in Glasgow. This lays an exciting foreground for studying the prevalent scenario amongst top corporates in India in terms of their GHG emission disclosures.

In this context, the present study attempts to analyze the sustainability reports (and other relevant reports) of top Indian companies to understand their performance on carbon disclosures. The present paper has two innovative dimensions: firstly, it provides a critical assessment of NIFTY 100 companies based on their GHG emission disclosure in present and previous reporting years across various sectors as well as their reduction trajectory based on their targets for the reduction of emission; secondly, the article discusses the opportunities of Voluntary Carbon Market in India in context to emerging demands of carbon offsetting and emission reduction. The carbon disclosure dataset for companies can be purchased on CDP but this study goes beyond that. It analyzes the top 100 companies of India, one of the fastest growing economies, and then categorizes them amongst different sectors for further assessment. It also takes into account the decarbonization targets set by these organizations.

For this, emission disclosure data of NIFTY 100 companies was hand-collected along with the trends of emission increase/decrease from the previous year and future reduction targets. The rest of the paper is organized as detailed. Section 2 details the literature review and Section 3 details the methodology applied. Section 4 details the results and findings of the study in terms of emission disclosures and trends bifurcated by sectors and discusses opportunities for the Voluntary Carbon Market in India. Section 5 Concludes the whole study.

2. Literature Review

2.1. Global trends of carbon emissions

GHG emissions have been on the rise globally. In 1850, the United Kingdom was the leading CO2 emitter, with emissions approximately six times those of the second-highest emitter, the United States. France, Germany, and Belgium rounded up the top five emitters. Later, the USA was the world's second-largest emitter; its emissions in 2011 were 266 times higher than in 1850. The most visible change, however, was the rise of China's emissions in the first decade of the twenty-first century and its subsequent overtake of the United States as the world's top emitter after 2005. The United Kingdom, previously the world's largest emitter, has stabilized its total CO2 emissions. With the dissolution of the Soviet Union, Russia experienced a considerable reduction in emissions. More than two-thirds of the world's carbon emissions currently come from emerging markets and developing nations. In contrast, emissions in advanced economies are structurally declining despite a rebound of emissions in 2021. In recent years, China, the United States, EU, and India contribute to more than half of GHG emitted [13].

2.2. Global trends in carbon disclosures

The first step in combating GHG emissions is to quantify them. Larger companies with higher visibility tend to make more comprehensive disclosures [14]. A study conducted by Albarrak et al. [15] suggested that increased disclosure of a company's carbon information enhances investor recognition among numerous potential investors and environmentalist groups, reduces information asymmetry between market participants, and allows investors to assess potential risk and acquire company information for less money, all of which assist in lowering the Cost of Equity. More countries are now mandating companies or businesses to measure and report their emissions regularly. For instance, the Securities and Exchange Commission of the United States (SEC) proposed a new climate disclosure rule in March 2022 that would mandate companies registered with the SEC to disclose information about climate change so that investors can take climate-related financial risks into account when making investment decisions [16]. Their disclosures provide details on senior management responsibilities for climate change, risk management strategies for the issue, climate change policies, steps taken to reduce GHG emissions, capital investments and payback times, goals and targets, and methods and assumptions used to calculate GHG emissions. It will be simpler for stakeholders, including those within the firms themselves, to track progress, compare performance, and exercise influence if data regarding corporate carbon management and GHG emissions are complete and consistent [17]. Countries use this data to set appropriate emission targets, determine which industries, procedures, or practices produce the most significant emissions and encourage emission-trading schemes.

The GHG Protocol, established by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD), was released in 1998. It is the most extensively used international system for measuring and reporting emissions. Governments, industry associations, non-profit organizations, and corporations use the GHG Protocol. Approximately 92% of Fortune 500 firms used the GHG Protocol in 2016, either directly or through a tailored program based on the protocol. WRI and WBCSD collaborated with several prominent international leaders to build their respective countries' reporting frameworks. Brazil, India, Mexico, and the Philippines use GHG Protocol-based emissions monitoring systems to acquire valuable data [18].

In 1992, during the Rio Earth Summit, the WBCSD was established. Since then, the business community has realized that it has an obligation to inform public discourse on economic, environmental, and social concerns by routinely disclosing information about their economic, social, and environmental

performance. The Global Reporting Initiative (GRI) Guidelines are a widely utilized framework on a global scale [19, 20].

There is evidence of a curved relationship between yearly carbon emissions and financial performance. The correlation is generally good for firms with outstanding carbon performance but negative for companies with poor carbon performance. This implies that firms should participate in climate change mitigation to attain an optimum level of carbon performance to remain financially viable and attractive. Firms may suffer investor penalties if they move along the curve toward higher carbon performance. This also suggests that enterprises have no motivation to enhance their carbon performance beyond a minimal level of carbon performance, which allows them to shift from a negative to a positive association and, as a result, gain financially from improved carbon performance. This finding may help explain why, despite increasing governmental pressure, businesses continue to be ineffectual in combating climate change [21].

2.3. Global trends in target setting

In response to climate change, multinational corporations are implementing GHG reduction targets at an increasing rate. These goals serve as a catalyst for carbon mitigation projects, offer recommendations for the selection of suitable mitigation measures, help in enhancing the brand equity, and establish benchmarks for tracking the advancement of mitigation activities [22–24]. 44% of companies currently declaring their GHG emissions are focusing on short-term goals, such as reducing emissions by 2025. While 2% of the companies concentrate on long-term goals (with reductions from 2031 to 2050 or later), 27% of the companies concentrate on medium-term goals (with reductions from 2026 to 2040). The remaining 27% of companies have objectives for each of the three time periods. 74% of the targets that have been made public are from companies looking to cut back on their own or controlled sources of GHG emissions (Scope 1 emissions) as well as the production of the heat, steam, or electricity that they buy (Scope 2). On the other hand, only 26% of the targets aim to lower Scope 3 emissions, which are not directly owned by the firm but are related to its activities—for example, in air cargo or supply chain [18]. This is likely because Scope 3 emissions are significantly more difficult for businesses to measure and regulate.

Between 2020 and 2050, 65 percent of the declared targets will be met. As may be expected, enterprises that outperform the average in terms of GHG reduction are in less extractive industries, such as fashion, infrastructure, manufacturing, power generation, and services. However, some corporations still fall short of their stated goals within these industries. Below-average companies belong to one of many categories: they are in more extractive industries (such as agriculture and fossil fuels), or in sectors that are more difficult to decarbonize (such as transportation), or they make fewer disclosures on target setting. There is a noteworthy correlation has been observed between the size of a company and its heightened disclosures about its climate change actions [25]. A positive relationship also exists between a company's reporting progress and targets set for emission reduction percentage. This means that the companies reporting regularly are also the ones setting ambitious targets for reduction. In other words, organizations with more ambitious goals appeared to outperform on the way to meeting those goals. Even carbon-intensive industries like materials, manufacturing, and power generation follow this trend [18].

