

# Green Finance

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Leveraging regulatory expertise and digital technologies to facilitate the net-zero transition

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## Executive Summary

Financial institutions are the key facilitators of the net-zero transition, providing funds to corporates and initiatives that pursue environmentally progressive goals, defined as engaging in 'green finance'. Green finance focuses on the E of ESG and is one type of sustainable finance, which in turn are investments relating to the broader spectrum of Environmental, Social and Governance (ESG) initiatives. In 2022, sustainable finance reached USD 3.7tn or 5% of the global debt market and is expected to reach 30% of the total debt markets by 2026. Throughout 2014-2022, two-thirds of sustainable investment was green finance.

To accelerate the growth of the green finance market, regulators are rallying to strengthen environmental disclosure regulations and provide a harmonised standard for environmentally sustainable investments. By as early as 2024, most businesses in the EU and the US will be mandated to disclose granular information on their environmental KPIs, climate impact from both direct operations and ecosystem partners, and transition plans.

In June 2023, the EU's Corporate Sustainability Reporting Directive (CSRD), perhaps one of the most impactful sustainability reporting regulations under development, will be strengthened by a comprehensive suite of requirements, namely the first set of European Sustainability Reporting Standards (ESRS). On top of these requirements, the second set of ESRS will mandate additional sector-specific environmental disclosures at the granular level, to be developed in the latter half of 2023. All EU and EU-listed companies in scope, amounting to 50 000 entities, will have to implement these requirements in their 2024 annual reports.

Corporates must start now and move quickly to remain compliant with the CSRD requirements. Specifically, adopt the ESRS standards as soon as they are approved by the European Commission in June 2023, and use 2023 as the preparation period to upgrade the reporting capabilities and supporting IT technologies. Companies must be prepared not only for this round of regulation, but also for subsequent consolidations of environmental disclosure requirements.

We unpack the most impactful regulatory developments to come in 2023 and beyond, map the most pressing challenges and opportunities that corporates and PEs encounter in the face of an evolving regulatory landscape of green finance, and introduce potential solutions and services that can help clients overcome the challenges to and leverage the opportunities of environmental transformation.

## 1 Green finance is a key facilitator of the net-zero transition

The net-zero transition is triggering a fundamental change in the financial services industry. Financial institutions are one of the biggest facilitators of the green transformation, engaging in ‘green financing’. Green finance is the funding of corporates and initiatives that pursue environmentally progressive goals, such as the development of alternative energy sources based on renewable standards. Green finance focuses on the E of ESG and is one type of sustainable finance, which constitutes investments relating to the broader spectrum of ESG initiatives.

In 2022, the total global market for sustainable finance reached a cumulative USD 3.7 trillion, representing an unprecedented 5% of the total global debt market.<sup>1</sup> Climate Bonds measures the sustainability market as the total volume of GSS+ bonds issued globally, which includes GSS bonds (green, social and sustainability), SLB (sustainability-linked bonds), and transition bonds.

GSS bonds represent more than three-quarters of the total GSS+ bonds and have grown exponentially by a compound annual growth rate of 44% in the past decade 2014-2022. In 2021, the annual issuance of GSS bonds peaked at USD 1 trillion. Green finance has continuously been the principal element of GSS, comprising 62.5% of the GSS bonds issued in 2022, and averaging at 73.2% across the period 2014-2022 (Exhibit 1).<sup>2</sup>

### The global volume of GSS debt instruments reached USD3.2tn in 2022, peaking in at USD1tn annual issuance in 2021 to date

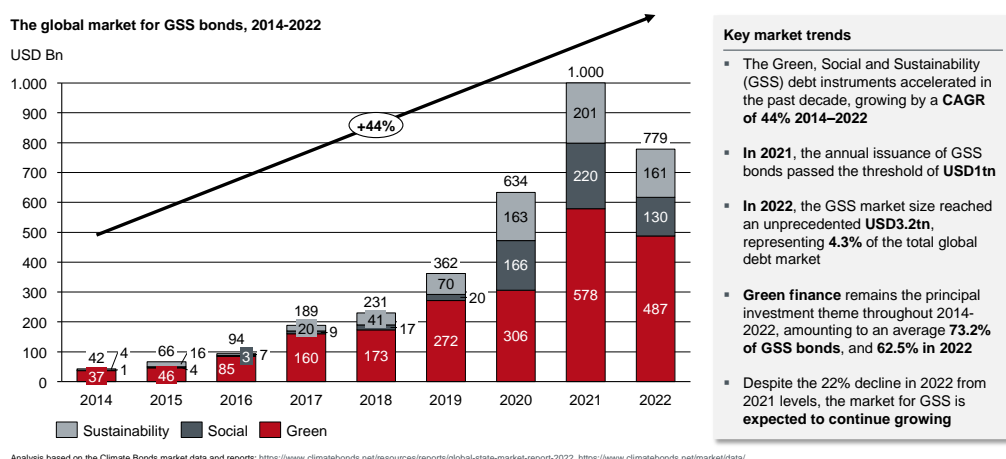


Exhibit 1: The global market for GSS debt instruments 2014-2022. Source: Climate Bonds market data and reports<sup>3</sup>

Among the main issuers of green finance, the financial sector became one of the main issuers between 2014-2022, taking the lead in 2022 by contributing 29% to the total global green bond issuance (Exhibit 2). The private sector is an increasingly significant contributor to green finance, amounting to 54% of green bond issuance in 2022. Of this, European corporates were the most significant contributors to the green bond issuance, with the German commercial bank Helaba issuing USD 5.2 billion and 45 deals, and the Danish multinational power company Orsted issuing USD 4 billion and 6 deals.<sup>4</sup>

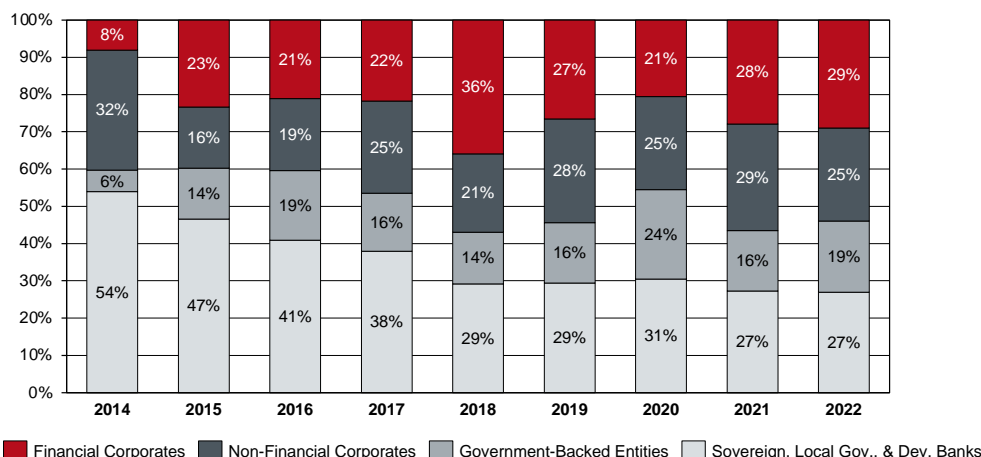
<sup>1</sup>Gartner, March 2023. ‘Predicts 2023: Achieving ROI With ESG — Leadership Perspective’

<sup>2</sup> <https://www.climatebonds.net/resources/reports/global-state-market-report-2022>

<sup>3</sup> <https://www.climatebonds.net/resources/reports/global-state-market-report-2022>

<sup>4</sup> <https://www.climatebonds.net/resources/reports/global-state-market-report-2022>

**The financial sector was leading the green bond issuance in 2022, contributing 29% to the total global volumes**



*Exhibit 2: The financial sector was the main contributor to the green finance market in 2022.*  
 Source: *Climate Bonds*<sup>5,6</sup>

Despite recording the first annual decline in a decade, of 22% in 2022 down from 2021 volumes due to high interest rates and energy prices, the sustainable finance market is expected to rebound. According to the Gartner 2023 Board of Directors survey, 80% of boards anticipate an increase in sustainability initiatives investments by 2025<sup>7</sup>, increasingly funded by opex and capex budgets. By 2025, 60% of large enterprises will double their existing investment in green capital expenditure projects, and by 2026, 30% of the total annual funding issued via debt capital markets will be directed to ESG initiatives<sup>8</sup>, a significant rise compared to the presently 5%<sup>9</sup>.

