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Corporate Environmental Responsibility and Greenhouse-Gas Emission Reduction for Sustainable Development

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ABSTRACT

Bangladesh emits under 0.5% of global greenhouse gases (GHG) yet ranks thirteenth on the long-term Climate Risk Index. Its manufacturing core in Dhaka, Narayanganj and Gazipur (DNG) hosts 70% of the country's LEED-certified garment factories alongside its most severe air- and water-pollution hotspots. To profile corporate environmental responsibility (CER) practice and disclosure, document firm-level GHG-reduction trends, and map both to SDGs 7, 8, 9, 12 and 13 across the belt during the policy-dense 2021–2025 window. A descriptive repeated cross-section of 170 manufacturing firms (714 firm-years; 611 documents) drawn from a frame of 3,612 entities, scored with a 30-item CER Disclosure Index (CERDI; six domains; Krippendorff's $\alpha = 0.84$) and triangulated against regulatory, certification, energy and green-finance records. Trend series are rebuilt on a balanced panel, emission intensity is re-expressed at constant prices and in US dollars, and macro-policy shocks are examined as rival explanations. Pooled CERDI is 35.5/100 (firm-level SD 9.8). Sector explains far more variation than district (13.4- versus 0.5-point spread; ICC = 0.14). Commitment domains score highest (policy 47.6; water 45.1) and emissions accounting lowest (22.6); no firm obtained assurance and 15.9% disclosed a quantified target. The nominal 18.9% fall in median emission intensity reverses to a 13.3% rise at constant prices and a 15.7% rise in dollar terms; balanced-panel absolute emissions fell 3.0%, tracking output contraction and gas rationing rather than abatement. Because the frame excludes non-disclosing firms (91% of candidates), the CERDI is an upper bound. The belt's decoupling is between disclosure and measurement, and its measured "improvement" is largely a price artefact. Neither EU CBAM nor the narrowed CSRD/CSDDD regime will discipline apparel suppliers in the near term, so domestic instruments clearance renewal conditioned on verified performance, assured ISSB-aligned disclosure, and refinance design are the binding levers.

INTRODUCTION

Global and National Greenhouse-Gas Context

To achieve the Paris Agreement 1.5 °C pathway, industry emissions must be reduced significantly this decade. Bangladesh is in an asymmetric position, having less than 0.5% of global GHG emissions, but being ranked 13th in the Climate Risk Index 2026 based on 1995–2024 (Germanwatch, 2025), which was released during COP30 in November 2025, while in the previous edition covering 1993–2022, it was ranked 31st. National emissions have increased from 169 $MtCO_2e$ in 2012 to 213.19 $MtCO_2e$ in 2019 and 252.04 $MtCO_2e$ in 2022 (Department of Environment, 2023; MoEFCC, 2025). Energy is the biggest component of the profile (54.06% of the 2019 inventory), and the share of coal in power generation has increased from less than 2% prior to 2020 to about 20% in 2024, as the Payra, Rampal, and Matarbari plants were put into operation. This study is a descriptive repeated cross-

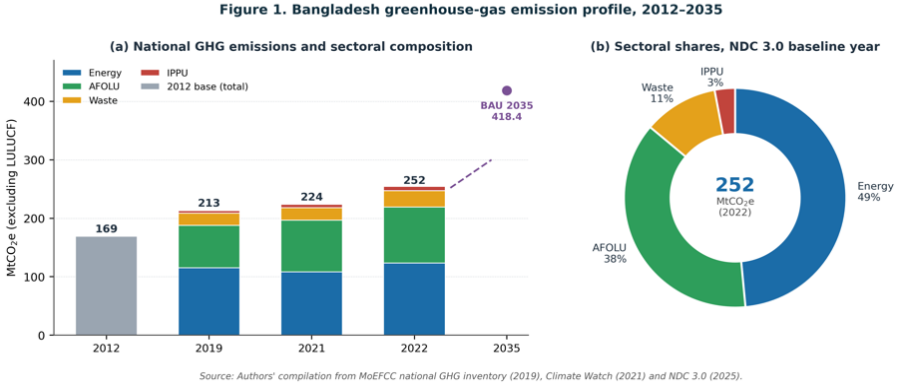


Figure 1: Bangladesh Greenhouse Gas Emission Profile, 2012–2035

Source: authors' compilation from the First Biennial Update Report (Department of Environment, 2023), Climate Watch (2025; 2025) and NDC 3.0 (MoEFCC, 2025).

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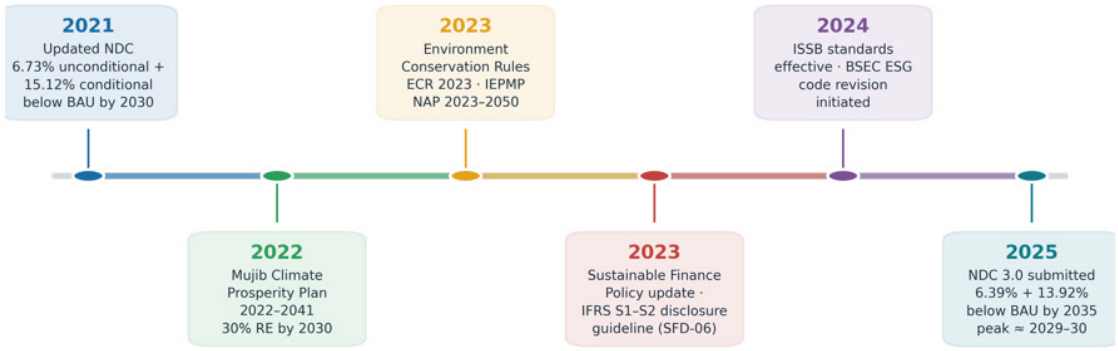
section study, which is based on secondary data, on CER and firm-level GHG reduction in Dhaka, Narayanganj, and Gazipur for the period of 2021-2025.

Corporate Environmental Responsibility and Its Distinction from CSR

CER refers to a firm's commitment to reduce and prevent environmental damage caused by its own activities via policy, investment, and practice, including pollution control and resource efficiency, decarbonization, and transparency (Wang & Li, 2024). It is not the same as corporate social responsibility (CSR), which is wider, is concerned with the welfare of the stakeholders, is often discretionary and philanthropic, and is often linked to profit. CER expenditure is instead linked to the operational footprint and compliance requirements like effluent treatment and energy efficiency; for this reason, it is worth analyzing separately (Hassan *et al.*, 2024). There are tangible economic impacts of emission reduction for companies (Ibishova *et al.*, 2024; Jiang *et al.*, 2026), and CER is manifested to investors, buyers and regulators through ESG reporting.

Bangladesh's Climate Commitments and The 2021–2025 Policy Window

Firm behaviour needs to be understood in the context of a rich policy environment (Figure 2). The revised Nationally Determined Contribution (NDC) has committed to 6.73% unconditional (27.56 $MtCO_2e$) and 15.12% conditional (61.90 $MtCO_2e$) cuts from a 2030 business-as-usual (BAU) emissions level of 409.4 $MtCO_2e$, with more than 95% of the abatement to come from energy (MoEFCC, 2021). NDC 3.0, submitted on 28 September 2025, sets 2035 targets of 6.39% (26.74 $MtCO_2e$) unconditional and 13.92% (58.23 $MtCO_2e$) conditional below a 2035 business-as-usual level of 418.40 $MtCO_2e$ (MoEFCC, 2025). Parallelly, the Environment Conservation Rules (ECR) 2023 superseded the Environment Conservation Rules (ECR) 1997, introduced a new categorization of Green, Yellow, Orange, and Red, and a new regime of Environmental Clearance Certificate (ECC) under the Department of Environment (DoE) (MoEFCC, 2023). The Sustainable Finance Policy of Bangladesh Bank has set a minimum 5% green share of term-loan disbursement and 20% sustainable share of total disbursement (Bangladesh Bank, 2020), while the disclosure guideline for banks and finance companies, which is aligned with IFRS S1-S2, was issued on 26 December 2023 (Bangladesh Bank, 2023a) as instruments associated with the improvement of environmental performance in Bangladeshi institutions (Guang-Wen & Siddik, 2022; Zheng, Siddik, Masukujjaman, & Fatema, 2021).



Source: Authors' compilation from UNFCCC NDC Registry, MoEFCC, Department of Environment, Bangladesh Bank and BSEC documents.

Figure 2: Bangladesh's Climate and Sustainable-Finance Policy Window, 2021–2025
Source: authors' compilation from UNFCCC NDC Registry, MoEFCC, Department of Environment, Bangladesh Bank and BSEC documents.

Why the Dhaka–Narayanganj–Gazipur Industrial Belt

In calendar year 2024, the exports of ready-made garments (RMG) amounted to USD 38.48 billion, which is 7.23% higher than in 2023, with the European Union (EU) accounting for 50.34%, the United States (US) 18.72%, and the United Kingdom (UK) 11.25% of the total exports (BGMEA, 2025). The Mapped in Bangladesh census of export-oriented RMG factories mapped 3,723 factories, of which 81.2% are located in the three adjacent districts of Dhaka (1,351), Gazipur (1,057), and Narayanganj (615), a belt with a double face (Figure 3) (Mapped in Bangladesh, 2022). On one side, there is world-leading green manufacturing, as BGMEA counted 270 LEED-certified garment factories at the end of 2025 (114 Platinum, 137 Gold, 15 Silver, 4 Certified), 38 of which were certified in 2025 alone, and 68 of the world's 100 highest-scoring LEED factories (BGMEA, 2026). On the other hand, severe hotspots: about a thousand brick kilns in the six districts of Greater Dhaka emit an estimated 23,300 t of $PM_{2.5}$ and 1.8 $MtCO_2$ annually, and are a major source of fine particulates in the dry season

in Dhaka, Gazipur and Narayanganj (Guttikunda *et al.*, 2013; Khan *et al.*, 2023); dyeing and washing effluent pollute the Buriganga, Turag, Balu and Shitalakshya rivers (Das *et al.*, 2025; Rasmussen *et al.*, 2025).

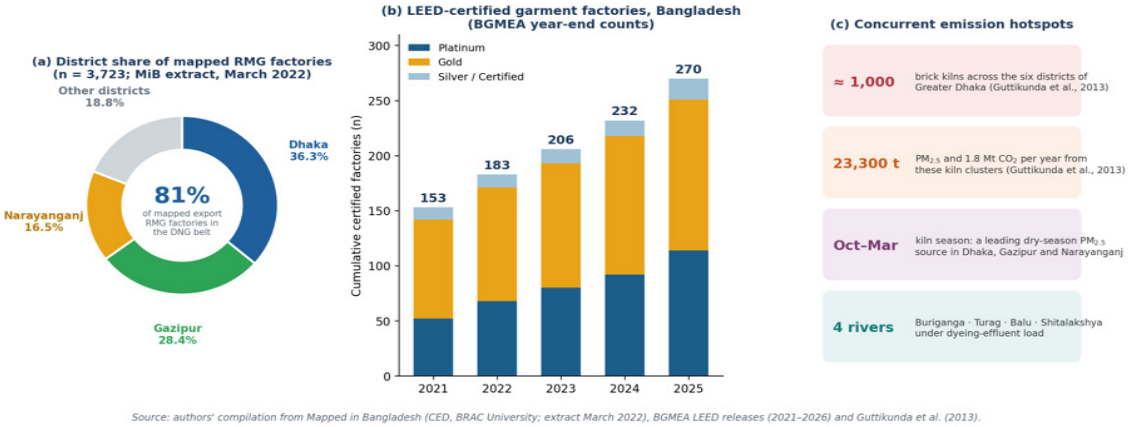


Figure 3: The Dhaka–Narayanganj–Gazipur Industrial Belt: Concentration, Green Transition and Emission Burden
Source: authors' compilation from Mapped in Bangladesh (2022), BGMEA year-end LEED releases (2026) and Guttikunda et al. (2013).