The United States, the European Union, and the United Kingdom want to achieve net zero emissions by 2050. China and Russia have targeted 2060, and India aims to be net zero by 2070, leaving little time to meet emission targets. If the current scenario continues, the US, EU27, and UK will have to reduce their emissions from present 2021 levels by 167 $MtCO_2$ per year and 105 $MtCO_2$ per year, respectively, to attain net zero targets. On the other hand, China would need to decrease emissions by 286 $MtCO_2$ per year and Russia by 41 $MtCO_2$ per year to attain net zero emissions by 2060. Along similar lines, India will have to reduce its emissions by 51 $MtCO_2$ each year till 2070. Even if these minimum yearly emission reduction objectives were met, these countries would emit more than 400 $GtCO_2$ cumulatively from 2020 to 2045; there is a 67% chance that they will be consuming the whole remaining 1.5 °C budget by 2045 [26]. Progress towards a circular economy effectively reduces CO_2 emissions [27]. Hence, countries making policies that demotivate linear economies are more likely to achieve their emission reduction goals.

2.4. Indian scenario

The recent biannual updated report submitted by the government of India shows the distribution of GHG emissions from different sources in the Indian scenario [28]. "Energy" and "Industrial Processes and Product Use" comprise approximately 83% of GHG emissions in India. This implies that industrial activities are responsible for around 83% of emissions in India. Further analysis in the BUR shows a bifurcation of categories in the energy sector. It is clear that electricity production accounts for the maximum, i.e., 40% of emissions from the energy sector.

However, Sustainability Reporting and GHG emission disclosures are nascent in the country [29]. Globally, economic considerations, innovation, employee motivation, and cost savings are key business drivers for companies to adopt sustainability. In India, factors like strengthening reputation and brand, as well as ethical considerations, have been observed to prompt companies to embrace this concept. This discrepancy emphasizes that Indian businesses have yet to incorporate sustainability into their core business strategy and operations [30].

The government has also taken several steps to make sustainability reporting more prominent. To help mainstream the idea of corporate social responsibility, the Ministry of Corporate Affairs (MCA) released the Voluntary Guidelines on Corporate Social Responsibility in 2009 and the National Voluntary Guidelines (NVGs) on Social, Environmental, and Economic Responsibilities of Business in 2011 [31]. In the Annual Reports of the top 100 listed companies based on market capitalization, the Securities and Exchange Board of India (SEBI) required non-financial reporting in the form of a Business Responsibility Report (BRR) in 2012. MCA's NVGs served as the foundation for the BRR format. In 2016, SEBI made BRR mandatory for the top 500 listed companies based on market capitalization, and in 2019, it made it mandatory for the top 1000 listed companies based on market capitalization. The same year, NVGs were revised and released as the National Guidelines on Responsible Business Conduct (NGRBCs). In 2020, a renewed format for BRR known as the Business Responsibility and Sustainability Report (BRSR) was recommended by the committee formed by MCA, which is in line with NGRBCs. In March 2021, SEBI decided to replace the present BRR with a BRSR, which will be voluntary for the top 1000 listed businesses (by market capitalization) in FY 2021–22 and mandatory from FY 2022–23.

In terms of target setting, it is not only the government coming forward but also Indian corporations are also performing well in aligning themselves with the Science-Based Target initiative. In

India, several businesses from various sectors are taking mitigating measures. These efforts vary from establishing renewable energy targets to increasing energy efficiency. However, the overall impact of such activities remains largely unquantified. When corporations devise and implement action, such as setting SBTs, more standardized approaches are needed to understand the cumulative contributions and evaluate their impacts on national emissions trajectories.

By March 2021, 23 Indian enterprises from various industries have established science-based targets (SBTs) to cut their GHG emissions. 33 more businesses have promised to set up SBTs soon. A study conducted by WRI India that focuses on 22 Indian companies that have set SBTs as of March 2021 finds that these companies have chosen their targets in different time frames. This is due to the fact that the targets need to align with the most recent findings in climate science in order to achieve the objectives of the Paris Agreement, which include keeping global warming to far below 2 °C and pursuing efforts to keep it to 1.5 °C. In comparison to the business as usual scenario, in which the companies' SBTs are not taken into account, the cumulative emissions reduction target of the 22 companies' SBTs is 181 million metric tonnes of carbon dioxide equivalent between 2021 and 2030. This represents more than half of 1% of India's expected emissions in 2030 and 7% of India's current emission reduction goal under the Nationally Determined Contributions (NDC). By 2030, the 22 firms, eight of which are in hard-to-abate industries like chemicals, mining, construction materials, air freight transportation, and logistics, would account for around 98% of the current emission reductions expected from SBTs [32]. It is integral to map the actions taken by the top companies of any country because other countries will eventually follow their lead. Hence, this study lays emphasis on the practices of the top 100 companies in India, which can be used as a basis to foresee the future of Indian companies in terms of environmental performance. Furthermore, as an emerging economy, India requires strong steps to implement low-carbon initiatives that can impact policy positively [33].

3. Research Framework and Methodology

In order to have a good overview of the Indian companies, a sample of NIFTY 100 companies was considered appropriate as these are the companies with the highest market capitalization, and the group also comprises companies from varied sectors.

This study analyzed sustainability reports/ ESG reports and Integrated reports. The most recent reports were studied to get GHG emission data and their carbon neutrality targets. Mostly, all companies that disclosed their emission data disclosed their sustainability report/ESG reports. In rare cases, the integrated report was checked if data were not available in the sustainability report. So, data was collected only from one source. The information from these reports was hand-collected in May 2022. Data from the Carbon Disclosure Project (CDP) was also considered in cases where emissions were not disclosed in any of these reports. CDP is a not-for-profit charity that runs the global disclosure system for investors, companies, cities, states, and regions to manage their environmental impacts. It is to be noted that not all companies report on CDP and that data are not freely available for public use. Furthermore, disclosures of CDP can be individually checked for different companies, but this study presents a collated analysis of NIFTY 100 companies. A good practice is to report GHG emissions separately for each scope as this makes it easier to understand which part of the operations is the most polluting so that appropriate measures for reduction can be taken. Essentially, there are three scopes, the definition of which, as per the India GHG Program, is given below. The India GHG Program, led by the WRI India, Confederation of India Industry, and The Energy and Resources Institute, is an industry-led voluntary framework to measure and manage GHG emissions [34].