The observed growth of green finance has been driven by both external pressures, such as increasing regulatory oversight and stakeholder demand for environmental investments, as well as internal benefits, such as improved valuations, reputation, talent retention and acquisition, and the long-term financial returns of portfolio stability from green portfolio transformation.

The ability of green finance to mitigate climate change invites regulators and stakeholders worldwide to pressure financial institutions to accelerate their portfolio transformation towards environmentally sustainable targets. However, the green finance growth is still significantly hindered by the lack of respective regulatory oversight and common definitions, such as of ‘green bonds’.

The recent strengthening and extension of mandatory environmental disclosure regulation is intended to bring a suite of benefits to financial institutions by harmonising climate reporting and facilitating greater transparency for green finance. However, for the businesses providing these disclosures, implementing the advancements in environmental disclosure requirements can pose a challenge. Corporates often find it challenging to provide the required granularity of disclosures,

<sup>5</sup> <https://www.climatebonds.net/resources/reports/global-state-market-report-2022>

<sup>6</sup> <https://www.climatebonds.net/market/data/>

<sup>7</sup> <https://www.gartner.com/en/articles/see-the-key-findings-from-the-gartner-2023-board-of-directors-survey>

<sup>8</sup> Gartner, March 2023. ‘Predicts 2023: Achieving ROI With ESG — Leadership Perspective’

<sup>9</sup> <https://www.climatebonds.net/resources/reports/global-state-market-report-2022>

whilst PEs often find it challenging to harmonise the climate-related information they receive from portfolio companies for standardised disclosures.

However, these can often be remedied by implementing fit-for-purpose IT systems that simultaneously foster upgrading the business's climate reporting capabilities in a structured way. With the mandatory environmental disclosure regulation likely to continue strengthening, corporates and PEs need to implement effective, scalable, and adaptive solutions that ensure regulatory compliance both in the short and the long term.

We unpack the most impactful regulatory developments to come in 2023 and beyond, map the most pressing challenges and opportunities that corporates and PEs encounter in the face of an evolving regulatory landscape of green finance, and introduce potential solutions and services that can help clients overcome the challenges and leverage the opportunities of environmental transformation.

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## 2 The rapidly changing environmental disclosure landscape will have a significant impact on green finance

Green financing presupposes investments in the corporates or projects that have positive environmental benefits and financial returns. Often, these investment decisions are based on the target's environmental disclosures and third-party green rating. However, environmental reporting is fragmented, with corporates disclosing varying environmental KPIs at different levels of granularity, which is one of the main challenges of green finance.

### 2.1 Mandatory environmental disclosures

Regulators in the EU, the UK and the US are strengthening mandatory environmental disclosure to standardise reporting and facilitate and support green financing strategies. To comply with mandatory climate reporting, corporates and PEs need to report on the nature and progress of their green activities and climate impact reduction in line with the respective requirements. A couple of the most relevant ones will be mentioned subsequently:

#### SEC environmental disclosure update, US, Mar 2022

The Securities and Exchange Commission (SEC) in the US in March 2022 proposed enhanced rules on climate-related disclosures whereby it will require registrants to periodically report on Green House Gas (GHG) Protocol's classification of Scope 1, 2 and 3 emissions<sup>10</sup>. Following a delay to the timeline in October 2022, the rules are expected to be finalised in 2023 and become mandatory for annual reports published in 2024.

The GHG Protocol<sup>11</sup> classification (illustrated in Exhibit 1) is a common metric in mandatory environmental disclosures used to assess a businesses' management of climate-related risks, where:

- **Scope 1:** direct GHG emissions from production
- **Scope 2:** indirect emissions from purchased electricity or other forms of energy, namely GHG emissions from operations
- **Scope 3:** GHG emissions from upstream and downstream activities in its value chain (smaller reporting companies are exempt), measured from the peer reports of its ecosystem

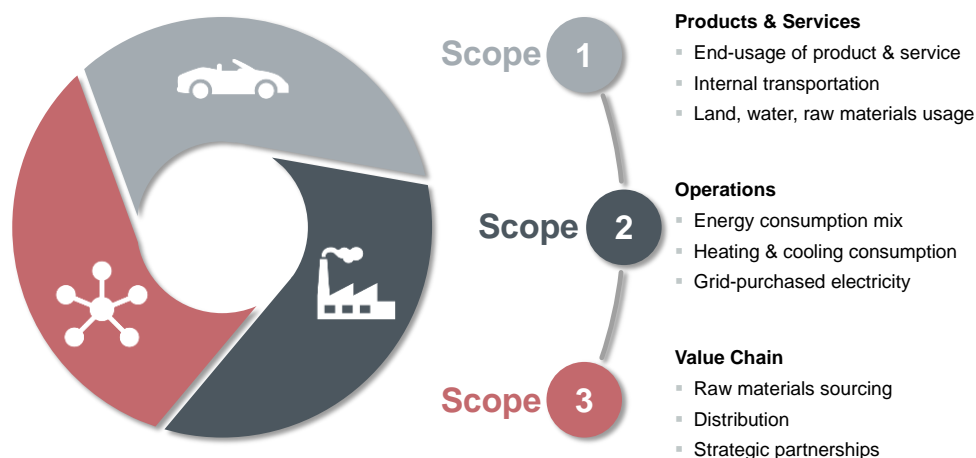
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<sup>10</sup><https://www.sec.gov/news/press-release/2022-46>

<sup>11</sup><https://ghgprotocol.org/corporate-standard>



**The GHG Protocol classifies emissions into three main categories, called Scope 1, 2 and 3 GHG emissions**



*Exhibit 3: The GHG Protocol classification of Scope 1, 2, and 3 GHG emissions. Source: CORE analysis*

**Climate Related Financial Disclosure (CRFD), UK, Apr 2022**

The Financial Conduct Authority (FCA) in the UK upgraded its set of environmental disclosure requirements for annual reporting in the Climate Related Financial Disclosure (CRFD). The requirements are significantly based on the EU's Task Force on Climate-related Financial Disclosures (TCFD) guidance introduced in 2017, as well as entails reporting under the UK's Streamlined Energy and Carbon Reporting (SECR), which requires disclosures on Scope 1 and 2 emissions<sup>12,13</sup>.

In effect since April 2022, companies in scope must adopt the new requirements in their annual reports published after April 2022, which makes 2023 the first year for their application. For new registrants, 2023 is the first reporting period for which they must produce a Non-Financial and Sustainability Information Statement (NFSI), namely environmental disclosures. Companies in scope include public interest entities and UK-registered companies with 500+ employees and £500m+ in revenue.

**Sustainable Finance Disclosure Regulation (SFDR), EU, Jan 2023**

The European Commission in the EU upgraded its mandatory environmental disclosure regulation with the 'level 2' (Sustainable Finance Disclosure Regulation) SFDR. In force since January 2023 and applicable to all investment management firms and advisors in the EU, the SFDR brings a more comprehensive suite of technical standards for sustainability reporting, and now also mandates Scope 3 emissions disclosures.

Additionally, in the EU's updated Market in Financial Instruments Directive II (MiFID II), from August 2022, all EU financial advisors must ask clients about their sustainability preferences, and direct those in favour to SFDR-aligned products, which report against the SFDR's 14 core PAI (principal adverse impact) metrics covering the last 5 years.

<sup>12</sup> <https://watershed.com/en-GB/blog/legislation-for-uk-eu-in-2023>

<sup>13</sup> <https://www.icaew.com/technical/non-financial-reporting/tcf-d-and-related-uk-reporting-regulations>

### 2.1.1 The Corporate Sustainability Reporting Directive (CSRD), EU, 2023

The EU's Corporate Sustainability Reporting Directive (CSRD) is perhaps one of the most impactful sustainability reporting regulations under development in 2023. In force since 5<sup>th</sup> of Jan 2023, the directive will mandate detailed sustainability reporting according to the comprehensive requirements of European Sustainability Reporting Standards (ESRS). The first set of ESRS will be published in June 2023, with the second set expected in the second half of the year, developed by the European Financial Reporting Advisory Group (EFRAG).