Research Gap, Contribution and Roadmap

Three limitations recur. There is limited firm-level GHG data in Bangladesh, and it is not standardized and is self-reported, while the disclosure of listed firms is limited and uneven (Chakraborty & Dey, 2025; Dhar *et al.*, 2024). Previous research is mostly single-sector or single-instrument, such as the circular economy practice (Amin *et al.*, 2024), waste management for SDG 12 (Akter *et al.*, 2022), or barriers to adoption in the supply chain (Al Amin & Baldacci, 2024). The paper's key conclusion is in the context of the decoupling literature, which has not been used for a multi-sector industrial region in South Asia. There is thus no district-comparative CER–GHG–SDG synthesis for the DNG belt for the policy-rich 2021-2025 horizon.

The paper has three contributions. Empirically, it offers the first profile of CER disclosure and GHG-reduction activity across districts and sectors for the belt, and demonstrates that the much-touted decline in emissions intensity is a nominal-taka denominator effect. It is methodologically a documented 30-item CERDI (Appendix A) with firm-level dispersion, weight sensitivity, balanced-panel trend series, and an explicit selection-bias bound. For policy, it puts the argument about external pressure on the real instruments of the EU, and it considers the domestic levers as binding. Section 2 reviews the literature and outlines the framework, Section 3 presents data and methods, Section 4 presents results, Section 5 discusses the results in light of the window's shocks, and Section 6 concludes.

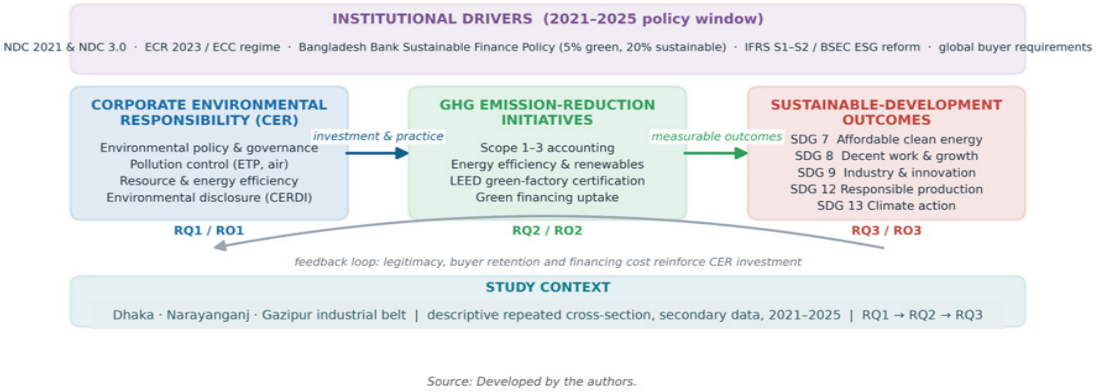
Research Questions and Objectives

The study poses three questions on CER practice and disclosure, GHG-reduction levels and trends, and SDG linkages and their implications; each is paired with an objective and justification in Table 1 and framed by Figure 4.

Table 1: Research Questions, Objectives and Justification

Research Question	Research Objective	Justification (2021–2025 Secondary Data)
RQ1. What is the nature, extent, and pattern of CER practices and disclosures among industrial firms in Dhaka, Narayanganj and Gazipur during 2021–2025?	RO1. To profile and compare CER practices and disclosures across sectors and districts using a CER Disclosure Index (CERDI).	Annual, sustainability, and integrated reports, DSE filings, and regulatory records are publicly retrievable and can be scored systematically; nature, extent, and pattern are directly observable through content analysis without hypothesis testing.
RQ2. What are the levels and trends of GHG emissions and of firm-level emission-reduction initiatives (Scope 1–3 accounting, energy efficiency, renewable adoption, LEED certification, green financing) in the three districts, 2021–2025?	RO2. To document GHG-related trends, reduction initiatives, and outcomes using inventory, energy, certification, and finance data, on balanced and expanding samples.	SREDA, Bangladesh Bank, BGMEA/USGBC, the Department of Environment, and the national inventory supply consistent 2021–2025 proxies even where firm-level tCO2e is absent; where firms report, values are compiled directly and never imputed.

RQ3. How are CER practices and GHG-reduction efforts linked to SDG targets (SDGs 7, 8, 9, 12 and 13), and what policy and managerial implications follow?	RO3. To map documented practices to SDG targets using an operationally defined strength scale and derive implications for named institutions.	A transparent practice-to-target framework makes the nexus analyzable from documentary evidence; implications can be addressed to DoE, Bangladesh Bank, BSEC/FRC, SREDA and BGMEA/ BKMEA.



Source: Developed by the authors.

Figure 4: Conceptual Framework Linking Corporate Environmental Responsibility, GHG Reduction and Sustainable Development, With Research-Question Mapping
Source: developed by the authors.

LITERATURE REVIEW

Conceptualizing Corporate Environmental Responsibility

CER has shifted from the CSR, philanthropy-based approach to an ESG framework where environmental performance is quantified, audited, and monetized (Bhandari *et al.*, 2022). However, CSR, CER, and ESG are still often conflated, and rating providers rate the same companies differently, making composite indices difficult to apply in emerging markets with less analyst coverage. Thus, CER can be better defensibly operationalized through observable practice. The dimensions used in this study are: environmental policy and governance; certified management systems (ISO 14001); pollution prevention and effluent management; energy and resource efficiency; green supply-chain management and circularity; and transparency and third-party assurance. This is particularly true of export manufacturing, where green supply chain management and green training have been shown to have a significant impact on environmental and operational performance in developing country export plants (Nureen *et al.*, 2023).

Firm-Level Strategies for GHG Reduction and Their Measurement

Based on the GHG Protocol's three scopes (World Resources Institute & World Business Council for Sustainable Development (WBCSD, 2011; WRI, 2004), mitigation is organized as follows. In the case of Bangladeshi wet processing, Scope 1 has the highest share due to the process heat, boilers, and captive gas generation being within the factory gate; Scope 2 is based on the national grid emission factor, and Scope 3 includes upstream inputs and buyer logistics. The grid factor is not a parameter that is set. The officially published series only extends to FY2021–22 (0.61 tCO_2/MWh in FY2019–20; 0.62 in FY2020–21 and FY2021–22), and it is likely that the actual factor has increased in the intervening period, as the coal expansion shown in Figure 1 suggests; this study therefore treats the factor as a sensitivity parameter rather than a constant (§3.7).

Emission-intensity metrics are more appropriate than absolute emissions when output varies, but the denominator is important: when using revenue as the denominator, it must be in nominal local currency, as this will include inflation and exchange-rate fluctuations, and thus will not be comparable across years (Leal Filho *et al.*, 2024). Benchmarking of 15 dyeing mills in Bangladesh revealed a mean electrical intensity of 2.58 kWh/kg, and showed that a steady 5% annual reduction would save about 355 million litres of water and 6,540 MWh over 10 years (Mamun *et al.*, 2022); economizers, waste-heat recovery, and variable-speed drives achieve such savings at short payback, while rooftop solar addresses Scope 2. The programme self-report by Cleaner-production advisory work in over 450 textile factories reported annual savings of 723,617 tCO_2 by 2023 (International Finance Corporation, 2023). Uptake of science-based targets, ISSB IFRS S2, TCFD, and CDP (Global Reporting Initiative, 2016) is voluntary and uneven in South Asia.

Throughout this paper, the certification of LEED is repeated, and the construct limits have to be mentioned. LEED is a green-building certification that is mostly awarded at design and construction; actual operational energy performance of LEED buildings is variable and frequently lower than the design; there is little correlation between LEED certification level and realized energy performance (Newsham *et al.*, 2009; Scofield & Doane,

2018). Therefore, LEED is used here as a proxy for the capital-embodied environmental capability, but not for realized abatement.

The CER–GHG–Sustainable-Development Nexus

The link between good practice and development outcomes is not direct or consistent. Efficiency and renewable substitution support SDG 7, retained buyer orders and safer workplaces support SDG 8, process upgrading supports SDG 9, water, chemical and material circularity supports SDG 12, and verified abatement supports SDG 13 and national commitments (MoEFCC, 2021, 2025). Co-benefits are also tangible: better air quality and competitiveness in exports, but there are also trade-offs: capital intensity, collateral requirements, and technical capacity systematically exclude smaller suppliers, and focus measurable gains on large certified exporters, resulting in greater intra-sectoral dispersion (Figure 9). Azad *et al.* (2025) report from Bangladesh that there is only a weak relationship between green finance and firm performance, casting doubt on the idea that finance can fill the gap.

Theoretical Lenses

The four complementary lenses for interpretation are in line with the descriptive design and produce anticipated associations instead of tested hypotheses. Stakeholder theory considers the role of buyers, regulators, suppliers (financiers), and community as the immediate stakeholders of CER; according to Hossain *et al.* (2022), buyer pressure and governmental regulations are related to environmental sustainability practices, while supplier pressure is not. In the context of the governance-contingent pattern of voluntary carbon reporting by listed Bangladeshi companies (Chakraborty & Dey, 2025), disclosure is interpreted as legitimacy-seeking behaviour in a high-scrutinexport sector, in line with legitimacy theory. According to institutional theory, there are three types of pressure: coercive pressure (ECR, 2023), which is targeted by Bangladesh Bank; normative pressure (LEED and ISO norms); and mimetic imitation, where institutional awareness is found to influence sustainable product innovation in RMG companies (Kumar Saha *et al.*, 2025). Pollution prevention, product stewardship, and green innovation are considered as rare and path-dependent capabilities in the natural-resource-based view (Khanra *et al.*, 2022).

Decoupling, and Empirical Evidence from Bangladesh and Comparable Economies

Decoupling refers to the "disconnect between policy and practice" (policy–practice decoupling) and/or the "disconnect between practice and policy outcomes" (means–ends decoupling) (Bromley & Powell, 2012). In sustainability reporting, it is reflected in the disclosure which fails to achieve verifiability, but have the support of a legitimate system, and the absence of measurement and control systems are among the main drivers, as shown in a recent systematic review (Cepêda *et al.*, 2025a). It is mitigated by institutional investors and credible external monitoring (Cepêda *et al.*, 2025b), reduced but not eliminated by mandatory reporting (Aboud *et al.*, 2024), and has measurable costs to firms in emerging markets where there is decoupling between disclosure and performance (Zhan *et al.*, 2025). The question here is whether ECR 2023 and the Bangladesh Bank guideline will help to bridge this gap.