1) Scope 1: Direct GHG Emissions
   Emissions from combustion in owned or controlled boilers, furnaces, cars, etc., and emissions from chemical manufacturing in owned or controlled process equipment are examples of sources of direct GHG emissions that are under the company's ownership or control. The direct carbon dioxide emissions resulting from burning biomass must be recorded individually rather than being included in Scope 1. GHG emissions not covered by the Kyoto Protocol, e.g., CFCs, NOx, etc., shall not be included in Scope 1 but may be reported separately.
2) Scope 2: Electricity Indirect GHG Emissions
   It takes into account the GHG emissions produced when a corporation generates electricity that it purchases. Electricity that is bought or otherwise brought within the company's organizational boundaries is referred to as purchased electricity. Physically, Scope 2 emissions take place at the electricity generation facility.
3) Scope 3: Other Indirect GHG Emissions
   It allows for the treatment of all other indirect emissions. Scope 3 emissions are a consequence of the activities of the company but occur from sources not owned or controlled by the company. Some examples of Scope 3 activities are extraction and production of purchased materials; transportation of purchased fuels; and use of products and services.
   There are 15 subcategories of Scope 3-

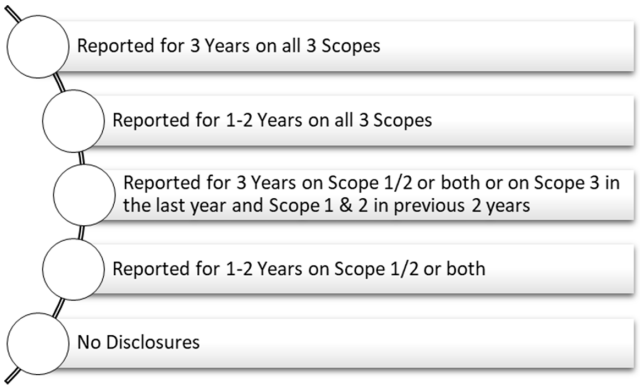
   - Purchased goods and services
   - Capital goods
   - Fuel- and energy-related activities
   - Transportation and distribution
   - Waste generated in operations
   - Business travel
   - Employee commuting
   - Leased assets
   - Processing of sold products
   - Use of sold products
   - End-of-life treatment of sold products
   - Franchises
   - Investments

For Scope 3, companies disclose the subcategories relevant to their operations if they calculate them appropriately.

The definition of Scopes 1, 2, and 3 remains the same for all the companies. As mentioned above, Scope 3 includes 15 categories. So a company disclosing on Scope 3 may disclose on all the relevant categories while another company might still be in process of devising a method to calculate data of some categories. This will result in variations in actual emissions and disclosed emissions and will create discrepancies in comparing the two companies, which is a limitation of this study.

In recent years, Indian companies have started to disclose their GHG emission. However, the reporting lacks uniformity and comprehensiveness, which makes it difficult for the stakeholders to compare their performance on their actions on climate change. Therefore, the current study used a comparative scale for rating and analyzing the carbon reporting trend of the top 100 Indian companies (Figure 1).

Figure 1
Rating criteria for companies on their GHG emission disclosures



3.1. Rating scale

A score of 1 is given to companies without disclosed scope in any year. A score of 2 is given to the companies that have reported on Scopes 1 & 2 in the last 1 or 2 years only. A score of 3 is given to companies that have reported on Scopes 1 & 2 in the last three years without Scope 3 (or) on Scope 3 in the last year, along with Scope 1 & 2 in the previous two years. Score 4 is given to companies that have reported on all three scopes for the last 1–2 years. Score 5 is given to companies that have reported on all three scopes for the last three years or more. Yadava and Sinha [20] have used a similar methodology to assess the environmental, economic, and social performance of the leading public and private Indian companies. Such a rating scale has also been used by Skouloudis et al. [35], where a set of GRI topics and performance indicators was converted into scoring criteria on a scale of 0 to 4, and various Triple Bottom Line reports were ranked accordingly.

More weightage (score) is given to companies disclosing emissions from all Scopes 1, 2 & 3. This is because Scope 3 is the most diverse and most difficult to calculate [36]. In order to formulate and achieve emission reduction targets, companies must calculate and disclose their Scope 3 emissions and make their reports more comprehensive.

It is to be noted that for this study, only the most recent sustainability report of the respective company is studied. So, one company could have reported all three scopes for 2018, 2019, & 2020, while the other could have reported for 2019, 2020, & 2021, but both will receive a score/rating of 5. Hence, the latest three consecutive years are considered. Reporting GHG emissions for consecutive years in the latest sustainability report is a good practice. It should be standardized since it gives the stakeholders a clear idea of the company's performance in terms of emission reduction.

4. Results

The disclosure and communication of an organization's environmental, social, and governance (ESG) objectives as well as its advancement towards them is known as sustainability reporting. As investors and customers are becoming more vigilant about how their money is being invested, there is an upward trend visible in corporate sustainability disclosures [37]. Enhancing consumer confidence, fostering innovation, enhancing corporate reputation, and even enhancing risk management are all advantages of sustainability reporting [38].

4.1. Existing GHG reporting practices in India

In the current scenario, since the developing countries are the ones emitting the highest, it is imperative for them to have reduction targets. For that, the corporates too will have to take the responsibility of responsibly calculating and disclosing their emissions. After studying the sustainability reports of NIFTY 100 companies, it was found that 66 of them reported on Scopes 1 & 2, whereas only 48 reported on Scope 3 (Figure 2). Scope 3 calculation and reporting are essential since Scope 3 emissions are an important source of climate-related financial risk across the business value chain [16].

4.2. GHG disclosures of NIFTY 100 companies

NIFTY 100 companies are divided into 11 sectors as per Sustainability Accounting Standards Board standards. SASB Standards guide companies' financial material sustainability information disclosure to their investors. Available for 77 industries, the Standards identify the subset of ESG issues most relevant to financial performance in each industry. The financial sector has the highest number of companies, i.e., 21, whereas the resource and transformation and Infrastructure sectors have only two companies (Table 1). The table also displays the number of companies from each sector reporting on Scope 1, Scope 2, and Scope 3, as per their most recent sustainability/annual reports. Extractives and Mineral Processing is the best-performing sector in terms of disclosure of GHG emissions since 17 out of 18 companies reported their Scopes 1 and 2 in their most recent sustainability/annual report, and 12 companies reported their Scope 3. The financial sector can be considered as the worst performing in this regard as only eight companies out of 21 report on Scopes 1 & 2 and only seven report on Scope 3 (Table 1).