**The CSRD will be enriched with granular sustainability disclosure requirements of the first and second sets of ESRS**

☐ Deep-dive follows

CSRD			
	Current State	First set of ESRS	Second set of ESRS
	5 <sup>th</sup> Jan 2023 – 30 <sup>th</sup> Jun 2023, General regulation	From 1 <sup>st</sup> Jul 2023, Specific disclosure requirements	H2 2023, Industry requirements
<b>Environment</b>	<ul style="list-style-type: none"> <li>Climate change mitigation</li> <li>Climate change adaptation</li> <li>Pollution</li> <li>Water and marine resources</li> <li>Biodiversity &amp; ecosystem</li> <li>Resource use &amp; the circular economy</li> </ul>	<ul style="list-style-type: none"> <li>Draft ESRS E1: Climate change</li> <li>Draft ESRS E2: Pollution</li> <li>Draft ESRS E3: Water and marine resources</li> <li>Draft ESRS E4: Biodiversity &amp; ecosystems</li> <li>Draft ESRS E5: Resource use &amp; circular economy</li> </ul>	<ul style="list-style-type: none"> <li>Oil &amp; Gas</li> <li>Automotive</li> <li>Manufacturing</li> <li>Energy production</li> <li>Other (food/beverage, agriculture, mining)</li> </ul>
<b>Social</b>	<ul style="list-style-type: none"> <li>Own workforce</li> <li>Workers in the value chain</li> <li>Affected communities</li> <li>Consumers and end-users</li> </ul>	<ul style="list-style-type: none"> <li>Draft ESRS S1: Own workforce</li> <li>Draft ESRS S2: Workers in the value chain</li> <li>Draft ESRS S3: Affected communities</li> <li>Draft ESRS S4: Consumers and end-users</li> </ul>	
<b>Governance</b>	<ul style="list-style-type: none"> <li>Business Conduct</li> </ul>	<ul style="list-style-type: none"> <li>Draft ESRS G1: Business Conduct</li> </ul>	

Exhibit 4: The outline of the CSRD regulation and the role of ESRS requirements. Source: CORE analysis, based on data from the European Commission and EFRAG

All EU and EU-listed companies will have to comply to the extensive suite of ESRS requirements by 2024 for annual reports published in 2025, which now amounts to 50,000 EU and EU-listed entities<sup>14,15</sup>.

<sup>14</sup><https://www.sullcrom.com/files/upload/sc-publication-eu-finalizes-esg-reporting-rules-with-international-impacts.pdf>

<sup>15</sup>[https://finance.ec.europa.eu/capital-markets-union-and-financial-markets/company-reporting-and-auditing/company-reporting/corporate-sustainability-reporting\\_en](https://finance.ec.europa.eu/capital-markets-union-and-financial-markets/company-reporting-and-auditing/company-reporting/corporate-sustainability-reporting_en)

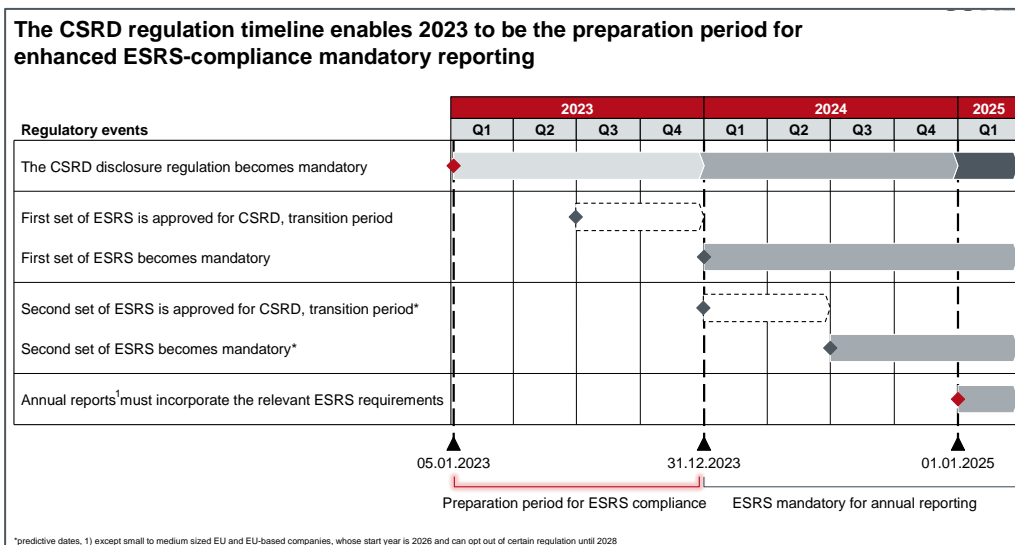


Exhibit 5: The CSRD regulation timeline and the introduction of ESRS sets, 2023-2025.

Source: CORE analysis, based on data from the European Commission<sup>16</sup>

Therefore, a common sentiment among the corporates is to start adapting the ESRS standards early and as soon as they are approved by the European Commission by the end of June 2023.

Although CSRD covers all three aspects of ESG disclosures: environmental, social, and governance, the environmental disclosure requirements are most relevant for green finance.

### The CSRD environmental disclosure requirements

CSRD reporting must be 'understandable, relevant, verifiable, comparable and represented in a faithful manner'<sup>17</sup> (Article 29b). To ensure adherence to these standards, CSRD also mandates companies in scope to conduct audits of the sustainability information reported. Corporates and institutional investors reporting under the CSRD, alongside the social and governance disclosures, must disclose the following environmental information<sup>18</sup>:

- **Climate change mitigation**, namely actions an organisation takes to minimise its impact on climate change, such as by reducing Scope 1, 2 and, where relevant, Scope 3 GHG emissions
- **Climate change adaptation**, namely actions an organisations takes to adjust to the expected adverse effects of climate change on its business model<sup>19</sup>
- Other metrics: water and marine resources; resource use and the circular economy; pollution; and biodiversity and ecosystem

Climate change mitigation and adaptation (highlighted above) are often challenging reporting aspects for companies. Compliance necessitates collecting, measuring, and disclosing information on the company's transition strategy and how it aligns with EU environmental

<sup>16</sup> <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32022L2464>

<sup>17</sup> <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32022L2464>

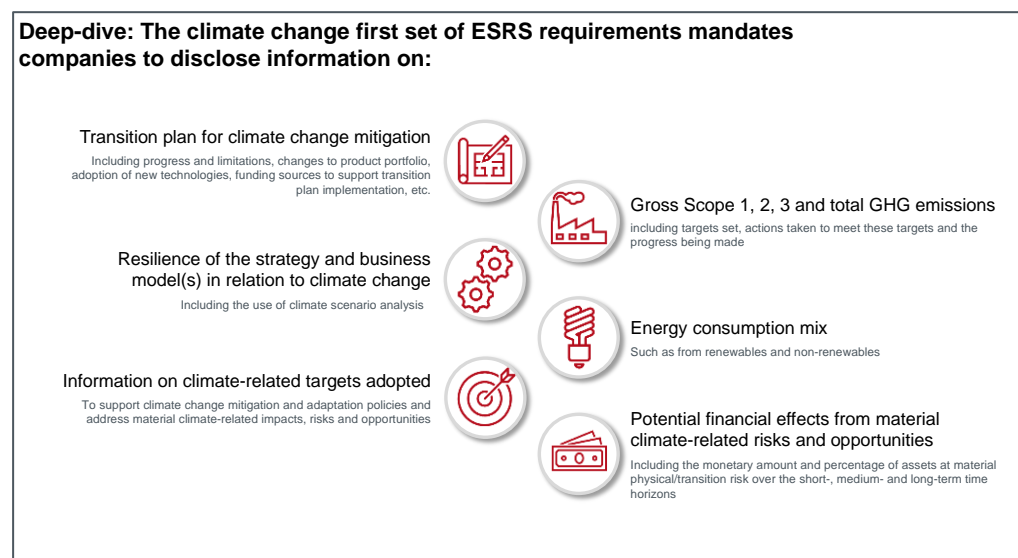
<sup>18</sup> <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32022L2464>

<sup>19</sup> <https://www.eea.europa.eu/help/faq/what-is-the-difference-between>

goals and with the certain UN Sustainable Development Goals (SDGs)<sup>20,21</sup>. For instance, the information needed comprises investment plans, GHG reduction targets and the progress to meet them, the due diligence processes implemented to mitigate the adverse impacts of their operations and value chains on the environment, to name a few.

**Proposed first set of ESRS climate change disclosure requirements**

The specific disclosure requirements on ‘climate change mitigation and adaptation’ will be published by the ESRS in June 2023.