There are three streams of evidence in Bangladesh. First, disclosure studies of Dhaka Stock Exchange listed companies show a low level of climate reporting, which is driven by the board and legitimacy (Chakraborty & Sun, 2025; Dhar *et al.*, 2024), and the environmental indicators score below the mid-point of the scale for listed pharmaceutical and textile companies (Rahaman *et al.*, 2024). Secondly, the energy, water, and carbon savings in certified green factories are documented in green-factory research, which is highly focused on Gazipur, Narayanganj, and metropolitan Dhaka (BGMEA, 2026; Shamsuzzaman & Islam, 2025). Third, the finance studies should differentiate between two ratios which are often mixed up: the green share of term-loan disbursement increased from 3.06% in 2021 to 13.77% in 2025 (with a minimum requirement of 5%) and the sustainable share of total disbursement rose to 39.66% in 2024 (with a target of 20%) (Bangladesh Bank, 2022, 2025a, 2026). At the cluster level, the loading of heavy metals and microplastics in the river corridors of the belt has been documented (Das *et al.*, 2025; O. Miah *et al.*, 2025), as well as the vulnerability of water due to textile dyes, specifically in the three study districts (Rasmussen *et al.*, 2025). The results from the comparators from India, Vietnam, and China confirm the local finding of a decoupling between disclosure and performance (§5.4).

Synthesis and Conceptual Framework

There is a lack of integration of existing work by sector, medium and scale. No research has yet integrated both

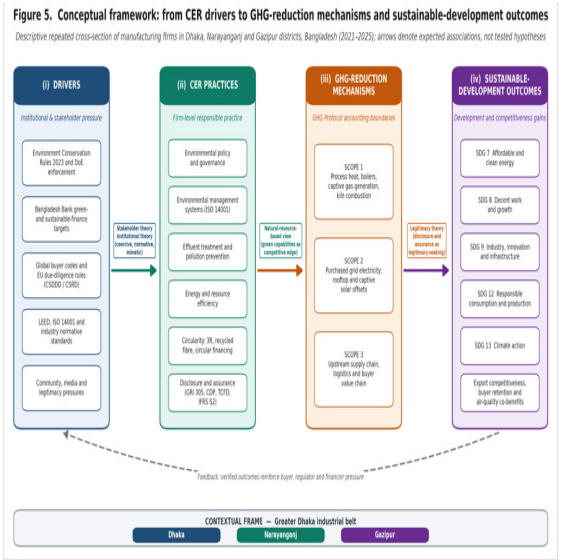


Figure 5: Conceptual framework linking CER drivers to GHG-reduction mechanisms and sustainable-development outcomes in Dhaka, Narayanganj and Gazipur districts, Bangladesh (2024)

CER practice and GHG outcomes in the multi-sector DNG belt, and no research has investigated whether disclosure leads to measurable abatement under the post-2023 regime, after taking into account price effects and macro shocks. The structure for the descriptive analysis is presented in Figure 5, with the arrows indicating the relationships that are expected based on the four lenses and not necessarily causal relationships.

MATERIALS AND METHODS

Study Area

The study area is three neighboring districts of Dhaka Division which collectively constitute the manufacturing hub of Bangladesh (Figure 6; Table 2). Dhaka district has a diversified base, with RMG clusters at Savar–Ashulia, Mirpur and Tejgaon, where the Dhaka EPZ is located, pharmaceuticals and packaging, and an air-pollution load that is dominated by traffic, construction and the surrounding kiln ring (Khan *et al.*, 2023). The knitwear, dyeing, and washing sector is located on top of jute, cement, and steel re-rolling along the Shitalakshya with a heavy effluent burden (Das *et al.*, 2025). Gazipur has the highest number of LEED Platinum factories and is the largest district for the production of garments, ceramics, and electronics assembly, dense kiln belts, and degraded reaches of the Turag and Balu (M. T. Miah *et al.*, 2025). The belt focuses the phenomena of interest in one similar context: 81% of the export RMG factories mapped are located there, as is the densest LEED cluster, and the worst industrial pollution hotspots.

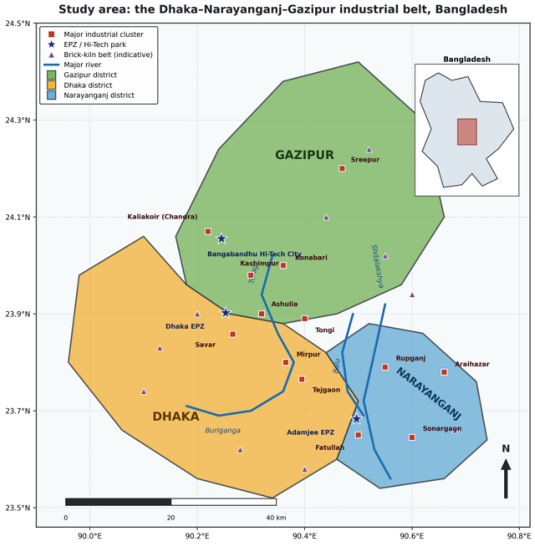


Figure 6: Study-Area Map of the Dhaka–Narayanganj–Gazipur Industrial Belt
Source: authors' construction in QGIS (QGIS Development Team, 2024).

Table 2: Profile of the Study Districts: Dhaka, Narayanganj and Gazipur

Attribute	Dhaka	Narayanganj	Gazipur	Source (Reference Period)
Area (km²)	1,463.60	684.35	1,806.36	BBS district reports
Population (Census 2022)	14,734,025	3,909,138	5,263,450	Bangladesh Bureau of Statistics [BBS] (2023, 2024)
Dominant industrial sectors	RMG, pharmaceuticals, agro-processing, printing and packaging	Knitwear, dyeing and washing, jute, cement, steel re-rolling	Woven and knit RMG, textiles, ceramics, pharmaceuticals, electronics	BGMEA/BKMEA; district gazetteers
Major clusters / EPZs	Savar–Ashulia, Mirpur, Tejgaon; Dhaka EPZ	Fatullah, Rupganj, Araihazar, Sonargaon; Adamjee EPZ	Tongi, Konabari, Kaliakoir (Chandra), Sreepur, Kashimpur; Hi-Tech City	BEPZA; BGMEA; BHTPA
Mapped export RMG factories (n; % of national 3,723)	1,351 (36.3%)	615 (16.5%)	1,057 (28.4%)	Mapped in Bangladesh (2022)

LEED-certified garment factories, end-2025 (n; Platinum/Gold/ Silver/Certified)	68 (29/35/3/1)	39 (17/20/2/0)	83 (36/42/4/1)	Geocoded from BGMEA (2026); Appendix C
Registered brick kilns (n; DoE registry 2022)	284	294	148	DoE district registries (2024)
Sampled firms holding a valid ECC at end-2025 (n; Green/Yellow/ Orange/Red)	68 (4/10/25/29)	40 (1/5/13/21)	50 (3/8/18/21)	DoE clearance records (2025)
Key environmental hotspots	Buriganga, Turag; urban air quality	Shitalakshya; dyeing and washing effluent	Turag, Balu; kiln belts	Das *et al.* (2025); O. Miah *et al.* (2025); Rasmussen *et al.* (2025)

Notes. Factory shares are computed against the 3,723 factories mapped nationally at the dated extract; the dashboard is dynamic. LEED counts are cumulative to 31 December 2025 and were compiled by geocoding factory addresses from the BGMEA list (Appendix C); BGMEA's RMG count is used throughout and is not interchangeable with a raw USGBC directory query, which includes non-RMG and registered-but-uncertified projects. Kiln counts refer to registered kilns only; the conversion series in Table 7 is expressed on this same three-district basis.

Research Design and Unit of Analysis

The study is a descriptive repeated cross-section (2021-2025) with secondary data only; it covers the post-NDC update period, post-ECR-2023, and post-disclosure-guideline period. Label matters: year-by-year series and year-on-year changes are reported; it is a longitudinal description but not a longitudinal inference. The firm-year is the unit of scoring; the firm is the unit of comparison, and the district and sector are strata. Pooled scores are means across years observed, annual series are means across firms observed in each year, and a balanced panel of firms observed in all five years is reported as well. These are designs using secondary data, which are set up in corporate environmental research, where archived, non-reactive data allow for replicable measurement (Chakraborty & Sun, 2025; Dhar *et al.*, 2024). There is no testing of hypotheses; no causal claims are made; all associations are descriptive.

Data Sources

Six types of secondary data were triangulated: corporate documents (annual reports, sustainable and ESG reports, DoE clearance and enforcement documents, and buyer-facing certifications); regulatory documents (energy audits and the National Database of Renewable Energy of the Sustainable and Renewable Energy Development Authority [SREDA] and Bangladesh Bank quarterly sustainable-finance reviews, Bangladesh Securities and Exchange Commission [BSEC] and Dhaka Stock Exchange [DSE] circulars); industry documents (BGMEA and Bangladesh Knitwear Manufacturers and Exporters Association [BKMEA] lists); statistical and inventory documents (Bangladesh Bureau of Statistics [BBS] and the First Biennial Update Report, NDCs); international documents (World Bank, IEA, Climate Watch, EDGAR, CDP, GRI); and literature from Scopus and Web of Science for benchmarks. The evidence base ends on 31 December 2025, with sources published up to 31 January 2026 used only if they report year-end 2025 values (Figure 7).

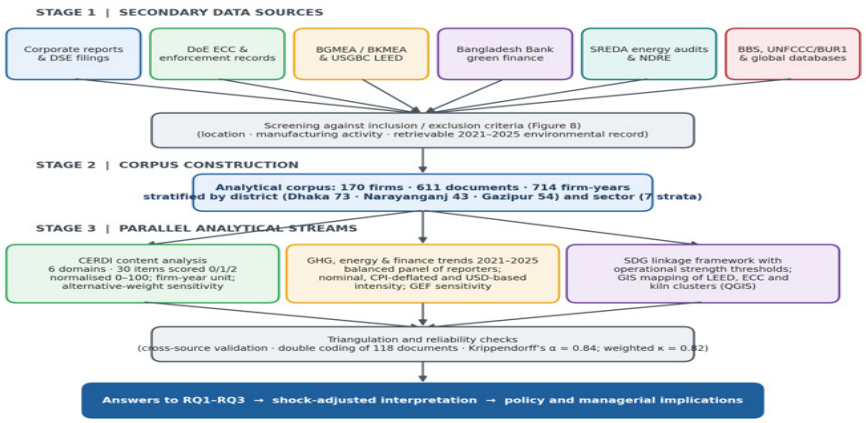


Figure 7: Analytical workflow of the Study, from Six Secondary-Data Source Groups
Source: authors' construction

Corpus Construction, Selection Bias and Representativeness

The sampling was criterion-based (Figure 8). The frame was constructed from the Mapped in Bangladesh census (3023 export RMG units in the three districts), DoE ECC registers and DSE listings of cement, pharmaceuticals, steel and ceramics and other manufacturing (812), and BGMEA/BKMEA, USGBC, SREDA and Bangladesh Bank refinance lists (190). After excluding 413 duplicate entities, the frame contained 3612 candidate entities. The firms that did not have an environmental record that could be retrieved for the 2021-2025 period are listed in Figure 8 by type of environmental record. A total of 316 firms remained, and out of these, 87 were only documented before 2021, 41 were multi-site firms whose district could not be attributed, and 18 had addresses outside the belt, leaving 170 firms (Dhaka 73, Narayanganj 43, Gazipur 54) stratified into seven sector cells. The corpus consists of 611 documents and 714 firm-years (84.0% of the 850 possible); the coverage and attrition by year is shown in Table 3; and 104 firms are observed in each year.