Sixty-six companies are disclosing at least on Scopes 1 & 2 without regulation. This is because it is a pool of the top 100 companies in the country. A study on Australian companies also suggests that larger firms with higher visibility tend to make more comprehensive carbon disclosures [14].

4.3. Comparison of disclosures

Sixty-six companies have reported either on Scopes 1 & 2 or on all Scopes 1, 2 & 3. The names of 100 companies, along with their ratings and their trend of emission reduction or increment from the previous reporting year, are presented in Table 2. For the companies which have reported emissions for only one year or have reported on

Figure 2
Number of NIFTY 100 companies disclosing on Scopes 1, 2 & 3

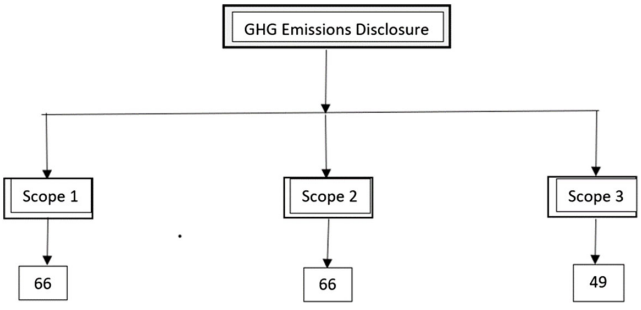


Table 1
The total number of NIFTY 100 companies and their reporting pattern on Scopes 1, 2 & 3 separately

Serial number	Sector	Total companies	Reporting on Scope 1	Reporting on Scope 2	Reporting on Scope 3
1	Consumer Goods	12	7 (58.3)*	7 (58.3)	6 (50)
2	Extractives & Mineral Processing	18	17 (94.4)	17 (94.4)	12 (66.6)
3	Financials	21	8 (38)	8 (38)	7 (33.3)
4	Food & Beverage	7	5 (71.4)	5 (71.4)	3 (42.8)
5	Healthcare	12	6 (50)	6 (50)	3 (25)
6	Renewable Resources & Alternative Energy	3	3 (100)	3 (100)	2 (66.6)
7	Resource Transformation	2	2 (100)	2 (100)	0 (0)
8	Services	7	5 (71.4)	5 (71.4)	5 (71.4)
9	Technology & Communications	8	6 (75)	6 (75)	6 (75)
10	Infrastructure	2	1 (50)	1(50)	1 (50)
11	Transportation	8	6 (75)	6 (75)	3 (37.5)
	TOTAL	100	66	66	48

*Value in parenthesis represents the percentage.

Table 2
List of NIFTY 100 Indian companies along with the scores on GHG emission disclosure and their trends

Serial number	Name of the company	Score	Emissions trend
1	ACC Limited	5	↓
2	Colgate Palmolive	5	↓
3	Dr Reddy's Laboratories	5	↓
4	Gail	5	↓
5	Hindustan Unilever	5	↑
6	IndusInd Bank	5	↓
7	Infosys	5	↓
8	Mahindra & Mahindra	5	↑
9	MindTree	5	↑
10	Ntpc	5	↑
11	SBI	5	↑
12	Shree Cement Ltd.	5	↑
13	Tata Steel	5	↓
14	Adani Enterprises	4	NA
15	Adani Ports Special Economic Zone	4	↑
16	Ambuja Cement	4	↓
17	Godrej Consumer Products	4	NA
18	HCL Technologies	4	↓
19	ITC	4	↓
20	Larsen and Turbo	4	↑
21	Larsen Toubro Infotech	4	↓
22	Marico	4	NA
23	Nestle	4	↑
24	Siemens	4	↓
25	Tata Consumer Products	4	↑
26	Ultratech Cement	4	↓

(*Continued*)

Table 2
(*Continued*)

Serial number	Name of the company	Score	Emissions trend
27	Axis Bank	3	
28	Bharat Petroleum	3	
29	Britannia Industries	3	
30	Cipla	3	
31	Eicher Motors	3	
32	Havells India Limited	3	
33	Hero MotoCorp	3	
34	Hindalco Industries	3	
35	ICICI Bank	3	
36	Indian Oil	3	
37	Jsw Steel	3	
38	Kotak Mahindra Bank	3	
39	Maruti Suzuki India	3	
40	Nmdc	3	
41	Oil Natural Gas	3	
42	Piramal Enterprises	3	
43	Reliance Industries	3	
44	Robert Bosch	3	
45	SBI Cards Payment Services	3	
46	Sun Pharmaceutical Industries	3	
47	Tata Consultancy Services	3	NA
48	Tata Motors	3	
49	Tech Mahindra	3	
50	Vedanta	3	
51	Wipro	3	NA
52	Adani Green Energy Ltd.	2	
53	Adani Transmission	2	NA
54	Asian Paints	2	
55	Biocon	2	
56	Coal India	2	NA
57	DLF	2	
58	Grasim Industries	2	
59	HDFC Bank	2	
60	Housing Development Finance	2	
61	Indus Towers	2	NA
62	Lupin	2	
63	PI Industries	2	
64	Pidilite Industries	2	
65	Power Grid of India	2	
66	SRF	2	

(*Continued*)

Table 2
(*Continued*)

Serial number	Name of the company	Score	Emissions trend
67	UPL	2	↑
68	Apollo Hospitals Enterprise	1	NA
69	Avenue Supermarts	1	NA
70	Bajaj Auto	1	NA
71	Bajaj Finance	1	NA
72	Bajaj Finserv	1	NA
73	Bajaj Investment	1	NA
74	Bandhan Bank	1	NA
75	Bank of Baroda	1	NA
76	Berger paints	1	NA
77	Bharti Airtel	1	NA
78	Cholamandalam Investment Finance Company	1	NA
79	Dabur India	1	NA
80	Divi's Laboratories	1	NA
81	FSN E Commerce Ventures	1	NA
82	Gland Pharma	1	NA
83	HDFC Asset Management Company	1	NA
84	HDFC Life Insurance Company	1	NA
85	ICICI Lombard General Insurance Company	1	NA
86	ICICI Prudential Life Insurance Company	1	NA
87	Info Edge India	1	NA
88	InterGlobe Aviation	1	NA
89	Jubilant Foodworks	1	NA
90	Muthoot Finance	1	NA
91	ONE97 communications	1	NA
92	Procter Gamble Hygiene Health Care	1	NA
93	Punjab National Bank	1	NA
94	SBI Life Insurance Company	1	NA
95	Steel Authority of India	1	NA
96	Titan Company	1	NA
97	Torrent Pharmaceuticals	1	NA
98	United Spirits	1	NA
99	Zomato	1	NA
100	Zydus	1	NA

↑ Increasing emission trend; ↓ Decreasing emission trend; NA: Insufficient Information/disclosure

different scopes/subcategories in different years, a trend of emission reduction/increment could not be identified.