*Exhibit 6: Deep-dive on the draft first set of ESRS on climate change requirements. Source: CORE analysis, based on data from the EFRAG<sup>22</sup>*

The basis for these requirements is the draft standards submitted by EFRAG on 22<sup>nd</sup> of November 2022<sup>23</sup>, presently under review by the EU institutional bodies and Member States, which proposed the following set of climate change disclosures, on<sup>24,25</sup>:

- The corporate’s transition plan for climate change mitigation, including progress and limitations, changes to product portfolio, adoption of new technologies, and funding sources to support the transition plan implementation
- Resilience of the strategy and business model(s) in relation to climate change, including the use of climate scenario analysis
- Information on climate-related targets adopted to support climate change mitigation and adaptation policies, and address material climate-related impacts, risks and opportunities

<sup>20</sup> <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32022L2464>

<sup>21</sup> <https://www.sullcrom.com/files/upload/sc-publication-eu-finalizes-esg-reporting-rules-with-international-impacts.pdf>

<sup>22</sup> <https://efrag.org/Assets/Download?assetUrl=%2Fsites%2Fwebpublishing%2FSiteAssets%2F08%2520Draft%2520ESRS%2520E1%2520Climate%2520Change%2520November%25202022.pdf>

<sup>23</sup> <https://www.efrag.org/Assets/Download?assetUrl=/sites/webpublishing/SiteAssets/EFrag+Press+release+First+Set+of+draft+ESRS.pdf&AspxAutoDetectCookieSupport=1>

<sup>24</sup> <https://efrag.org/Assets/Download?assetUrl=%2Fsites%2Fwebpublishing%2FSiteAssets%2F08%2520Draft%2520ESRS%2520E1%2520Climate%2520Change%2520November%25202022.pdf>

<sup>25</sup> <https://www.sullcrom.com/files/upload/sc-publication-eu-finalizes-esg-reporting-rules-with-international-impacts.pdf>

- Gross Scope 1, 2, 3 and total GHG emissions, including targets set, actions taken to meet them, and the progress made
- Energy consumption and mix, such as renewables and non-renewables
- Potential financial effects from material climate-related risks/ opportunities, including the monetary amount and percentage of assets at material physical/transition risk over the short-, medium- and long-term time horizons

Corporates and institutional investors will have to disclose the data required even if not material, whereas other ESRS disclosures will be required only subject to materiality considerations.

## 2.2 Certain industries are under even higher pressure

Certain industries will be required to produce additional and more granular reporting due to their high contribution to climate change and greater need for environmental transformation. According to the second set of ESRS standards, expected in the second half of 2023, the ten sectors that will have to produce additional sector-specific disclosures are: agriculture, coal mining, mining, oil and gas (upstream), oil and gas (midstream and downstream), energy production, road transport, motor vehicle production, food/beverages, and textiles.<sup>26,27</sup>

Entities in these sectors will thus have to disclose additional data points on top of the first set of ESRS. This puts additional pressure on the technology infrastructure and reporting capabilities to measure the climate impact of the corporates in these sectors.

## 2.3 Additional voluntary reporting

Additional voluntary climate reporting, indicative of strong capabilities in and technology solutions for climate reporting, has become a source of competitive advantage among corporates and PEs. Benefits include strengthened reputation and brand, increased corporate valuation, and improved talent retention and acquisition. The Gartner 2023 Board of Directors survey finds that 47% of society considers sustainability to a substantial or significant extent during company evaluation<sup>28</sup>.

Guidance on additional voluntary disclosures with international application are provided by the EU's TCFD and the global non-profit CDP (Carbon Disclosure Project). The EU's TCFD guidance, established in 2017, consists of four pillars of environmental disclosures, namely Governance, Strategy, Risk Management, and Metrics and Targets<sup>29,30</sup>, whilst the CDP administers the carbon disclosure rating, which measures the environmental sustainability of a company, and runs an internationally accepted unified system for self-reported environmental disclosures.<sup>31</sup>

<sup>26</sup><https://www.sullcrom.com/files/upload/sc-publication-eu-finalizes-esg-reporting-rules-with-international-impacts.pdf>

<sup>27</sup><https://www.efrag.org/Assets/Download?assetUrl=/sites/webpublishing/SiteAssets/EFrag+Press+release+First+Set+of+draft+ESRS.pdf&AspxAutoDetectCookieSupport=1>

<sup>28</sup><https://www.gartner.com/en/articles/see-the-key-findings-from-the-gartner-2023-board-of-directors-survey>

<sup>29</sup><https://www.fsb-tcfid.org/>

<sup>30</sup><https://www.icaew.com/technical/non-financial-reporting/tcfid-and-related-uk-reporting-regulations>

<sup>31</sup><https://www.cdp.net/en>

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Positive climate reporting is often an untapped source of value in voluntary environmental disclosures. Namely, the disclosure of progressive, carbon-negative initiatives, whose aim is to contribute to restoring environmental resources on top of cutting back emissions/pollution. Example of positive carbon reporting include absorbing CO<sub>2</sub> emissions, replenishing biodiversity, and purifying natural resources (air, land, water).

### 3 Challenges arise in complying with the evolving environmental disclosure regulation

According to Forrester’s survey of 268 ESG decision-makers at global enterprises in 2022, regulatory compliance is the most important goal of the respondents’ ESG strategy, cited as important and very important by 80% of respondents<sup>32</sup>. But even that is challenging and comes partially with a significant cost impact, particularly if not done right.

The tightening of environmental disclosure regulation produces both direct and indirect challenges for corporates in scope of the regulation. The direct challenge for corporates and PEs is the measurement and reporting of their environmental impact to the required granularity, potentially limited by insufficient climate impact measurement technologies and reporting capabilities.

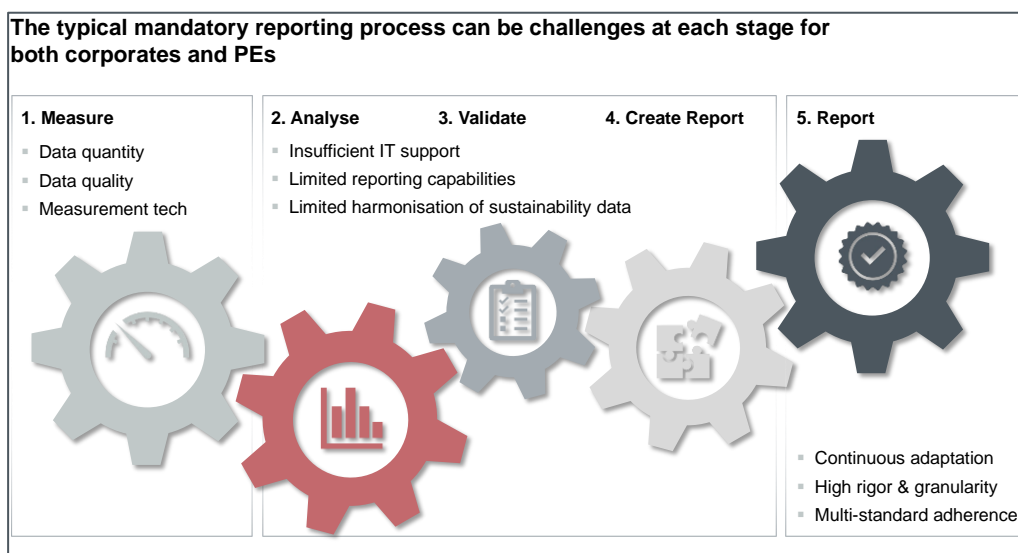


Exhibit 7: The typical sustainability disclosure process and the reporting challenges at each stage. Source: CORE analysis

Meanwhile, the indirect challenge companies face is the need to transform their business model towards environmental goals to maintain their competitive position. The direct challenges are currently most pressing for corporates and PEs, and hence in focus.

#### 3.1 Climate impact measurement is still in early stages

Accurate and meaningful climate impact data measurement is a precursor to high-quality environmental disclosures. However, environmental data management is a key challenge for corporates and PEs. According to the Forrester survey, 89% of the respondents attest that their company is limiting investment in ESG data analytics for two main reasons: limited internal data management practices, and lack of trust in ESG data to make decisions.<sup>33</sup>

<sup>32</sup>[https://www.dnb.com/content/dam/english/dnb-solutions/DNB\\_Prioritizing\\_ESG\\_Isn%E2%80%99t\\_Optional\\_Anymore.pdf](https://www.dnb.com/content/dam/english/dnb-solutions/DNB_Prioritizing_ESG_Isn%E2%80%99t_Optional_Anymore.pdf)

<sup>33</sup>[https://www.dnb.com/content/dam/english/dnb-solutions/DNB\\_Prioritizing\\_ESG\\_Isn%E2%80%99t\\_Optional\\_Anymore.pdf](https://www.dnb.com/content/dam/english/dnb-solutions/DNB_Prioritizing_ESG_Isn%E2%80%99t_Optional_Anymore.pdf)

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To comply with the CSRD in the financial year 2024, entities need to overcome the three common obstacles to measuring climate impact and hence mitigating it: data availability, data quality, and the availability of measurement technology, automated reporting and straight through processing to avoid manual interventions.