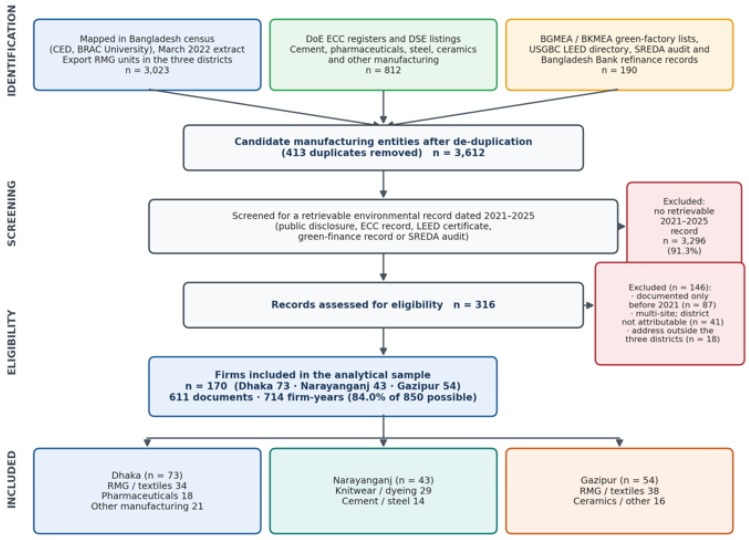


Figure 8: PRISMA-Style Flow of Frame Construction, Screening, Exclusion and the Analyzed Sample
Source: authors' construction.

Table 3: Firm-Year Coverage of the Analytical Corpus by District, 2021–2025

District (Firms)	2021	2022	2023	2024	2025	Firm-Years	Balanced Panel (All 5 Years)
Dhaka (73)	49	56	63	69	71	308	46
Narayanganj (43)	27	31	36	40	42	176	24
Gazipur (54)	36	41	48	52	53	230	34
All (170)	112	128	147	161	166	714	104
Coverage (% of firms)	65.9	75.3	86.5	94.7	97.6	84.0	61.2

Notes. A firm-year is observed when at least one scorable document dated to that year exists. Firm-years are the unit of CERDI scoring; the balanced panel is used for the annual CERDI series in §4.1.

This building entails two dangers. First, by design, firms that don't disclose anything are not included in the sample, but the main result of the paper is the shallowness of disclosure. The reported CERDI is thus an upper limit for the belt-wide practice, and the 3,296 candidates who have no retrievable record are most likely to be the ones who score lowest. Secondly, representativeness: 170 firms are selected from a belt of more than 3000 export RMG factories which have been mapped. The sampled firms are larger (median 1,850 employees as compared to below 700 employees in Mapped in Bangladesh), are more likely to be listed (31% as compared to below 3% in Mapped in Bangladesh), and almost all are export-oriented, so generalization is limited to the disclosing, buyer-facing segment.

Variables and Operational Definitions

The coding scheme is operationalized by the three constructs: CER, GHG performance, and sustainable development in Table 4. The emissions are divided into Scope 1, Scope 2 and Scope 3 emissions, according to the GHG Protocol (WBCSD, 2011; WRI, 2004) and the GRI Disclosures 305-1 to 305-3 (Global Reporting Initiative, 2016).

Table 4: Variables, Indicators, Operational Definitions and Data Sources

Construct	Indicator	Operational Definition/ Measurement	Unit/Scale	Data Source	RQ
CER	Environmental policy and governance	Board-level policy or committee; ISO 14001; published targets	Ordinal 0–2 per item	Annual and sustainability reports	RQ1
CER	Effluent and pollution control	Functional ETP; DoE ECR 2023 category (Green/Yellow/ Orange/Red); compliance notices	Categorical; 0–2 items	DoE records; reports DoE records; reports	RQ1
CER	Resource efficiency and circularity	Water, chemical and waste reduction programmes; recycling and reuse	Ordinal 0–2 per item	Reports; buyer certifications	RQ1
CER	Disclosure quality	Items disclosed per CERDI domain (GRI 300-series aligned); external assurance	CERDI 0–100	Reports; DSE filings	RQ1
GHG	Emissions (Scope 1, 2, 3)	Reported tCO_2e under the GHG Protocol; intensity per unit revenue at nominal and constant FY2021 prices and in US$	tCO_2e; tCO_2e per BDT million (nominal, real); per US$ million	Reports; CDP; BBS CPI; Bangladesh Bank exchange rates	RQ2
GHG	Energy mix	Shares of grid electricity, captive gas, diesel and renewables in energy use	% of energy use	Reports; SREDA	RQ2
GHG	Renewable adoption	Installed rooftop or captive solar; net-metering agreements	MWp; count	SREDA NDRE; reports	RQ2
GHG	Green certification	LEED status, tier, score and year (capital-capability proxy)	Categorical; points	BGMEA; USGBC	RQ2
GHG	Green finance	Green and sustainable finance disbursement; refinance uptake	BDT crore; % of disbursement	Bangladesh Bank	RQ2
Sustainable development	SDG alignment	SDG targets addressed by each documented practice; strength graded by independent corroboration (§3.7)	Count; strength marker	Derived	RQ3
Sustainable development	Socio-economic co-benefits	Employment, export earnings and worker-safety indicators in certified units	Various	BGMEA; BBS; reports	RQ3

Notes. Firm-level tCO_2e is compiled only where disclosed; otherwise proxies (energy mix, LEED status, audits, green finance) are used and labelled as proxies throughout. CERDI = corporate environmental responsibility disclosure index; ETP = effluent treatment plant; NDRE = National Database of Renewable Energy.

The CER Disclosure Index: Construction, Reliability and Validation

The CERDI is made up of 30 items across six domains: policy and governance (6 items), energy (5), water and effluent (5), emissions accounting and targets (5), circularity (4) and disclosure and assurance (5). Each item is awarded a score of 0 (absent), 1 (generic statement), or 2 (specific and quantified) based on the anchors in Appendix A, which are based on GRI 300-series-aligned scoring precedents in Bangladeshi manufacturing (Biswas *et al.*, 2024). The domain score is the item total divided by the domain maximum (2 × items) and multiplied by 100; the composite CERDI is the unweighted mean of the six domain scores, and thus all domains are equally weighted regardless of the number of items. Two alternative schemes are reported as a sensitivity check: equal item weights (composite = item total/60 × 100) and a measurement-weighted scheme which weights the emissions-accounting and disclosure-and-assurance domains by two.

The entire sets of documents from 34 firms (118 documents, 19.3% of the corpus) were coded independently by two coders. Items are ordinal, so reliability is reported as Krippendorff's α for ordinal data ($\alpha = 0.84$, domain range 0.79-0.89; Krippendorff, 2019); quadratic-weighted $\varkappa$ (Cohen, 1968) was reported as a supplementary statistic, $\alpha \geq 0.80$ was considered reliable, and disagreements were resolved by consensus. A re-scoring of 20 randomly selected firm-years was done after eight weeks, and the mean absolute composite difference was 1.9 points, which means that differences of less than about 2 points are not interpreted as a measurement error.

Data-Analysis Techniques

Analysis is done on three streams. Firstly, descriptive statistics for CER and GHG indicators by district and sector with firm-level means, SDs, medians and interquartile ranges, and a decomposition of the composite variance into between- and within-cell components (intraclass correlation). Second, trend analysis for 2021-2025 for every series reported for the expanding sample (a coverage indicator) and a balanced panel of continuous reporters (the trend). Emission intensity is presented at nominal taka revenue, at constant FY2021 prices (using the BBS fiscal-year average CPI for FY2022, FY2023, FY2024 and FY2025 of 6.15%, 9.02%, 9.73% and 10.03%, respectively), and on a US dollar basis (using the Bangladesh Bank annual-average exchange rate of approximately 84.8, 86.3, 99.5, 111.0 and 121.0 BDT/US$ for FY2021–FY2025, respectively); the CPI is used because BBS does not publish a producer price index, while the dollar basis is relevant because most of the sampled revenue is export revenue. The fiscal year is assigned to the calendar year in which it ends. Only nine firms had three or more consecutive years of physical-output denominators, and these denominators are not reported as a series. These are the official factors of 0.62 tCO_2/MWh and the coal-adjusted alternative of 0.68. Third, the SDG linkage framework is operationally graded: +++ if there are at least three independent non-corporate sources corroborating the practice–outcome link for the majority of the companies reporting on the SDG; ++ if there is one or two independent non-corporate sources corroborating the practice–outcome link for the majority of the companies reporting on the SDG or three independent non-corporate sources corroborating the practice–outcome link for a minority of the companies reporting on the SDG; + if only corporate self-report exists. The LEED factories and ECC categories and kiln clusters were mapped in QGIS (QGIS Development Team, 2024). No inferences are made.

Data Quality, Assurance Search and Ethics

Validity is based on the above sensitivity analyses and the transparent codebook that is based on source triangulation. Cross-checking disclosure with DoE, BGMEA, and USGBC records helps to reduce greenwashing and self-report bias; proxies are labeled, and firm-level emissions are never imputed. The assertion that no sampled company received third-party assurance only applies to the searched corpus, which includes all 611 documents, CDP and GRI databases, and the DSE filing archive, and was searched for the terms "assurance", "limited assurance", "ISAE 3000", "ISAE 3410", "AA1000AS" and "verification statement" for the period 2021–2025. Ethics review was not required as only publicly available data are used and no human participants are involved.