There are 13 companies (ACC Limited, Colgate Palmolive, Dr Reddy's Laboratories, GAIL, Hindustan Unilever, IndusInd Bank, Infosys, Mahindra & Mahindra, MindTree, NTPC, SBI, Shree Cement Ltd. and Tata Steel), which have a perfect score of 5. The sector which stood out the most is the Extractives & Mineral Processing sector since it has three companies scoring a 5. This is a very encouraging trend since it is one of the highest polluting sectors, and emission disclosure by these companies indicates that they are taking responsibility and being transparent regardless of their high emissions volume. Food & Beverage, Infrastructure, and Resource Transformation are the three sectors from which none of the companies scored 5. A direct relationship exists between companies' disclosure of GHG emissions and their firm size, company leverage, return-to-equity ratio, and market-to-book ratio [39].

It is clear (from Table 2) that Infrastructure, Renewable Resources & Alternative Energy, and Resource Transformation are the only sectors with no companies with ambiguous emissions, meaning all the companies from these sectors have also reported in the past.

In order to decrease GHG emissions and increase energy efficiency in the Indian industry, the Perform, Achieve and Trade (PAT) program was implemented. Thermal power plants, cement, aluminium, iron and steel, pulp and paper, fertilizer, chlor-alkali, petroleum refineries, petrochemicals, distribution firms, railroads, textile, and commercial buildings (hotels and airports) were among the about 13 energy-intensive industries covered by PAT.

This can be the reason behind the good performance of sectors like Extractives & Mineral Processing, Infrastructure, Renewable Resource & Alternate Energy, and Transportation in terms of disclosures (as they all have less than or equal to 25% of companies with ambiguous trends) (Table 3). This is further corroborated by a study [40] that shows companies with higher carbon emissions reveal more information about climate change. This relationship is more pronounced in businesses that are part of carbon-intensive sectors like utilities, materials, and energy. Sectors like Consumer goods, Financials, Healthcare, and Resource Transformation have equal to or more than 50% of companies having ambiguous emission trends.

It can also be noted that Extractives & Mineral Processing, Infrastructure, Renewable Resource & Alternative Energy, and

Table 3
The average score and trends on the emission disclosure of different sectors in India

Serial number	Sector	Average score	Number of companies with increasing emissions	Number of companies with decreasing emissions	Number of companies with ambiguous emission trends
1	Extractives & Mineral Processing	3.39	6 (33.33)*	9 (50)	3 (16.66)
2	Infrastructure	3	1 (50)	1 (50)	0 (0)
3	Renewable Resource & Alternative Energy	3	0 (0)	2 (66.66)	1 (33.33)
4	Technology & Communications	2.88	0 (0)	5 (62.5)	3 (37.5)
5	Transportation	2.88	4 (50)	2 (25)	2 (25)
6	Services	2.86	1 (14.28)	2 (28.57)	4 (57.14)
7	Consumer Goods	2.58	3 (25)	2 (16.66)	7 (58.33)
8	Food & Beverage	2.43	3 (42.85)	2 (28.57)	2 (28.57)
9	Healthcare	2	3 (25)	3 (25)	6 (50)
10	Resource Transformation	2	2 (100)	0 (0)	0 (0)
11	Financials	1.86	4 (19.04)	4 (19.47)	13 (61.9)

*Value in parentheses represents the percentage of companies in the respective sector.

Technology & Communication sectors have 50% or more than 50% companies with decreasing emissions and also happen to have scores on the upper end, i.e., 3.39, 3, 3, and 2.88, respectively. With this, it can be inferred that companies with decreasing emissions trends tend to be more active in disclosing their emissions. This can be because companies with decreasing emissions want to showcase their progress to the stakeholders.

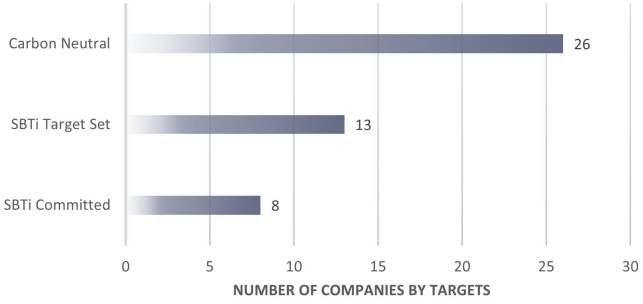
Disclosing is not enough; it is also essential to see these companies' targets for emission reduction. In all, there are 35 companies which have either carbon neutral targets available on the company webpage or sustainability report or are aligned with SBTi or both. Out of these, only eight companies are currently using carbon offsets. All these eight except one are either SBTi target set/ committed or are future carbon neutral. That one company is ACC Cement, and it has achieved carbon neutrality for the operations of just one of its products.

4.3. Target setting on carbon neutrality of NIFTY 100 companies

Companies increasingly recognize the importance of target setting as a primary step towards carbon management and regulation. Furthermore, it is also evident that there exists a positive relationship between companies with any future emission reduction commitment and the computed scores. Companies with future carbon neutral commitments have an average score of 3.04, and those aligned with SBTi (Target set or Committed) have an average score of 3.61. Hence, it could be inferred that companies that are more environmentally conscious and have serious plans to reduce emissions are also the companies that are proactively disclosing their current and previous emissions.

Committed companies register online and submit a letter to commit to setting a SBT or to verify the existing targets independently. At the same time, Target set companies are offered comprehensive guidance on setting their targets. In the current scenario, out of 100 top NIFTY Indian companies, 26 have set carbon neutral targets, 13 have set targets with SBTi, and eight have committed to set targets with SBTi (Figure 3). It is essential to mention that the SBTi Net Zero target set/committed and carbon neutral companies are not mutually exclusive. Seven of the 13 SBTi target set companies are aligned to a 1.5-degree scenario, whereas six are aligned to a 2-degree or below scenario.