### 3.1.1 Measurement and availability of environmental data is limited

The CSRD and similar regulations mandate entities to disclose detailed information about their climate impact, such as Scope 1, 2 and 3 GHG emissions and energy consumption. However, gathering this necessary data is one of the key challenges for both corporates and the PEs.

The greatest difficulty comes with gathering data from 3<sup>rd</sup> parties, or data related to the value-chain such as Scope 3 emissions, which will become mandatory three years after the CSRD implementation in 2025 according to the first set of ESRS. Scope 3 emissions data, for example, often the biggest component of a company's total GHG emissions requires emission disclosures from the company's ecosystem. However, the data from ecosystem partners is difficult to access due to diverging geographies and reporting requirements.

The difficulty to measure emissions and environmental data accurately and systematically is not only a challenge for corporates, but also for PEs. The climate reporting regulation mandates disclosure of environmental information at the company-level, which can be difficult to obtain from the PEs' portfolio companies due to differences in environmental reporting processes and climate impact measurements. PEs must therefore ensure that the same rigor in environmental reporting is applied throughout its portfolio of companies.

The European Commission recognises that corporates may encounter difficulties in collecting 3<sup>rd</sup> party data, such as the required information for Scope 3 emissions reporting. Hence, the CSRD disclosure requirements will have a degree of flexibility and adaptability for different entities, depending on their capabilities, value-chain characteristics, and the scale and complexity of their operations. For instance, the sustainability reporting requirements for SMEs (small to medium-sized enterprises) shall differ from the requirements for large entities and will be specified by the EFRAG in June 2023 in its second set of ESRS.

### 3.1.2 Quality of environmental data varies across companies and industries

High-quality climate reporting necessitates evidence-based and accurate data-points. However, climate reporting is not always complemented with scientific proof, and hence its exactitude becomes ambiguous. 47% of Forrester respondents expressed that they would disregard ESG data if it conflicted with business goals, such as achieving certain revenue targets, whilst 46% have found ESG data to be inconsistent or of poor quality<sup>34</sup>.

The degree of granularity between corporates' climate reports varies depending on their capacity to produce them to the required standards. 42% of respondents attested that insufficient ESG data from privately held corporates are preventing their firms from reaching ESG targets<sup>35</sup>.

Moreover, PEs and investors are faced with the challenge of comparing or harmonising environmental reporting across industries. This is especially significant when a PE operates across multiple sectors. For instance, the metrics and quality of environmental data that a portfolio

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<sup>34</sup>[https://www.dnb.com/content/dam/english/dnb-solutions/DNB\\_Prioritizing\\_ESG\\_Isn%E2%80%99t\\_Optional\\_Anymore.pdf](https://www.dnb.com/content/dam/english/dnb-solutions/DNB_Prioritizing_ESG_Isn%E2%80%99t_Optional_Anymore.pdf)

<sup>35</sup>[https://www.dnb.com/content/dam/english/dnb-solutions/DNB\\_Prioritizing\\_ESG\\_Isn%E2%80%99t\\_Optional\\_Anymore.pdf](https://www.dnb.com/content/dam/english/dnb-solutions/DNB_Prioritizing_ESG_Isn%E2%80%99t_Optional_Anymore.pdf)



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company in the energy and utilities sector discloses are not comparable to the environmental data disclosed by a portfolio company in the retail sector. Furthermore, the difference becomes visible between the historically less-regulated sectors and the highly regulated sectors such as health care and the financial services.

Therefore, PEs need to agree on a set of environmental issues and KPIs that can be assessed at the portfolio-level, which will enable detailed climate reporting at corporation level according to environmental disclosure regulations. To obtain this level of quality, precise data collection and measurement tools, processes and governance need to be in place.

### **3.1.3 Limited use of carbon measurement technology & skills**

Emerging IT sustainability technology ease the measurement of companies' environmental impact, from carbon tracking and energy consumption to financial climate impact assessment.

However, it can be challenging to make the best use of the latest IT solutions and tools, such as the integration into existing landscapes or a successful IT transformation. The opportunity cost of a limited carbon measurement technology can include insufficient measurement of emissions and other climate impact data to comply with the ESRS requirements and foregone benefits of reducing of total emissions by approximately 15-20%<sup>36</sup>.

On top of measurement technology limitations, companies might also be hindered by the lack of skills to in the domain of environmental sustainability mitigation. Namely, insufficient skills 'at the intersection of business continuity, climate science, data analysis, and strategic planning' able to identify, mitigate and plan responses to systemic climate-related risks and capabilities to manage complex data models for predictive modelling.<sup>37</sup>

Inaccurate or incomplete climate impact measurement can hinder its mitigation, and hence a company's ability to meet the environmental goals required.

## **3.2 Limited capabilities on environmental reporting**

The lack of capacity and resources to work on environmental standards reporting is a second key challenge for corporates. For PEs, this challenge manifests itself as the lack of a standardised climate reporting mechanism among its portfolio companies. To meet the mandatory sets of first and second ESRS standards of the CSRD, reporting capabilities will have to rise to the level of quality of financial statements.

However, three common obstacles make it difficult for both corporates and PEs to adopt a high-quality of climate reporting and install an automated process for producing climate reports to the evolving standards. These include: a fragmented approach, regulatory inexperience, and insufficient IT support systems.

### **3.2.1 Fragmented approach across departments and portfolio companies**

Part of the ESRS requirements is to report on the company's climate mitigation and adaptation plans and climate targets, which requires a cross-departmental and portfolio-wide agreement on the organisation's most relevant environmental issues, environmental KPIs, climate targets, and harmonisation of risk management and data collection processes.

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<sup>36</sup> [https://joint-research-centre.ec.europa.eu/jrc-news/5-digital-solutions-greener-europe-2022-07-05\\_en](https://joint-research-centre.ec.europa.eu/jrc-news/5-digital-solutions-greener-europe-2022-07-05_en)

<sup>37</sup> <https://www.forrester.com/blogs/climate-adaptation-demands-new-skills-technology-and-commitment/>

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However, climate issues have often been managed by a single or various individual departments, which developed their own protocols and controls. This has created little coherence on the environmental initiatives and has limited the harmonisation of standards and guidance for climate mitigation at the corporate/portfolio level. Thus, reporting the progress of an integrated climate mitigation plan can become a challenge for companies with fragmented approaches to ESG.

Efforts to harmonise environmental data and climate reporting capabilities at the corporate level are not always straightforward. Often, corporates and PEs dedicate significant resources to solving this challenge without having first defined a clear strategy or acquired the necessary technological oversight to deliver the desired outcome. This usually results in companies incurring high costs that do not always yield a proportionate outcome.

### **3.2.2 Regulatory inexperience**

Companies in less heavily regulated industries are often unequipped to face the high degree of regulatory scrutiny, unlike those in the financial services for instance. Complying with the ESRS's comprehensive disclosure requirements might necessitate the development of new capabilities and processes previously untapped. For instance, ESRS requires the disclosure of information on the resilience of a company's strategy and business model(s) via the use of climate scenario analysis, and of data on the potential financial effects from material physical and transition risks, which can be challenging to meet.

Furthermore, environmental disclosure compliance becomes more difficult when firms must comply to different regulatory frameworks, from TCFD to SFDR. More than half of the Forrester respondents use at least 4 different ESG standards, and whilst 85% agree this helps them meet ESG goals, 81% also agree that they struggle to transform the data from one standard to the other<sup>38</sup>.

Although guidance exists from the CSRD and TCFD on the targets, metrics, and transition plans to be disclosed<sup>39</sup>, the heart of this particular challenge is organisational transformation.

### **3.2.3 Insufficient IT support**

ESG data management capabilities are often limited to the standard office technology, such as the use of spreadsheets and email to manage environmental data collection, processing, and reporting. These legacy data management practices are often time consuming, labour intensive, with limited scalability and accuracy, and often lead to unnecessary high costs.