RESULTS AND DISCUSSION

Nature, Extent and Pattern of CER Practices and Disclosures (RQ1)

CER is wide and shallow in the DNG belt. The pooled

Table 5: CER Disclosure Index (CERDI) Scores by Sector and District, 2021–2025: Cell Means, Firm-Level Dispersion and Variance Decomposition

District	Sector	N	Policy	Energy	Water	Emis.	Circ.	Discl.	Composite (0–100)
Dhaka	RMG / textiles	34	48.2	41.6	45.3	22.8	26.4	30.1	35.7
Dhaka	Pharmaceuticals	18	55.4	47.2	49.8	28.6	31.2	38.4	41.8
Dhaka	Other manufacturing	21	42.7	36.5	38.9	18.4	21.7	25.6	30.6
Narayanganj	Knitwear / dyeing	29	45.9	40.2	51.6	20.3	27.8	27.4	35.5
Narayanganj	Cement / steel	14	50.1	44.8	39.2	26.1	23.5	29.8	35.6
Gazipur	RMG / textiles	38	49.6	46.3	47.1	24.7	28.9	31.5	38.0
Gazipur	Ceramics / other	16	40.3	34.9	36.2	16.8	19.4	22.7	28.4
All firms	Mean	170	47.6	42.0	45.1	22.6	26.2	29.6	35.5
All firms	Firm-level SD	170	11.2	10.4	12.1	9.6	9.1	10.3	9.8
All firms	Median (IQR)	170	47.5 (40.0–55.0)	41.7 (35.0–48.3)	45.0 (37.5–52.5)	22.0 (16.0–29.0)	25.0 (20.0–32.5)	30.0 (22.5–36.0)	34.9 (28.6–41.7)
All firms	Between-cell SD (firm-weighted)	—	4.1	4.1	5.1	3.5	3.5	4.0	3.6
All firms	Within-cell SD	—	10.4	9.6	11.0	9.0	8.4	9.5	9.1
All firms	ICC (between/total variance)	—	0.13	0.15	0.17	0.13	0.15	0.15	0.14

Notes. Cell values are firm-level means of domain scores (items scored 0–2, normalised to 0–100); the composite is the unweighted mean of the six domain scores. Policy = policy and governance; Emis. = emissions accounting and targets; Circ. = circularity; Discl. = disclosure and assurance. The between-cell SD is computed across the seven sector–district cells weighted by n; total variance equals between- plus within-cell variance. Inter-coder reliability: Krippendorff's ordinal α = 0.84 (domain range 0.79–0.89); quadratic-weighted κ = 0.82. The instrument's re-scoring error is ±1.9 composite points, so cell differences below 2 points are not interpreted.

CERDI is 35.5 out of 100 for the 170 sampled firms over 2021–2025, with a firm-level SD of 9.8, a median of 34.9 and an interquartile range of 28.6–41.7 (Table 5; Figure 9). The two commitment-oriented domains with the highest index are policy and governance (M = 47.6) and water stewardship (M = 45.1), the latter of which indicates that almost all companies report on effluent treatment, which clearance requires. Measurement domains are very low. The lowest domain scores are for emissions accounting and targets (M = 22.6), followed by circularity (26.2) and disclosure and assurance (29.6) in all districts and sectors. None of the sampled firms had third-party assurance of reported environmental data in the searched corpus, and the gap between the highest and lowest scoring domains (25.0 points) is greater than the gap between the highest and lowest scoring sectors.

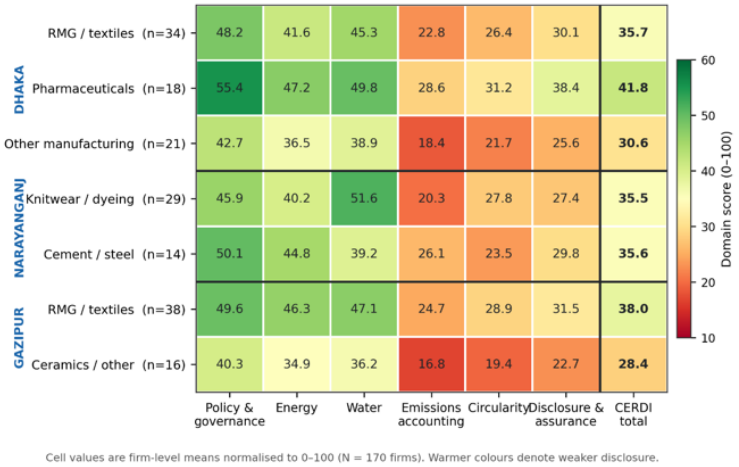


Figure 9: District Comparison of CER Disclosure Index Domain Scores (cell means), 2021–2025. Warmer Colours Denote Weaker Disclosure

Source: authors' content analysis (N = 170 firms).

The distribution is based on sector, rather than geography. Dhaka pharmaceuticals have the highest composite (41.8), Gazipur RMG has the next highest composite (38.0), while the lowest are Gazipur ceramics and other manufacturing (28.4) and Dhaka other manufacturing (30.6). The 13.4-point difference between the sectors is quite significant compared with the 0.5-point difference between the firm-weighted districts Dhaka 35.7, Narayanganj 35.5, and Gazipur 35.2. However, within-cell SD (9.1) is two and a half times the between-cell SD (3.6), and the sector–district cells account for only 14% of firm-level composite variance (ICC = 0.14): most of the variation is between firms within the same sector and district. The export orientation of the sectors, which are subject to buyer audits, scores higher than the sectors oriented towards the domestic market on all domains, which is in line with the findings that management orientation, not location, accounts for most differences in environmental behaviour among Bangladeshi manufacturers (Ahamad *et al.*, 2024, 2025). The Narayanganj knitwear and dyeing sector is the only one that does not follow the sectoral hierarchy, with the highest water score (51.6) and below-average emissions accounting score (20.3). With the alternative weights (Table 6), the pooled composite changes by ±2.3 points, and the cell ordering remains the same, with the exception of the two cells in Narayanganj, whose composites are within the measurement error of the instrument.

Table 6: Sensitivity of CERDI Composites to Alternative Weighting Schemes

Cell	Equal Domain Weights (Baseline)	Equal Item Weights	Measurement-Weighted (Emissions and Disclosure × 2)	Rank (Baseline / Item / Measurement)
Dhaka RMG / textiles	35.7	36.5	33.4	3 / 3= / 4
Dhaka pharmaceuticals	41.8	42.6	39.7	1 / 1 / 1
Dhaka other manufacturing	30.6	31.3	28.5	6 / 6 / 6
Narayanganj knitwear / dyeing	35.5	36.1	32.6	5 / 5 / 5
Narayanganj cement / steel	35.6	36.5	33.7	4 / 3= / 3
Gazipur RMG / textiles	38.0	38.7	35.5	2 / 2 / 2
Gazipur ceramics / other	28.4	29.1	26.2	7 / 7 / 7
Pooled (n = 170)	35.5	36.2	33.2	Spearman ρ vs baseline: 0.96 / 0.96

Notes. Equal item weights: composite = sum of 30 item scores / 60 × 100. Measurement-weighted: domain weights 1, 1, 1, 2, 1, 2 (sum 8). Rank differences involve cells whose baseline composites differ by ≤ 0.2 points, within measurement error.

Disclosure has been gradually increasing over the window, albeit with some variation. The pooled CERDI for the expanding sample increased from 28.6 in 2021 to 41.9 in 2025 (+46.5%), while the balanced panel CERDI for the 104 firms increased from 27.9 to 40.6 (+45.5%), indicating that this is not due to entry by better disclosers. The biggest increases are in 2023 and 2024, which correspond to the ECR 2023 and the disclosure guideline of the Bangladesh Bank. In relative terms, disclosure and assurance have increased the most (+71.2%), and emissions accounting has increased from the lowest base and has been the laggard throughout. Targets are almost exclusively narrative, with only 27 firms (15.9%) having a quantified GHG target by 2025, and none of these are science-based. Programs focus on effluent treatment, lighting and motor retrofit, boiler recovery, and rooftop solar; identified challenges include captive-gas availability, captive-gas costs, retrofit capital costs, lack of measurement protocols, and that environmental measures are buyer-driven, not regulatory.

Levels and Trends of GHG Emissions and Emission-Reduction Initiatives (RQ2)

Nationally, the total emissions in 2019 are 213.19 $MtCO_2e$, where energy contributes 54.06% and industrial processes contribute 2.00% (Department of Environment, 2023), and NDC 3.0 shows the total emissions in 2022 as 252.04 $MtCO_2e$ (MoEFCC, 2025). There is no official inventory after 2022, so the observed series has been cut off at 2022, and the years 2023-2025 are projected by the authors at the observed growth rate for 2019-2022 and plotted in Figure 10(a). The sampled firms are not compared to the national pathway because they represent a small and unrepresentative part of the national emissions (170 firms in three districts).

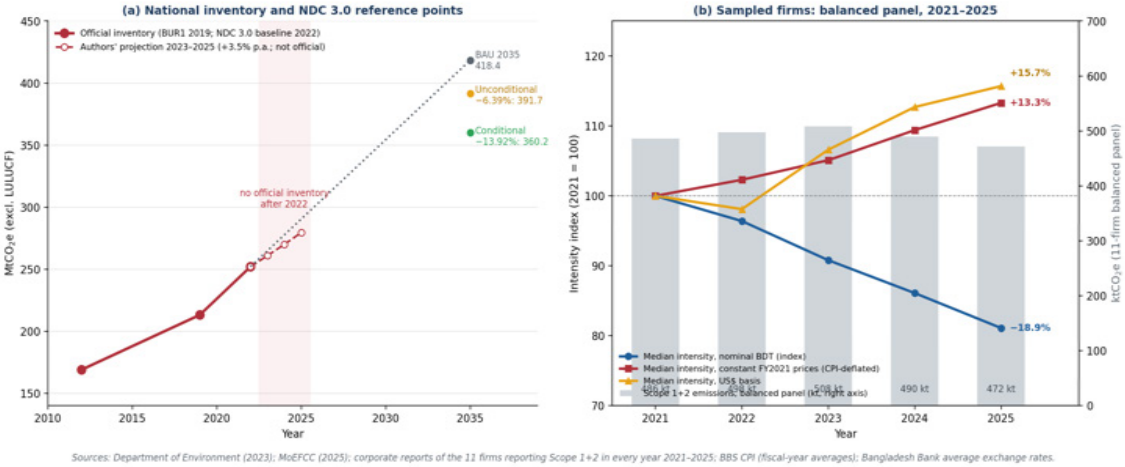


Figure 10: (a) National Inventory to the Last Official Year with the Authors' 2023–2025 Projection and NDC 3.0 Reference Points; (B) Balanced-Panel Emissions and Median Emission Intensity of Sampled Firms on Nominal, Constant-Price and US-Dollar Bases, 2021–2025. Sources: Department of Environment (2023); Moefcc (2025); Corporate Reports; BBS (2025); Bangladesh Bank (2025a)

Belt Level Indicators are shown in Table 7. The increase in the series of all reporters' Scope 1 and 2 emissions from 486,300 tCO_2e (11 reporters) in 2021 to 573,800 tCO_2e (34 reporters) in 2025 is due to the inclusion of smaller reporters and is not a trend. On the balanced panel of the 11 continuous reporters, emissions rose to 508,400 tCO_2e in 2023 and then fell to 471,900 tCO_2e in 2025, 3.0% below 2021. The median emission intensity of the balanced panel decreased from 3.38 to 2.74 tCO_2e per BDT million of nominal revenues (-18.9%, -21.1% when expanding the sample). Re-expressed at constant FY2021 prices, however, intensity rose from 3.38 to 3.83 (+13.3%), and on a US-dollar basis from 286.6 to 331.5 tCO_2e per US$ million (+15.7%) (Figure 10b). The nominal improvement is thus completely due to the inflation rate of around 9-10% per year and the depreciation of taka from around 85 to 121 per dollar; in real terms, the panel has become more, not less, emission-intensive as output has shrunk faster than emissions since 2023. Scope 2 is approximately 10% higher each year, with a grid factor of 0.68 tCO_2/MWh.