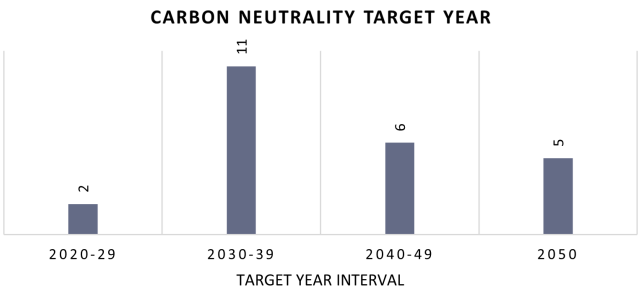
Figure 3
Number of NIFTY 100 companies aligned with various emission reduction targets in India



Additionally, few companies have already made bold declarations regarding their target for achieving carbon neutrality, despite not being mandated by the government. We attempted to segregate NIFTY 100 companies to show their target time interval to achieve carbon neutrality (Figure 4). Overall, 24 companies have set their time frame for achieving carbon neutrality by 2050, with a maximum of 11 companies targeting to achieve it in 2030–39.

In context to India's declaration to achieve carbon neutrality by 2070, the government of India has recently amended the Energy Conservation Act, 2001, with the Energy Conservation (Amendment) Bill, 2022, to create a carbon credit market in India. With the intention of encouraging measures for emission reduction, the amendment offers a legal basis for a carbon market. As "Registered Entities" for the carbon credit trading scheme, entities can register on the Indian carbon credit market. The federal government or any organization it has licensed will be the one to issue the certificate for carbon credits. The voluntary purchase of Energy Saving Certificates or carbon credit certificates is open to any other individual or organization. The Bureau of Energy Efficiency has not yet provided details on the technical and operational specifics of the carbon markets, which has been tasked to do so. However, it is certain that India will soon have an operational guideline for the carbon market and targets for different sectors/industries.

Figure 4
Carbon neutrality targets of companies by year



4.4. Opportunities for emerging carbon market (voluntary carbon market) in India

There has been a paradigm shift towards reducing GHGs to mitigate climate change post-Kyoto protocol. Today's main international carbon market scheme was established as part of the United Nations' Kyoto Protocol on Climate Change in 1997. The protocol entailed the developed countries reducing their emissions to a specified target in a time-bound manner. Furthermore, the concept of Cap & Trade was introduced with three flexible mechanisms: Emission Trading, Joint Implementation & Clean Development Mechanism (CDM), allowing developed countries to trade carbon to meet their commitments. The trading under these three schemes primarily involved developed countries in meeting their commitments. However, CDM was an opportunity provided to developing countries to undertake projects with additional reductions of GHGs and to promote broader development goals and their participation in global climate governance [41, 42]. The GHG reduced under projects was sold to the developed countries to meet the additional cost. However, post Paris Agreement entailed every country establishing and publicizing their post-2020 climate measures, known as NDCs. These climate actions will determine whether the world achieves the long-term goals of the Paris Agreement, including reaching global peaking of GHG emissions as soon as possible and implementing rapid reductions after that by the best available science in order to achieve a balance between anthropogenic emissions by sources and removals by sinks of GHGs in the second half of this century. As a responsible nation, India has committed to becoming carbon neutral by 2070 and is modifying the existing policies and programs to achieve this. The Energy Conservation (Amendment) Bill, 2022, which mandated the creation of a carbon credit market in India, is a step in this regard.

All these are ambitious targets for India, being a developing country. The responsibility for emission reduction has to eventually fall on the corporate, which are the major contributors to such emissions. Hence, the corporates will have to either internally reduce their emissions or enter the carbon market of two types – Compliance-based market and Voluntary Carbon Market. The compliance market is used by companies and governments that, by law, have to account for their GHG emissions. Mandatory national, regional, or international carbon reduction regimes regulate it. Post Energy Conservation (Amendment) Bill, 2022, India is expected to have a domestic carbon market soon. At the same time, companies trade carbon through a voluntary carbon market voluntarily to achieve carbon neutrality. As discussed above, eight out of 100 top NIFTY companies in India are offsetting their carbon through the voluntary market. Therefore, until a proper compliance-based market is developed in India, companies will have to enter the VCM to achieve their targets and meet the National targets (like that of 2070 Net Zero). By entering the VCM, companies can purchase the offsets of their choice from the country of their choice. To strengthen the Indian market, the government can also set a quota for Indian companies wherein a certain percentage of carbon credits has to be bought from Indian boundaries only. In 2021, the total volume of carbon traded was over USD 850 Billion. Forecasts suggest that the global carbon market could grow to USD 22 trillion by 2050. In India alone, 89% of investment in CDM projects to date is still active (as of 2019) (UNFCCC, 2022). Indian proponents have taken advantage of the success of CDM in India, as a result of which skepticism from the minds of Indian investors has receded.

The above analysis noted that out of 100, only 48 companies report on all Scopes 1, 2, & 3. In all, there were 35 companies with some or the other emission reduction target and eight companies already using carbon credits to offset their emissions. For all these companies to align with the targets set by their countries, they first need to calculate and report their GHG emissions regularly. In the case of India, the SEBI has mandated the top 1000 companies by market capitalization to disclose their Scopes 1 & 2 (and Scope 3 is possible) in their BRSR from the FY 2022. This will ensure that from the current year onwards, all the NIFTY 100 companies will at least disclose their Scopes 1 & 2.

5. Conclusions

The Paris Agreement aims to keep global warming to 1.5 degrees Celsius above pre-industrial levels. Carbon neutrality must be achieved globally by the middle of the twenty-first century to meet the IPCC's goal. However, the United Nations Environment Programme's "Emissions Gap Report 2019" shows that there is still a significant gap between countries' commitments to cut carbon emissions and the 1.5 °C objective. To close this gap, many governments have adopted carbon neutrality targets to alleviate the effects of climate change. Some large economies, including Germany and Canada, announced in 2020 that they would achieve carbon neutrality by 2050. China, the world's largest contributor to carbon emissions, has pledged to achieve carbon neutrality by 2060. Up to 2020, more than 100 countries have made carbon neutral commitments. More countries in the world will follow this trend in the coming future [43].

Carbon neutrality has become an irreversible global trend. Several companies worldwide have published reports on moving towards a carbon neutral society. With the ever-increasing stakeholder participation, it is equally necessary to disclose the progress and current performance concerning emission reduction. In the case of India, as discussed above, 66 out of NIFTY 100 companies reported their Scopes 1 & 2 emissions, and 48 companies reported their Scopes 1, 2 & 3. The scenario is better in Western countries. In the UK, for example, 97 out of FTSE 100 companies reported on Scopes 1 & 2 and 93 companies reported on Scope 3 too. These disclosures, both in the case of India and the UK, were completely voluntary without any mandate from the government. This implies two things: firstly, western or more developed countries are performing better in terms of disclosure because the top companies there are mostly multinationals with a wide range of stakeholders, and secondly, if these many companies have reported without any government regulation, with proper implementation of mandates, companies can be pushed to be more transparent in their operations and disclosures.