The opportunity cost of not implementing an IT support system to automate and scale environmental reporting outweighs its initial set-up cost. When implemented correctly, the upgraded IT system is an investment that will lead to significant cost savings in a short period of time and within the course of a PE investment cycle.

The opportunity cost is especially higher in the backdrop of the CSRD, which will require greater granularity of disclosures with every iteration and hence the costs of using standard reporting technology will increase. For instance, the draft of first ESRS already requires disclosure on the metrics of energy consumption and mix, internal carbon pricing, GHG removals and GHG

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<sup>38</sup>[https://www.dnb.com/content/dam/english/dnb-solutions/DNB\\_Prioritizing\\_ESG\\_Isn%E2%80%99t\\_Optional\\_Anymore.pdf](https://www.dnb.com/content/dam/english/dnb-solutions/DNB_Prioritizing_ESG_Isn%E2%80%99t_Optional_Anymore.pdf)

<sup>39</sup><https://www.fsb-tcf.org/>

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mitigation projects financed through carbon credits, progress against climate-related targets, and financial impacts from material physical and transition risk.

Hence, corporates and PEs necessitate an integrated IT system to collect, analyse and report this data both for the immediate compliance as well as for ongoing future compliance with the evolving climate reporting standards. Although the CSRD includes provisions for the SMEs, and for the collection of environmental data related to the value-chain, companies would benefit from an automated IT system for the collection and formulation of these reports, hence from a targeted technical transformation.

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## 4 Digital transformation can improve environmental disclosure compliance in both the short and long term

A range of solutions exist that corporates and PEs can implement to tackle the common challenges of environmental disclosure compliance in the short-term and ensure processes are automated for optimal use in the long-term.

### 4.1 Software solutions for environmental reporting are already available

Corporates and PEs can benefit from an integrated IT support system to automate environmental data gathering from direct and 3<sup>rd</sup> party sources<sup>40</sup>, rapid and accurate data analysis, validation against specific environmental reporting standards, and creation of sustainability reports to the rigor of financial statements as per CSRD. Most importantly, such an IT system should be adaptable and programmed to ensure that the corporate remains compliant with the evolving climate regulation in the long-term at minimal costs.

The necessary software solutions are already available, ranging from metric-specific data-point tracking to wholistic sustainability tracking and reporting systems.

Certain vendors offer targeted software solutions that specialise in the measurement of specific environmental metrics or for use in certain stages of the reporting process. These products are especially useful often at the measurement stage of climate reporting, mitigating the challenges of limited environmental data availability and tracking. Examples of such software includes:

**The GHG Management Software** – the software is specifically geared towards GHG emissions measurement, which is one of the key areas of CSRD. The GHG management software enables the collection, processing, and reporting of Scope 1, 2, 3 and total GHG emissions from past and on-going activities for climate reporting, especially relevant for corporates. For PEs, integrating the GHG management software into the existing IT systems can support forecasting and portfolio optimisation based on environmental sustainability priorities.<sup>41</sup>

**Advanced Grid Management Software** – the software enables the measurement of a corporate's energy consumption mix and utilised energy resources by leveraging physical and machine learning models. The software has been historically predominantly used by electricity system operators, however with the CSRD requiring the detailed disclosure of the energy consumption mix in granularity, this software can become useful for a wider business audience, especially when disclosing Scope 2 emissions. Vendors include Emerson, GE Digital, Hitachi Energy, and others.<sup>42</sup>

**Climate Risk Analytics** – the suite of automated risk management tools enables businesses to measure and assess how climate change is impacting their financial statements, which is a disclosure requirement under CSRD. Specifically, the climate risk analytics toolkit models the impact of climate-related physical, transition, and litigation risks on a corporates business model

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<sup>40</sup> Harvard Business Review, 'Private Equity should take the lead in Sustainability', July-Aug 2022

<sup>41</sup> <https://www.gartner.com/en/articles/are-you-thinking-too-small-about-sustainable-technology>

<sup>42</sup> <https://www.gartner.com/en/documents/4013224>

and profitability. It is often offered as part of a general-purpose risk software offerings by vendors like BlackRock, IBM, Moody's, Esri, and others.<sup>43</sup>

**Supply Chain Blockchain for Sustainability** – the technology enables tracking of end-to-end supply chains, and ensures temper-proof product provenance, which if supplemented with the required data can help corporates better track 3<sup>rd</sup> party emissions (Scope 3) and their ecosystem's progress on environmental KPIs. Capturing this data in the blockchain network enables automation of audit and reporting processes.<sup>44</sup>

**Material.One Supply Chain Collaboration Platform (BMW)**<sup>45</sup> – the platform aggregates data from across the company's value chain to create a wholistic understanding of the state and progress of the company's Material.One project to implement a circular production model. The platform facilitates knowledge sharing between the company's departments, laboratories, as well as external stakeholders such as authorities, research institutions, and end-users of vehicles. Such a platform is especially useful for harmonising climate data across portfolio companies for PEs and across departments for corporates. The supplier of this platform is Microsoft Azure.

On the other hand, other vendors offer systemic software solutions that specialise on the entire reporting process, providing corporates with a unified IT system that measures, analyses, validates and creates environmental reports on the full range of a company's environmental KPIs. These are especially useful for improving the overall climate reporting capacity and capability. PEs especially are heavily investing in sustainability management software. Some sustainability providers include:

**Net Zero Cloud (Salesforce)** – the vendor leverages its internal platform of cloud solutions to offer optimised environmental reporting processes, providing differentiated carbon calculations, performance monitoring and reporting services. The software is best suited for businesses seeking net zero reporting as a service, due to its strong system integration capabilities with the buyer's existing IT architecture.

**Climate Management and Accounting Platform (Persefoni)** – dubbed by the vendor as the 'ERP for Climate', the software has differentiated carbon accounting and reporting capabilities, however with improvements to be made to its capability to support its customers' climate action strategy. The software is best for operationalising and automating GHG accounting and financial reporting on climate-risks, such as for banks and asset managers.

**OneTrust Planetly (One Trust)** – the software offers wide-coverage and in-depth ESG compliance and risk management, which comprises climate-related risk management and sustainability management software. Offering differentiated materiality assessment, by helping customers focus on the relevant environmental KPIs, and data management capabilities. The software is based on OneTrust's interconnected platforms and is best suited to companies wishing to measure sustainability risk impact across their entire business.

<sup>43</sup> <https://www.gartner.com/en/documents/4013224>

<sup>44</sup> [https://www.forrester.com/report/the-forrester-new-wave-tm-climate-risk-analytics-q4-2022/RES176391?ref\\_search=0\\_1682692494021](https://www.forrester.com/report/the-forrester-new-wave-tm-climate-risk-analytics-q4-2022/RES176391?ref_search=0_1682692494021)

<sup>45</sup> [https://www.cio.de/a/bmw-erhoeht-nachhaltigkeit-mit-der-cloud.3710627?utm\\_source=First+Look&utm\\_medium=email&utm\\_campaign=newsletter&pm\\_cat%5B1%5D=cloud+computing+allgemein&tap=d67cad8dd356302a3eeb2c4874ee0673](https://www.cio.de/a/bmw-erhoeht-nachhaltigkeit-mit-der-cloud.3710627?utm_source=First+Look&utm_medium=email&utm_campaign=newsletter&pm_cat%5B1%5D=cloud+computing+allgemein&tap=d67cad8dd356302a3eeb2c4874ee0673)

Corporates and PEs have a spectrum of software solutions and vendors to choose from to upgrade their climate reporting capabilities, ranging from targeted to wholistic software solutions. However, the purchase of a specific software solution is not an instant and exhaustive solution and as such, must be accompanied by a clear digital transformation strategy.

#### 4.2 Integrating climate reporting software should follow a targeted digital transformation strategy

Corporates and PEs can choose to lease the software of a vendor to optimise their environmental reporting capability or develop their own environmental reporting IT system in-house. However, both choices require an understanding of the digital transformation process involved to effectively integrate the IT solution into its business model and strategy.