Table 7: Belt-level GHG, Energy and Emission-Reduction Indicators, Dhaka–Narayanganj–Gazipur, 2021–2025

Indicator	2021	2022	2023	2024	2025	Source
Reported Scope 1+2 emissions, all reporting firms (tCO_2e; n) — coverage indicator	486,300 (11)	512,700 (15)	548,900 (22)	561,400 (29)	573,800 (34)	Corporate reports; CDP
Reported Scope 1+2 emissions, balanced panel of 11 continuous reporters (tCO_2e)	486,300	497,900	508,400	489,600	471,900	Corporate reports
Median intensity, nominal (tCO_2e per BDT million revenue): all reporters / balanced panel	3.41 / 3.38	3.28 / 3.26	3.06 / 3.07	2.87 / 2.91	2.69 / 2.74	Corporate reports

Median intensity, constant FY2021 prices, balanced panel (tCO_2e per BDT million)	3.38	3.46	3.55	3.70	3.83	Derived; BBS (2025)
Median intensity, US$ basis, balanced panel (tCO_2e per US$ million)	286.6	281.3	305.5	323.0	331.5	Derived; Bangladesh Bank (2025b)
Captive-gas share of industrial energy use (%)[a]	41.8	40.3	38.6	36.9	35.4	SREDA; BPDB; Petrobangla
Rooftop-solar capacity in sampled firms (MW, cumulative)	18.6	27.4	41.9	58.3	74.6	SREDA NDRE; corporate reports
LEED-certified garment factories, cumulative (n; national, BGMEA count)	153	183	206	232	270	BGMEA (2026)
LEED-certified garment factories, cumulative (n; DNG belt)[b]	108	129	145	163	190	Geocoded from BGMEA (2026)
Firms with registered energy audits (n)	23	34	47	63	78	SREDA
Registered kilns in the three districts using zigzag/HHK/tunnel technology (n of 726)	299	360	426	485	537	DoE district registries
Sampled firms holding a valid ECC at year-end (n of 170) — clearance-coverage indicator	118	127	139	151	158	DoE
Firms disclosing quantified GHG targets (n; %)	6 (3.5)	9 (5.3)	14 (8.2)	21 (12.4)	27 (15.9)	Corporate reports

Notes. Firm-level values are assigned to the calendar year in which the fiscal year ends; all other values are calendar-year. [a] *National proxy in the absence of district-disaggregated series.* [b] *District counts derived by geocoding factory addresses from the BGMEA list (Appendix C); data as at 31 December 2025. ECC = environmental clearance certificate; HHK = hybrid Hoffmann kiln; NDRE = National Database of Renewable Energy. The ECC row counts sampled firms whose clearance was valid at year-end and indicates growing clearance coverage, not performance.*

The energy mix of the site is broken down in Figure 11. In all three districts, grid electricity increased in share between 2021 and 2025, captive gas decreased by 8.5% to 9.8%, and rooftop solar grew from less than 2% to 7.9% to 9.2% of electricity consumed. By 2025, the cumulative rooftop capacity has reached 74.6 MW, where Dhaka (28.1 MW) and Gazipur (26.8 MW) contribute 73.6% of the capacity. The renewable share of the belt is still far from the policy target of 30% by 2030, and renewables provide less than 5% of national generation (SREDA, 2025), regardless of the effort made.

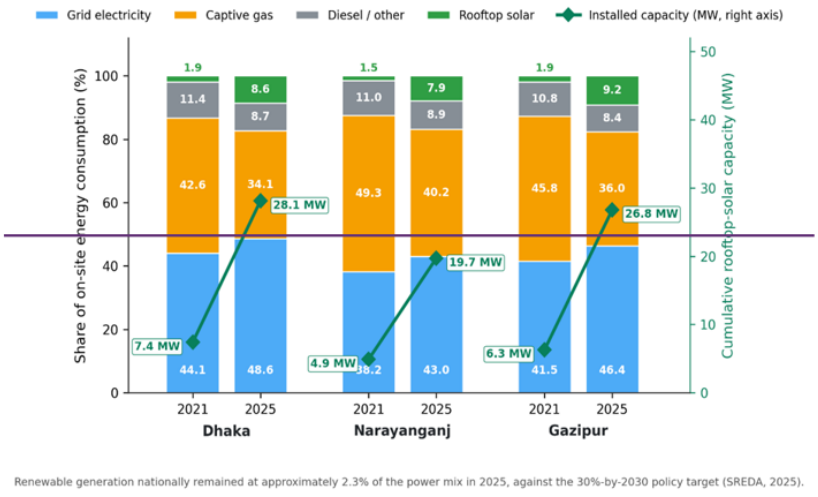


Figure 11: Energy Mix and Renewable-Energy Adoption among Sampled Firms, 2021 and 2025
Source: corporate reports; SREDA (2025).

The number of LEED-certified garment factories by BGMEA has increased at the highest rate of all indicators, from 153 at the end of 2021 to 270 at the end of 2025, with 190 of them (70.4%) in the three study districts, 83 of which are in Gazipur (Figure 12). While certified plants have the ability to achieve post-treatment effluent compliance, non-certified plants do not, as certified plants have capital capability indexes, but actual abatement is not necessarily realized (§2.2).

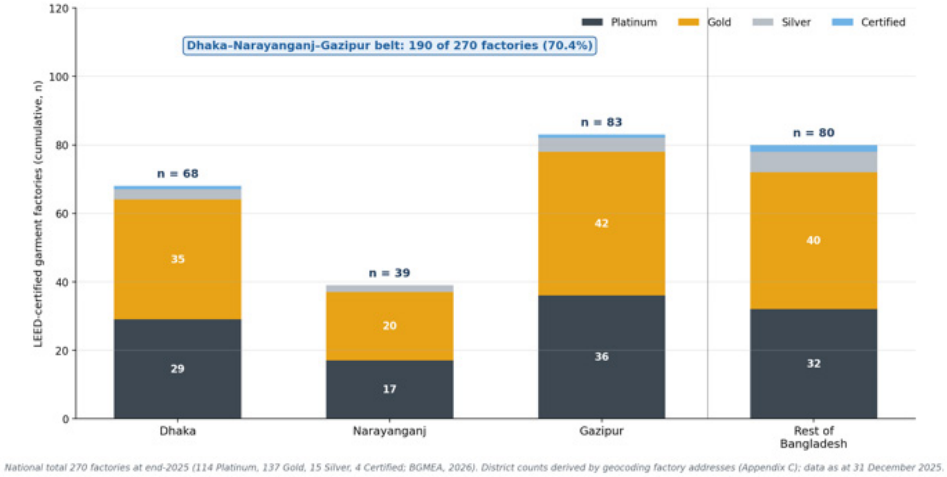


Figure 12: Distribution of LEED-Certified Garment Factories by District and Certification Tier at End-2025
Source: BGMEA (2026); authors' geocoding (Appendix C).

The financing flows grew in parallel (Table 8). The amount of green finance disbursement has increased from BDT 7,232.85 crore in 2021 to BDT 30,369.26 crore in 2025, which is 13.77% of the total term-loan disbursement (the minimum target is 5%). The share of sustainable-finance disbursement has increased from 8.04% in 2021 to 39.66% in 2024, on track to meet the 20% target. The increase from 17.23% in 2023 to 39.66% in 2024 is not necessarily organic but rather due to the change in the definition of sustainable finance, as Bangladesh Bank expanded the types of financing considered (sustainable agriculture, CMSME, working capital, and socially responsible financing) and reset the target basis (Bangladesh Bank, 2025b, 2026). Two more facts are reported but not interpreted: green finance decreased in absolute terms between 2024 and 2025, but the share of green finance increased, indicating that the amount of green finance disbursed in the textile and RMG borrowers dominated green-industry category decreased from a peak of around BDT 266,270 crore

Table 8: Green and Sustainable Finance Flows Relevant to DNG Firms, 2021–2025 (Calendar-Year Basis)

Year	Green Finance (BDT Crore)	% of Term-Loan Disbursement	Sustainable Finance (BDT Crore)	% of Total Disbursement	Implied Term-Loan Disbursement (BDT Crore)	Green-Industry / RMG Share of Green Finance (%)[c]	Source
2021	7,232.85	3.06	82,551.67	8.04	236,370	32.4	Bangladesh Bank (2022)
2022	12,226.46	4.97	130,762.23	11.59	246,010	35.8	Bangladesh Bank (2023b)
2023	19,304.31	7.25	197,369.14	17.23	266,270	39.6	Bangladesh Bank (2024)
2024	30,653.78	13.29	459,483.82	39.66[d]	230,650	42.1	Bangladesh Bank (2025a)
2025	30,369.26	13.77	n.a.	n.a.	220,550	43.5	Bangladesh Bank (2026)

Notes. BB QRRSF = Bangladesh Bank Quarterly Review Report on Sustainable Finance of Banks and Financial Institutions (Bangladesh Bank, 2022, 2023b, 2024, 2025b, 2026). Implied term-loan disbursement = green finance ÷ its share. [c] *Estimated from the disbursement category tables; national figures, as Bangladesh Bank does not disaggregate by district.* [d] *Taxonomy and reporting-template revision; not comparable with earlier years. Full-year 2025 sustainable-finance data were not published at the evidence cut-off.*

in 2023 to BDT 220,550 crore in 2025, a 17.2% decline; and during the period, the share of green finance in the green-industry category, which is dominated by textile and RMG borrowers, increased.

Documented Linkages between CER, GHG Reduction and the SDGs (RQ3)

Table 9 is an analytical framework that was developed from the coded evidence; it is not an empirical result, but rather a record of the SDG targets that are addressed by each practice, and the strength of independent corroboration under the thresholds in §3.7. Row counts are not reported, as all practices can be attributed to SDGs 8, 9, 12 and 13 by construction. Readiness by strength, energy-efficiency retrofits, LEED certification, and effluent treatment have the most documented linkages (to 9.4, 7.3, 12.4, respectively) and are based on SREDA audits, USGBC or DoE records, and peer-reviewed evidence. There is a strong association between rooftop solar and 7.2 and 13.2 via SREDA registration. The circular-economy practices are strongly associated with 12.5, which is in line with the national recovery gap (Akter *et al.*, 2022), for the minority of companies documenting them. Carbon accounting has only a weak connection to 12.6, as reporting was almost universal, but not assured in all instances. The degree of profile alignment varies by cell: Gazipur RMG has the most alignment with 7.2, 9.4 and 13.2; Dhaka pharmaceuticals has the most alignment with 12.6, although its governance scores are higher; Narayanganj knitwear and dyeing has the most alignment with 12.4, and its emissions-accounting linkage is the weakest; Gazipur ceramics and other manufacturing has the least alignment with any goal. The financing channel is linked to 7. a, 9.3 and 13. in all three districts, which aligns with the evidence that links the dimensions of green finance with environmental performance in Bangladesh (Dai *et al.*, 2022; Guang-Wen & Siddik, 2022; Zheng, Siddik, Masukujjaman, & Fatema, 2021; Zheng, Siddik, Masukujjaman, Fatema, *et al.*, 2021), corporate responsibility disclosure with SDG progress (M. T. Miah *et al.*, 2025) and green manufacturing with SDG 12 and 13 outcomes (Huda, 2024).