A positive insight gained from analyzing the top 100 Indian companies is about the Extractives & Mineral Processing sector. It is the sector which had the highest average score for GHG emission disclosures against the common belief that this sector would try to hide its emissions given their high intensity. Since this is a sector covered under PAT (Perform, Achieve & Trade Scheme), which could be the probable reason for its good performance on disclosures.

Another important insight that came to light is that 35 out of NIFTY 100 companies have some or the other emission reduction targets made voluntarily. This shows that Indian companies are increasingly becoming self-aware of their responsibilities. The current scenario certainly gives hope for a future with less air pollution, making it possible to combat climate change. Furthermore, companies with carbon reduction targets scored better in disclosures than those without any foreseeable targets, suggesting that more companies will follow comprehensive disclosures and responsible emission reduction targets. The finding of this study could be important for setting the benchmark and new standard for different sectors/industries on emission reduction targets in India.

As more and more companies take voluntary targets for emission reduction, the demand for offsets in VCM is bound to increase. This is because a company can never achieve Net Zero by energy efficiency improvements in hard-to-abate sectors like manufacturing (steel, aluminium, etc.). They will require a significant amount of carbon offsets for them to be able to achieve their targets. For that matter, companies in every sector will need to use carbon offsets (in lesser volume than those in the hard-to-bate sector) to be able to claim themselves as Net Zero. Therefore, opportunities for VCM in India look bright in the coming years as the corporate milestone targets years are 2030 & 2050.

Ethical Statement

This study does not contain any studies with human or animal subjects performed by any of the authors.

Conflicts of Interest

The authors declare that they have no conflicts of interest to this work.

Data Availability Statement

The data that have been used for this study have been accessed through the respective websites of NIFTY 100 companies that are openly available and can be made available on request from the corresponding author upon reasonable request.

Author Contribution Statement

Manvi Jain: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Data curation, Writing – original draft, Writing – review & editing, Visualization, Project administration. **Bhaskar Sinha:** Conceptualization, Methodology, Validation, Formal analysis, Writing – review & editing, Visualization, Supervision, Project administration.

References

[1] Zheng, X., Streimikiene, D., Balezentis, T., Mardani, A., Cavallaro, F., & Liao, H. (2019). A review of greenhouse gas emission profiles, dynamics, and climate change mitigation efforts across the key climate change players. *Journal of Cleaner Production*, *234*, 1113–1133. https://doi.org/10.1016/j.jclepro.2019.06.140

[2] Masson-Delmotte, V., Zhai, P., Pirani, A., Connors, S. L., Péan, C., Berger, S., . . . , & Zhou, B. (2021). Climate change 2021: The physical science basis. *Contribution of working group I to the sixth assessment report of the intergovernmental panel on climate change*. UK: Cambridge University Press.

[3] Gouldson, A., & Sullivan, R. (2013). Long-term corporate climate change targets: What could they deliver? *Environmental Science & Policy*, *27*, 1–10. https://doi.org/10.1016/j.envsci.2012.11.013

[4] Amran, A., & Keat Ooi, S. (2014). Sustainability reporting: Meeting stakeholder demands. *Strategic Direction*, *30*(7), 38–41. https://doi.org/10.1108/SD-03-2014-0035

[5] Buallay, A. (2019). Between cost and value: Investigating the effects of sustainability reporting on a firm's performance. *Journal of Applied Accounting Research*, *20*(4), 481–496. https://doi.org/10.1108/JAAR-12-2017-0137

[6] Herzig, C., & Schaltegger, S. (2006). Corporate sustainability reporting. An overview. In S. Schaltegger, M. Bennett & R. Burritt (Eds.), *Sustainability accounting and reporting*, *21*, Netherlands: Springer. https://doi.org/10.1007/978-1-4020-4974-3_13

[7] Tadros, H., & Magnan, M. (2019). How does environmental performance map into environmental disclosure? A look at underlying economic incentives and legitimacy aims. *Sustainability Accounting, Management and Policy Journal*, *10*(1), 62–96. https://doi.org/10.1108/SAMPJ-05-2018-0125

[8] Busch, T., Cho, C. H., Hoepner, A. G., Michelon, G., & Rogelj, J. (2023). Corporate greenhouse gas emissions' data and the urgent need for a science-led just transition: Introduction to a thematic symposium. *Journal of Business Ethics*, *182*(4), 897–901. https://doi.org/10.1007/s10551-022-05288-7

[9] Döring, S., Drobetz, W., El Ghoul, S., Guedhami, O., & Schroder, H. (2023) Foreign institutional investors, legal origin, and corporate greenhouse gas emissions disclosure. *Journal of Business Ethics*, *182*(4), 903–932. https://doi.org/10.1007/s10551-022-05289-6

[10] Albertini, E. (2013). Does environmental management improve financial performance? A meta-analytical review. *Organization & Environment*, *26*, 431–457. https://doi.org/10.1177/1086026613510301

[11] Hahn, R., Reimsbach, D., & Schiemann, F. (2015). Organizations, climate change, and transparency. *Organization & Environment*, *28*(1), 80–102. https://doi.org/10.1177/1086026615575542

[12] James, M. L. (2015). The benefits of sustainability and integrated reporting: An investigation of accounting majors' perceptions. *Journal of Legal, Ethical and Regulatory Issues*, *18*, 1.

[13] Tang, K. H. D. (2022). Climate change policies of the four largest global emitters of greenhouse gases: Their similarities, differences and way forward. *Journal of Energy Research and Reviews*, *10*(2), 19–35. https://doi.org/10.9734/JENRR/2022/v10i230251

[14] Choi, B. B., Lee, D., & Psaros, J. (2013). An analysis of Australian company carbon emission disclosures. *Pacific Accounting Review*, *25*(1), 58–79. https://doi.org/10.1108/01140581311318968

[15] Albarrak, M. S., Elnahass, M., & Salama, A. (2019). The effect of carbon dissemination on cost of equity. *Business Strategy and the Environment*, *28*(6), 1179–1198. https://doi.org/10.1002/bse.2310

[16] Lloyd, S. M., Hadziosmanovic, M., Rahimi, K., & Bhatia, P. (2022). Trends show companies are ready for Scope 3

reporting with US climate disclosure rule. *World Resources Institute*, *24*.