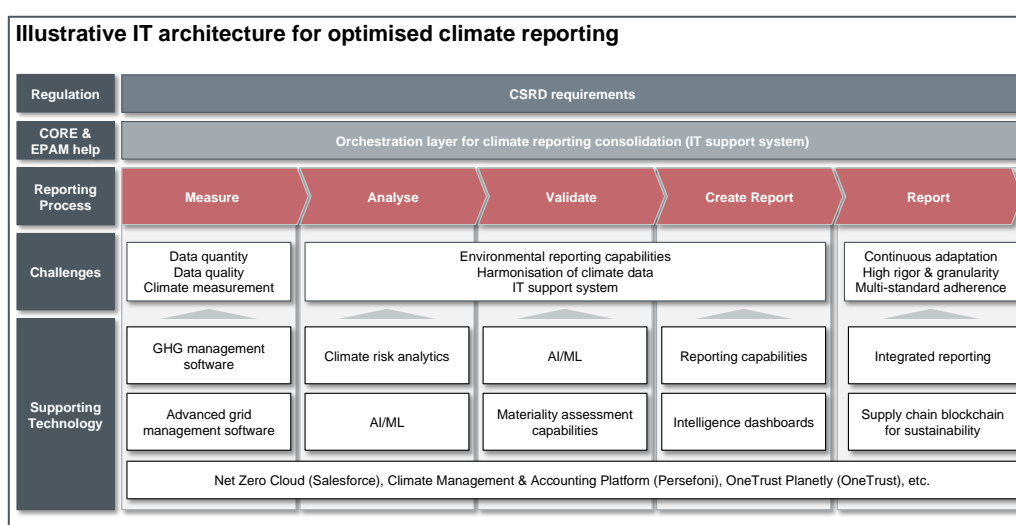


Exhibit 8: The illustrative IT solution architecture for optimised climate reporting. Source: CORE analysis

A typical process for integrating environmental reporting software solutions includes the following steps:

1. **Win leadership support** – secure the support, accountability and sponsorship of the leadership and key stakeholders within the domains of environmental reporting, often found in the risk management, compliance and/or finance teams
2. **Audit the current state software architecture** – analyse the current IT architecture for reporting (financial, environmental, or otherwise), outline the target state for environmental reporting, and devise a transformation roadmap for achieving the target state architecture
3. **Establish data management and progress tracking** – ensure data is properly managed, internal processes are established, and that responsibilities are assigned and tracked to support and facilitate the digital transformation roadmap
4. **Migrate to the new IT architecture paradigm** – ensure that the upgraded IT architecture is fully functional, fit-for-purpose and has the supporting internal processes, before retiring the legacy system

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5. **Communicate the launch to stakeholders** – announce the upgrade in environmental reporting software and capabilities to the key internal and external stakeholders, secure their support, and produce the first report

Internal processes need to support and be aligned with the new IT architecture for environmental reporting. For instance, corporates should establish processes for routinely updating the environmental KPIs in line with leadership goals, market developments and regulatory requirements, and bridge the skills gaps by training employees in environmental reporting, data analysis and climate risk management, along with synchronising methodologies for climate risk management across departments.

PEs can benefit from developing an internal mechanism or framework for harmonising climate reporting across the portfolio companies. This could also be done by establishing an IT system for environmental reporting at the portfolio level, which will harmonise reporting standards across existing and target portfolio companies. An example initiative is the 'ESG Data Convergence Project' led by CalPERS and Carlyle, in which the PEs agree on six prevalent ESG issues and KPIs for measuring climate impact across the portfolio based on existing standards and frameworks.

Organisational transformation may also include an upgrade in the corporate governance structure, such as to ensure that environmental considerations are included at all the relevant levels of the organisation to promote accountability and leadership: in the decision making, escalation processes, committee operations, legal entity management, and roles/ responsibilities.

To maximise the benefits of digital solutions for environmental reporting, businesses need a good understanding of their specific business requirements in environmental reporting, define a tailored digital transformation strategy, and implement the target architecture with accuracy.

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## 5 Now is the time to strengthen the IT and regulatory capabilities to unlock short and long-term growth potential

European companies, especially financial institutions, are leading on environmental sustainability in 2023, according to the Forrester analysis of EMEA50, the Fortune 50 biggest firms in the EMEA region. Advents in EU reporting regulation are prompting European corporates to pressure their ecosystem partners to provide granular environmental disclosures and engage in environmental transformations.<sup>46</sup>

However, now is not a time for complacency. Sizeable upgrades to the environmental disclosure requirements are being drafted for the CSRD, the first set of which will be published as early as June 2023, and will become mandatory as soon as 2024 for the majority of EU and EU-listed entities. The regulatory tightening will only accelerate. Businesses need to ensure continuous and cost-effective compliance, and upgrade their climate reporting capabilities not only for this round of regulation, but for the perpetual improvements to come as regulatory accelerations are to be expected. Therefore, 2023 is the best time to act to stay on top of the climate reporting regulation.

Engaging in digital transformation to implement an IT architecture that supports climate reporting is a solution that yields both short and long-term benefits. An upgraded IT system can incorporate the latest climate reporting technologies into the organisation's existing architecture and thus automate and scale the process of environmental disclosures: from data collection and analysis to report creation and automated submission.

The opportunity cost of not upgrading the IT support systems greatly outweighs its set-up cost. As the CSRD strengthens, and further requirements are being drafted, climate reports will come to match the rigor of financial reports. The use of legacy technology to create granular climate reporting will become more costly as time passes. Now is the time to start the digital transformation that will secure your organisation's seamless transition to the new environmental disclosure standards of 2024 and beyond.

To navigate the evolving climate reporting environment, CORE & EPAM can help define the digital transformation strategy, create a meaningful and reasonable approach, and implement the software tools and the automated IT architecture that best suit the needs and requirements of its clients, helping them tackle the environmental disclosure landscape now and in the future.

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<sup>46</sup> Forrester, 2023, 'The State of Environmental Sustainability in the Fortune EMEA50, 2023'



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## About CORE

CORE is a Technology Think Tank and part of EPAM Systems. CORE is based on the following three principles: **Competence leads, thought leadership, and a trusted partner** for start-ups, FinTechs, universal banking, and government institutions, especially in highly regulated industries such as finance, biotech, automotive, and aviation. Our actions are guided by the values of trust, performance, and expertise as a reliable and trustworthy partner in co-operation, focusing on high quality technology delivery with unparalleled professional competence.

### Competence Leads – Excellence in digital transformation

Past successes underpin our excellence in technology transformation. We have delivered both large scale and targeted technology transformation for our clients, helping them on their journey from defining a digital transformation strategy to implementing and launching the target state architecture. Leveraging our detailed market knowledge, in-depth technology expertise, and high methodological competence, we can assess both the technological and business requirements of our clients in environmental disclosures compliance and support them in implementing a long-lasting IT architecture ready for the future of climate reporting.

### Thought Leadership – Expertise in regulatory compliance with the EU legislation

With strong experience in the regulatory sector, we have advised clients on the intricacies of financial services regulation in the EU, implementing solutions compliant with the high rigor of requirements such as PSD2 and DORA. Leveraging our regulatory expertise, we can help clients navigate the strengthening environmental disclosure regulation in the EU by optimising climate reporting capabilities in line with the CSRD requirements. The typical project roadmap would follow a series of steps: specify how the company is impacted by regulation, identify data sources needed to fulfil requirements, design business architecture to comply with regulation, and creating reports, fulfilled with efficient data lake and data analytics.

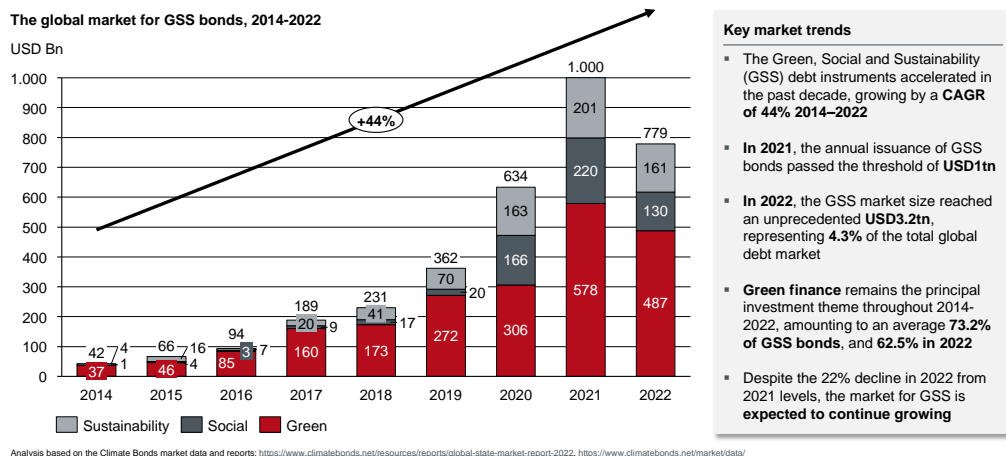
### Trusted Partner – Industry experience and presence in the most impacted sectors

With a strong presence and expertise in the highly impacted sector of automotive, we have helped sector-specific clients with successful cost-optimisation, technological transformation and strategic transformation endeavours. Leveraging our sector expertise, we can offer clients in the automotive industry a tailored and insightful insight to best overcome environmental disclosure challenges and optimise climate reporting for the strengthening CSRD and international requirements.