Table 9: Analytical Framework Linking CER Practices and GHG-Reduction Outcomes to SDG Targets, Graded by Independent Corroboration

CER Practice / GHG-Reduction Outcome	SDG 7	SDG 8	SDG 9	SDG 12	SDG 13	Independent Sources
Energy-efficiency retrofits	7.3 (+++)	8.4 (++)	9.4 (+++)	12.2 (++)	13.2 (++)	SREDA audits; Al Mamun *et al.* (2022)
Rooftop / captive solar and net metering	7.2 (+++)	8.4 (+)	9.4 (++)	12.2 (+)	13.2 (+++)	SREDA NDRE registration
ETP operation and cleaner production	7.3 (+)	8.8 (++)	9.4 (+++)	12.4 (+++)	13.1 (+)	DoE ECC; Shamsuzzaman & Islam (2025)
LEED certification	7.3 (++)	8.2, 8.8 (++)	9.4 (+++)	12.2 (++)	13.2 (++)	USGBC; BGMEA (2026); Newsham *et al.* (2009)
Circular economy and recycling	7.3 (+)	8.4 (++)	9.4 (++)	12.5 (+++)	13.2 (+)	Buyer certifications; Amin *et al.* (2024)
Carbon accounting and disclosure	—	8.4 (+)	9.4 (+)	12.6 (+)	13.2, 13.3 (+)	None (self-report only)
Green and sustainable financing	7.a (++)	8.3, 8.10 (++)	9.3 (++)	12.6 (+)	13. a (++)	Bangladesh Bank refinance records

Legend: +++ at least three independent non-corporate sources corroborate the linkage for a majority of documenting firms; ++ one or two sources, or three for a minority; + corporate self-report only; — no direct linkage. Markers reflect the volume and independence of documentary evidence, not measured impact.

Discussion

Macro and Policy Shocks as Rival Explanations

The window was not a controlled environment, and there are four shocks that provide competing explanations to each headline finding. First, energy prices: The government increased the price of energy for industries from Tk 11.98 to Tk 30 per cubic metre in January 2023, and from Tk 16 to Tk 30 per cubic metre in January 2023 for captive power gas; in April 2025, the energy regulator increased the price of energy for new industrial connections to Tk 40 per cubic metre and for new captive connections to Tk 42 per cubic metre, with existing consumers paying the new price on their energy consumption over the sanctioned load (Bangladesh Energy Regulatory Commission, 2025). In combination with the 2022 LNG price shock, a supply shortfall of over 1,300 MMcfd and rationing of captive supply, this makes the decline in the captive-gas share (41.8% to 35.4%) at least as much a function of price and availability as of environmental strategy; the same pressures plausibly drove energy-

audit registration and rooftop solar. Second, the credit stress and factory closures in July–August 2024 and the corresponding 17% decline in term-loan disbursement in 2023–2025 (Table 8) are its financial footprints, with Gazipur the worst hit. Third, the nominal revenue was inflated by the high level of inflation (around 10%) and the depreciation of the taka by 43%, which alone turns the intensity trend to the opposite sign, as is shown in §4.2. Fourth, the change in the taxonomy of sustainable finance is a definitional change that explains the 2024 discontinuity. None of these shocks has an impact on the sectoral CERDI pattern, which is stable in every year and in the balanced panel; all of them qualify the GHG and finance trends.

Interpreting CER Patterns through the Theoretical Lenses

Tables 5 and 6 and Figure 9 are not an expression of independent strategic choice but of convergence. The distribution of the differences, which are 0.5 points in districts and 13.4 in sectors, is more in line with institutional isomorphism in buyer-facing sectors than geography. The timing matches coercive pressure: the highest CERDI increases in 2023 and 2024 are in the wake of ECR 2023 and the disclosure guideline of the Bangladesh Bank, respectively (but the design doesn't distinguish between this and the buyer requirement that occurred during the same period). There is a correlation between the ranking and the normative pressure, as export-oriented sectors that are exposed to buyer codes have a better score on each domain compared to domestic-oriented sectors (Hossain *et al.*, 2022; Kumar Saha *et al.*, 2025). However, the variance between cells accounts for just 14% of the variance at the firm level, while the remaining 86% is due to the difference between firms operating in the same institutional field, which is consistent with the natural-resource-based view that the difference between performers is due to capabilities, not pressures (Khanra *et al.*, 2022). Gazipur's 83 LEED certificates and 26.8 MW of rooftop solar are a testament to the capabilities of measurement and energy management that have been built up over time, and that can't be replicated by competitors easily. The score reflects compliance and not capability, as is the case in Narayanganj, where the high score is due to effluent treatment conditions clearance.

The Measurement Problem: Decoupling in Two Forms

The internal shape of the index is the well-known hallmark of policy–practice decoupling (Bromley & Powell, 2012; Cepêda *et al.*, 2025a): commitment domains carry it, while emissions accounting remains at 22.6, and no firm achieves assurance, as was the case with the thin, board-driven carbon reporting of DSE issuers (Chakraborty & Sun, 2025) and sub-midpoint environmental scores among listed pharmaceutical and textile companies (Rahaman *et al.*, 2024). The GHG results provide a second, means–ends form. The nominal 21.1% intensity improvement that firms report and that would have been reported here without correction evaporates at constant prices and in dollars; in absolute terms, at constant prices and in dollars, there is a 3% decline in emissions that is more of a reflection of the contraction of output after 2023 than of abatement. The fact that this measure of the sector's performance, based on revenue, shows an improvement without any improvement in physical performance is not unique to this sample: revenue-denominated intensities are common in Bangladeshi disclosure and in buyer scorecards, and in a high-inflation, depreciating-currency economy they will systematically overstate progress. The sectoral inventory assumes the status quo and expects the emissions from natural gas combustion to be the main drivers of emissions from the textile and apparel sector, which is projected to continue growing if there is no energy transition (Biswas *et al.*, 2024). However, since mandatory reporting is only partially effective in narrowing the decoupling (Aboud *et al.*, 2024) and decoupling is expensive in emerging markets (Zhan *et al.*, 2025), what is needed is not more disclosure, but assurance and physical metrics.

Regional Comparison and the External-Pressure Argument, Corrected

The binding constraint is disclosure architecture and grid access, when compared regionally. In India, the Securities and Exchange Board of India (2023) has introduced a phased-in, assured core Business Responsibility and Sustainability Reporting for the largest issuers, while China has implemented a phased-in approach requiring sustainability reporting for major listed companies starting from 2024 through the three exchanges (Shanghai Stock Exchange, 2024), and the Ministry of Finance of the People's Republic of China (2025) issued a trial climate disclosure standard in alignment with IFRS S2 in December 2025. The economy-wide regime in Bangladesh is still voluntary and non-assured, and the renewable share is capped for Scope 2 abatement. Furthermore, NDC 3.0 in the power sector is seen as no more ambitious than the previous NDC (Climate Analytics, 2025; Institute for Energy Economics and Financial Analysis, 2025).

Two outside mechanisms have been pointed to as ways of disciplining Bangladeshi suppliers, but will not do so in the near future, and the previous version of this argument needs to be corrected. The EU Carbon Border Adjustment Mechanism (CBAM) has been in its definitive phase since 1 January 2026, but only applies to cement, iron and steel, aluminium, fertilisers, electricity and hydrogen; textiles and apparel are not covered by the CBAM and not currently in the expansion proposals (EU Directive, 2025; Regulation (EU) 2023/956 of the European Parliament and of the Council of 10 May 2023 Establishing a Carbon Border Adjustment Mechanism (Text with EEA Relevance), 2023). CBAM is not relevant to the RMG sector, but to cement and steel in the belt. Instead, the EU corporate-sustainability regime is being loosened: the "stop-the-clock" directive for 2025 is

deferred (EU Directive, 2025); the Omnibus I package adopted in February 2026 only applies to large firms (those with more than 1,000 employees and a turnover exceeding €450 million) and CSDDD is deferred to 2029; and the Omnibus I package caps the requirements that large firms can impose on value-chain suppliers (Council of the European Union, 2026). What suppliers have in common is that they are buyer-specific; the belt's key buyers have brand codes and validated science-based Scope 3 targets (Science Based Targets initiative, 2025). It is not border or directive pressure, but domestic instruments that are the binding lever.

Policy and Managerial Implications

Table 9 illustrates the nexus where capital expenditure is visible and where it is not, accountability is required, and Figure 13 synthesizes the pathways. There are four implications, each to a named actor. Regulators (DoE, BSEC and Financial Reporting Council [FRC]) should link ECC renewal under ECR 2023 to proven performance, extend the low-cost transition of zigzag kilns whose benefits per kiln are causally proven (Brooks *et al.*, 2025) and phase in ISSB-aligned assured disclosure beyond banking. Financiers (Bangladesh Bank, banks) need to redirect refinancing towards SMEs and non-RMG borrowers, excluded by the green-industry concentration, and introduce sustainability-linked instruments for the retrofit segment, which has been left out of the certification. Energy agencies (SREDA, BERC, Petrobangla) should implement net metering and scale up the mandatory audits belt-wide and publish a time-varying grid emission factor. Firms and associations (BGMEA, BKMEA) should consider using physical-output intensity metrics, validated Scope 1–2 inventories, and link targets to validated Scope 3 commitments from buyers, and cluster effluent and energy services (Amin *et al.*, 2024; M. T. Miah *et al.*, 2025).