[17] Doda, B., Gennaioli, C., Gouldson, A., Grover, D., & Sullivan, R. (2016). Are corporate carbon management practices reducing corporate carbon emissions? *Corporate Social Responsibility and Environmental Management*, *23*(5), 257–270. https://doi.org/10.1002/csr.1369

[18] Banchik, L., Siccardo, G., & Rehm, W. (2021). *On target: How to succeed with carbon-reduction initiatives*. Retrieved from: https://decarbconnect.com/wp-content/uploads/2021/05/on-target-how-to-succeed-with-carbon-reduction-initiatives-McKinsey.pdf

[19] Mori Junior, R., & Best, P. (2017). GRI G4 content index: Does it improve credibility and change the expectation–performance gap of GRI-assured sustainability reports? *Sustainability Accounting, Management and Policy Journal*, *8*(5), 571–594. https://doi.org/10.1108/SAMPJ-12-2015-0115

[20] Yadava, R. N., & Sinha, B. (2016). Scoring sustainability reports using GRI 2011 guidelines for assessing environmental, economic, and social dimensions of leading public and private Indian companies. *Journal of Business Ethics*, *138*, 549–558. https://doi.org/10.1007/s10551-015-2597-1

[21] Lewandowski, S. (2017). Corporate carbon and financial performance: The role of emission reductions. *Business Strategy and the Environment*, *26*(8), 1196–1211. https://doi.org/10.1002/bse.1978

[22] Chakrabarty, S., & Wang, L. (2013). Climate change mitigation and internationalization: The competitiveness of multinational corporations. *Thunderbird International Business Review*, *55*(6), 673–688. https://doi.org/10.1002/tie.21583

[23] Wang, D. D., & Sueyoshi, T. (2018). Climate change mitigation targets set by global firms: Overview and implications for renewable energy. *Renewable and Sustainable Energy Reviews*, *94*, 386–398. https://doi.org/10.1016/j.rser.2018.06.024

[24] Dong, B., Xu, Y., & Fan, X. (2020). How to achieve a win-win situation between economic growth and carbon emission reduction: Empirical evidence from the perspective of industrial structure upgrading. *Environmental Science and Pollution Research*, *27*, 43829–43844. https://doi.org/10.1007/s11356-020-09883-x

[25] Eleftheriadis, I. M., & Anagnostopoulou, E. G. (2015). Relationship between corporate climate change disclosures and firm factors. *Business Strategy and the Environment*, *24*(8), 780–789. https://doi.org/10.1002/bse.1845

[26] Liu, Z., Deng, Z., Davis, S. J., Giron, C., & Ciais, P. (2022). Monitoring global carbon emissions in 2021. *Nature Reviews Earth & Environment*, *3*(4), 217–219. https://doi.org/10.1038/s43017-022-00285-w

[27] Hailemariam, A., & Erdiaw-Kwasie, M. O. (2022). Towards a circular economy: Implications for emission reduction and environmental sustainability. *Business Strategy and the Environment*, *32*(4), 1951–1965. https://doi.org/10.1002/bse.3229

[28] India BUR. (2021). *India: Biennial update report (BUR 3)*. Retrieved from: https://unfccc.int/documents/268470

[29] Kumar, K., & Prakash, A. (2019). Examination of sustainability reporting practices in Indian banking sector. *Asian Journal of Sustainability and Social Responsibility*, *4*, 1–16. https://doi.org/10.1186/s41180-018-0022-2

[30] Goel, P., & Misra, R. (2017). Sustainability reporting in India: Exploring sectoral differences and linkages with financial performance. *Vision*, *21*(2), 214–224. https://doi.org/10.1177/0972262917700996

[31] Durana, M. (2020). Sustainability reporting: A literature review. *SSRN: 3608500*.

[32] Gajjar, C., Chakrabarty, S., & Shah, P. (2022). *Estimating the impact of corporate science-based emissions targets on India's nationally determined contribution goals*. Working Paper, World Resource Institute.

[33] Kumar, A., Luthra, S., Mangla, S. K., Garza-Reyes, J. A., & Kazancoglu, Y. (2023). Analysing the adoption barriers of low-carbon operations: A step forward for achieving net-zero emissions. *Resources Policy*, *80*, 103256. https://doi.org/10.1016/j.resourpol.2022.103256

[34] India GHG Program. (2022). *Explaining Scope 1, 2 & 3*. Retrieved from: https://www.indiaghgp.org/explaining-scope-1-2-3

[35] Skouloudis, A., Evangelinos, K., & Kourmousis, F. (2009). Development of an evaluation methodology for triple bottom line reports using international standards on reporting. *Environmental Management*, *44*, 298–311. https://doi.org/10.1007/s00267-009-9305-9

[36] Shrimali, G. (2022). Scope 3 emissions: Measurement and management. *The Journal of Impact and ESG Investing*, *3*(1), 31–54. https://doi.org/10.3905/jesg.2022.1.051

[37] Goel, P. (2021). Rising standards of sustainability reporting in India: A study of impact of reforms in disclosure norms on corporate performance. *Journal of Indian Business Research*, *13*(1), 92–109. https://doi.org/10.1108/JIBR-06-2018-0166

[38] Taliento, M., Favino, C., & Netti, A. (2019). Impact of environmental, social, and governance information on economic performance: Evidence of a corporate 'sustainability advantage' from Europe. *Sustainability*, *11*(6), 1738. https://doi.org/10.3390/su11061738

[39] Prado-Lorenzo, J. M., Rodríguez-Domínguez, L., Gallego-Álvarez, I., & García-Sánchez, I. M. (2009). Factors influencing the disclosure of greenhouse gas emissions in companies world-wide. *Management Decision*, *47*(7), 1133–1157. https://doi.org/10.1108/00251740910978340

[40] Ding, D., Liu, B., & Chang, M. (2023). Carbon emissions and TCFD aligned climate-related information disclosures. *Journal of Business Ethics*, *182*(4), 967–1001. https://doi.org/10.1007/s10551-022-05292-x

[41] Hultman, N., Lou, J., & Hutton, S. (2020). A review of community co-benefits of the clean development mechanism (CDM). *Environmental Research Letters*, *15*(5), 053002. https://doi.org/10.1088/1748-9326/ab6396

[42] Shi, B., Wu, L., & Kang, R. (2021). Clean development, energy substitution, and carbon emissions: Evidence from clean development mechanism (CDM) project implementation in China. *Sustainability*, *13*(2), 860. https://doi.org/10.3390/su13020860

[43] Wu, X., Tian, Z., & Guo, J. (2022). A review of the theoretical research and practical progress of carbon neutrality. *Sustainable Operations and Computers*, *3*, 54–66. https://doi.org/10.1016/j.susoc.2021.10.001

How to Cite: Jain, M., & Sinha, B. (2024). Analyzing Greenhouse Gas Emission Trends of Indian Companies Through Their Disclosures. *Green and Low-Carbon Economy*. https://doi.org/10.47852/bonviewGLCE42022291