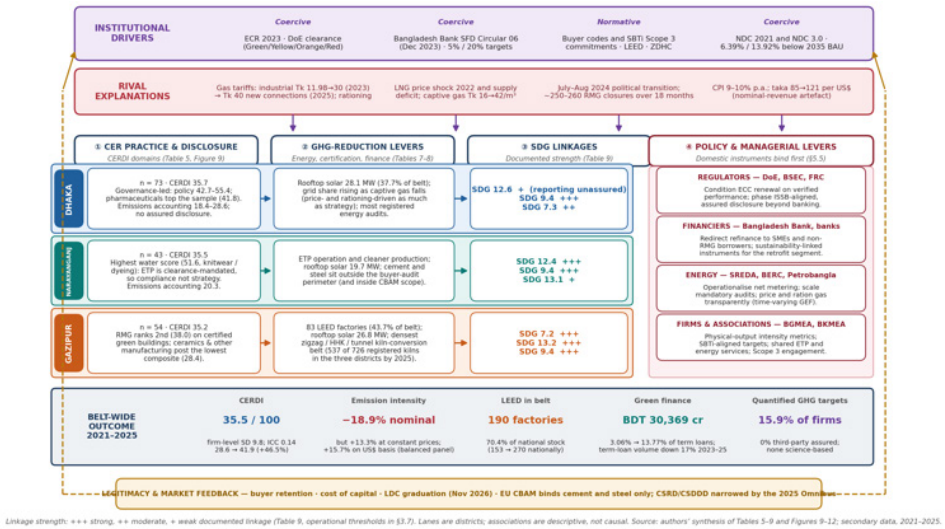


Figure 13: The CER–GHG–SDG Pathway: Synthesis of Findings. Institutional Drivers and Rival Explanations (Top Bands) Feed Three District Lanes Traced Across Cer Domains (Table 5), Emission-Reduction Levers (Tables 7–8) and Best-Documented SDG Targets (Table 9), with Actor-Specific Policy Levers at Right and Belt-Wide Outcomes Below. Associations are Descriptive, Not Causal. Source: Authors' Synthesis

CONCLUSION

The study reveals that corporate environmental reporting (CER) in the DNG belt remains broad but superficial (RQ1). Policy, governance, and water stewardship achieved the highest CERDI score (35.5/100), while emissions accounting ranked lowest. Only 15.9% of firms reported quantified targets, and none obtained external assurance. Disclosure increased by approximately 46% following ECR 2023 and Bangladesh Bank guidelines, although 86% of variation occurred between firms. Emission reductions remain unverified (RQ2), as nominal intensity improvements reflect price effects, while declining emissions partly resulted from production disruptions. Solar adoption, LEED certification, and green finance indicate growing environmental capabilities rather than confirmed abatement. Documented SDG alignment was strongest for SDGs 9.4, 7.2, 7.3, and 12.4 (RQ3). The study contributes a replicable 30-item CERDI, district-comparative CER–GHG–SDG evidence, and insights into policy–practice and means–ends decoupling. However, disclosure-based selection, self-reporting bias, revenue-based intensity measures, limited emissions coverage, certification proxies, and confounding shocks constrain interpretation. Future research should incorporate physical-output measures, independent carbon audits, operational assessments, broader SME and Scope 3 coverage, and causal designs examining regulatory impacts across industrial clusters, including Chattogram.

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Appendix A. CERDI Coding Manual: Items, Domains and Scoring Anchors

Each item is scored 0 (absent), 1 (generic statement) or 2 (specific and quantified) using the anchors below (0 / 1 / 2). Domain score = item total ÷ (2 × number of items) × 100. Composite CERDI = unweighted mean of the six domain scores. Items are scored per firm-year from all documents dated to that year; where a document covers multiple years, only the year-specific data are scored. Coders record the page reference for every score of 2.

Domain (Items)	Item	Anchors: 0 / 1 / 2
A. Policy and governance (6)	A1 Board-level environmental policy or committee	No policy / Generic commitment / Named committee with published charter or minutes
	A2 ISO 14001 (or equivalent) certification	None / Stated intention or expired / Current certificate with scope and expiry
	A3 Published environmental targets	None / Narrative aspiration / Numeric target with base year and deadline
	A4 Environmental risk in enterprise risk register	Absent / Mentioned / Rated with mitigation owner
	A5 Environmental KPIs in executive remuneration	Absent / Stated / Quantified weight disclosed
	A6 Environmental compliance record (DoE notices)	Notices undisclosed / Disclosed without resolution / Disclosed with resolution and date
B. Energy (5)	B1 Energy consumption reported	No / Total only / By source with units and boundary
	B2 Energy audit registered with SREDA	No / Planned / Registered with year
	B3 Efficiency measures	None / Listed / Quantified savings (kWh, MJ or BDT)
	B4 Renewable capacity	None / Stated / MWp with generation data
	B5 Captive-generation efficiency or fuel data	None / Narrative / Quantified
C. Water and effluent (5)	C1 Water withdrawal reported	No / Total / By source with intensity
	C2 ETP operation	Not mentioned / Stated / Design capacity, uptime and effluent quality
	C3 ECC category and validity	Undisclosed / Stated / Category with validity date
	C4 Water-efficiency measures	None / Listed / Quantified savings
	C5 Chemical management (ZDHC or equivalent)	None / Stated / Verified compliance level

D. Emissions accounting and targets (5)	D1 Scope 1 emissions	Not reported / Narrative / tCO_2e with methodology
	D2 Scope 2 emissions	Not reported / Narrative / tCO_2e with grid factor stated
	D3 Scope 3 emissions	Not reported / Categories identified / Quantified for ≥ 1 category
	D4 Emission intensity	None / Stated / Value with denominator and base year
	D5 Quantified GHG target	None / Narrative / Numeric target (science-based alignment noted)
E. Circularity (4)	E1 Waste generation and diversion	None / Narrative / Tonnes with diversion rate
	E2 Recycled or recovered inputs	None / Stated / Share of input by mass
	E3 Product or packaging circularity	None / Stated / Quantified
	E4 Supplier environmental requirements	None / Code of conduct / Audited compliance data
F. Disclosure and assurance (5)	F1 Reporting framework (GRI, ISSB, CDP)	None / Referenced / Index with disclosure-level mapping
	F2 Materiality assessment	None / Stated / Method and stakeholder groups disclosed
	F3 Third-party assurance of environmental data	None / Internal review / External assurance statement (standard named)
	F4 Time series (≥ 3 years) for key indicators	None / Partial / Complete
	F5 Public availability and timeliness	Not public / Public with > 12-month lag / Public within 12 months of year-end

Appendix B. Fact Register: Recurring Statistics, Sources, Reference Periods and Access Dates

Statistic	Value Used Throughout	Source	Reference Period	Accessed
Climate Risk Index rank	13th (long-term, 1995–2024)	Germanwatch (2025), CRI 2026	Released 12 Nov 2025	31 Jan 2026
National GHG inventory 2019	213.19 $MtCO_2e$; energy 54.06%; IPPU 2.00%	Department of Environment (2023), BUR1	2019	31 Dec 2025
NDC 3.0 baseline 2022	252.04 $MtCO_2e$; 2035 BAU 418.40	MoEFCC (2025)	Submitted 28 Sep 2025	31 Dec 2025
NDC 3.0 targets	6.39% (26.74 Mt) / 13.92% (58.23 Mt) below 2035 BAU	MoEFCC (2025)	2035	31 Dec 2025
Updated NDC targets	6.73% (27.56 Mt) / 15.12% (61.90 Mt) below 2030 BAU 409.4	MoEFCC (2021)	2030	31 Dec 2025
Grid emission factor	0.61 (FY2019–20); 0.62 (FY2020–21, FY2021–22); none later	Department of Environment (2025)	Fiscal years	31 Dec 2025
RMG exports	US$38.48 bn; EU 50.34%, US 18.72%, UK 11.25%	BGMEA (2025)	Calendar 2024	31 Dec 2025
Mapped RMG factories	3,723 national; Dhaka 1,351; Gazipur 1,057; Narayanganj 615 (81.2%)	Mapped in Bangladesh (2022)	Extract 15 Mar 2022	15 Mar 2022
LEED-certified garment factories	270 (114 Pt / 137 Au / 15 Ag / 4 Cert); 38 in 2025; 68 of global top 100	BGMEA (2026)	31 Dec 2025	31 Jan 2026
LEED year-end series	153 / 183 / 206 / 232 / 270	BGMEA year-end releases	2021–2025	31 Jan 2026

Green finance	BDT 7,232.85 cr (3.06%) → 30,369.26 cr (13.77%) of term loans; FY2023 5.84%	Bangladesh Bank (2022–2026)	Calendar 2021–2025	31 Jan 2026
Sustainable finance	8.04% (2021) → 39.66% (2024) of total disbursement; taxonomy revised 2024	Bangladesh Bank (2025a)	Calendar 2021–2024	31 Jan 2026
Registered kilns, three districts	726 (Dhaka 284; Narayanganj 294; Gazipur 148)	DoE district registries (2022)	2022	31 Dec 2025
Greater Dhaka kilns	≈ 1,000 across six districts; 23,300 t $PM_{2.5}$; 1.8 $MtCO_2$ per year	Guttikunda *et al.* (2013)	2012 estimate	31 Dec 2025
Gas tariffs	Industrial Tk 11.98 → 30 (Jan 2023) → 40 new (Apr 2025); captive Tk 16 → 30 → 42	EMRD (2023); BERC (2025)	2023; 2025	31 Dec 2025
CPI inflation (fiscal-year average)	6.15% / 9.02% / 9.73% / 10.03% (FY2022–FY2025)	BBS (2025)	FY2022–FY2025	31 Dec 2025
Exchange rate (annual average)	≈ 84.8 / 86.3 / 99.5 / 111.0 / 121.0 BDT per US$ (FY2021–FY2025)	Bangladesh Bank (2025b)	FY2021–FY2025	31 Dec 2025
Factory closures	457 units incl. 108 BGMEA, 35 BKMEA members, Aug 2024–Jun 2026	Dhaka Tribune (2026)	Aug 2024–Jun 2026	31 Jul 2026
CBAM scope	Cement, iron and steel, aluminium, fertilisers, electricity, hydrogen; definitive phase 1 Jan 2026	European Union (2023, 2025b)	2026	31 Jul 2026
CSRD/CSDDD thresholds	CSRD > 1,000 employees and €450 m; CSDDD > 5,000 and €1.5 bn, application 2029	European Union (2025a); Council of the EU (2026)	2026	31 Jul 2026
IFC PaCT	> 450 factories; 723,617 tCO_2 per year avoided (programme self-report)	IFC (2023)	Cumulative to 2023	31 Dec 2025
Population 2022	Dhaka 14,734,025; Narayanganj 3,909,138; Gazipur 5,263,450	BBS (2023, 2024)	Census 2022	31 Dec 2025

Appendix C. Geocoding Method for District Attribution

Factory addresses were taken from the BGMEA LEED list as at 31 December 2025 (n = 270) and, for non-RMG firms, from DoE clearance records and DSE filings. Each address was geocoded in QGIS 3.34 using the OpenStreetMap Nominatim service, then cross-checked against the Mapped in Bangladesh point layer (extract of 15 March 2022) and, where the two disagreed by more than 500 m, against satellite imagery of the named site. District assignment used the Bangladesh Bureau of Statistics 2022 administrative boundaries. Of the 270 LEED factories, 262 geocoded unambiguously; 8 with multiple listed sites were assigned to the site named on the USGBC certificate. For the 41 candidate firms in Figure 8 whose production sites spanned more than one district and whose environmental documents did not separate sites, no assignment was made and the firm was excluded. Coordinates, assignment codes and the eight manual decisions are provided in the deposited data set.