Appendices

Exhibit 1: The global market for GSS debt instruments 2014-2022

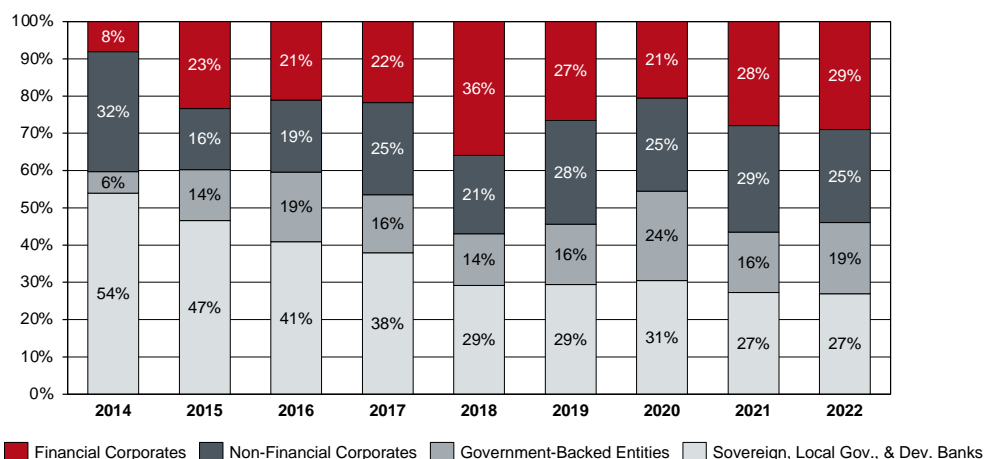
The global volume of GSS debt instruments reached USD3.2tn in 2022, peaking in at USD1tn annual issuance in 2021 to date



Source: Climate Bonds market data and reports<sup>47</sup>

Exhibit 2: The financial sector was the main contributor to the green finance market in 2022

The financial sector was leading the green bond issuance in 2022, contributing 29% to the total global volumes



Source: Climate Bonds<sup>48,49</sup>

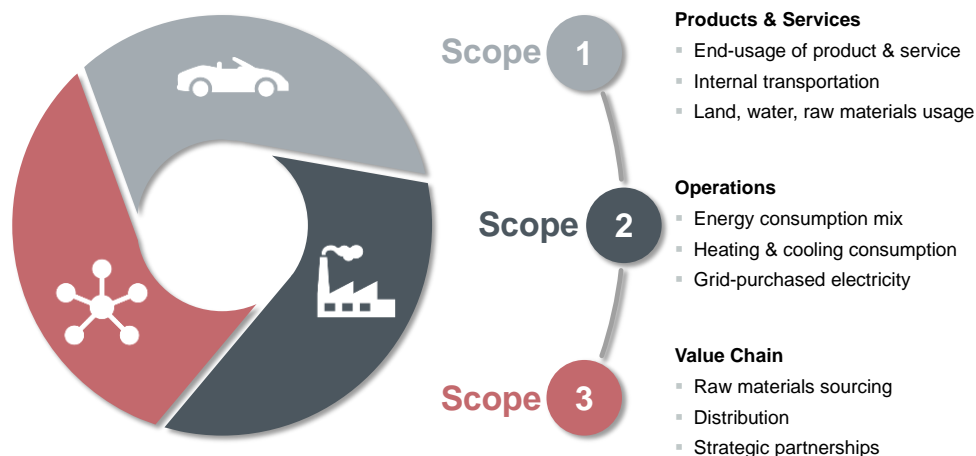
<sup>47</sup> <https://www.climatebonds.net/resources/reports/global-state-market-report-2022>

<sup>48</sup> <https://www.climatebonds.net/resources/reports/global-state-market-report-2022>

<sup>49</sup> <https://www.climatebonds.net/market/data/>

**Exhibit 3: The GHG Protocol classification of Scope 1, 2, and 3 GHG emissions**

The GHG Protocol classifies emissions into three main categories, called Scope 1, 2 and 3 GHG emissions



Source: CORE analysis, based on data from GHG Protocol

**Exhibit 4: The outline of the CSRD regulation and the role of ESRS requirements.**

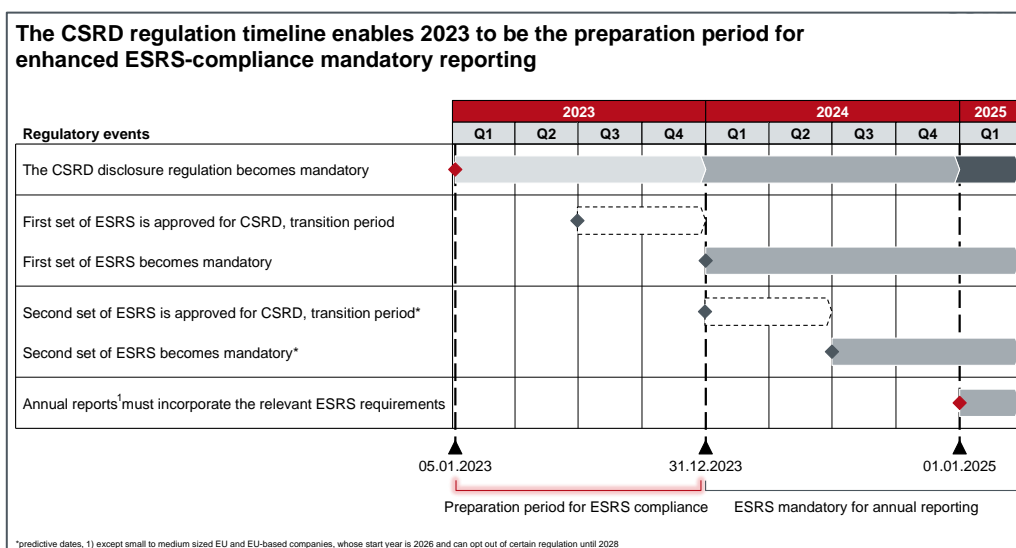
The CSRD will be enriched with granular sustainability disclosure requirements of the first and second sets of ESRS

Deep-dive follows

CSRD		
Current State	First set of ESRS	Second set of ESRS
5 <sup>th</sup> Jan 2023 – 30 <sup>th</sup> Jun 2023, General regulation	From 1 <sup>st</sup> Jul 2023, Specific disclosure requirements	H2 2023, Industry requirements
<b>Environment</b> <ul style="list-style-type: none"> <li>Climate change mitigation</li> <li>Climate change adaptation</li> <li>Pollution</li> <li>Water and marine resources</li> <li>Biodiversity &amp; ecosystem</li> <li>Resource use &amp; the circular economy</li> </ul>	<ul style="list-style-type: none"> <li>Draft ESRS E1: Climate change</li> <li>Draft ESRS E2: Pollution</li> <li>Draft ESRS E3: Water and marine resources</li> <li>Draft ESRS E4: Biodiversity &amp; ecosystems</li> <li>Draft ESRS E5: Resource use &amp; circular economy</li> </ul>	<ul style="list-style-type: none"> <li>Oil &amp; Gas</li> <li>Automotive</li> <li>Manufacturing</li> <li>Energy production</li> <li>Other (food/beverage, agriculture, mining)</li> </ul>
<b>Social</b> <ul style="list-style-type: none"> <li>Own workforce</li> <li>Workers in the value chain</li> <li>Affected communities</li> <li>Consumers and end-users</li> </ul>	<ul style="list-style-type: none"> <li>Draft ESRS S1: Own workforce</li> <li>Draft ESRS S2: Workers in the value chain</li> <li>Draft ESRS S3: Affected communities</li> <li>Draft ESRS S4: Consumers and end-users</li> </ul>	
<b>Governance</b> <ul style="list-style-type: none"> <li>Business Conduct</li> </ul>	<ul style="list-style-type: none"> <li>Draft ESRS G1: Business Conduct</li> </ul>	

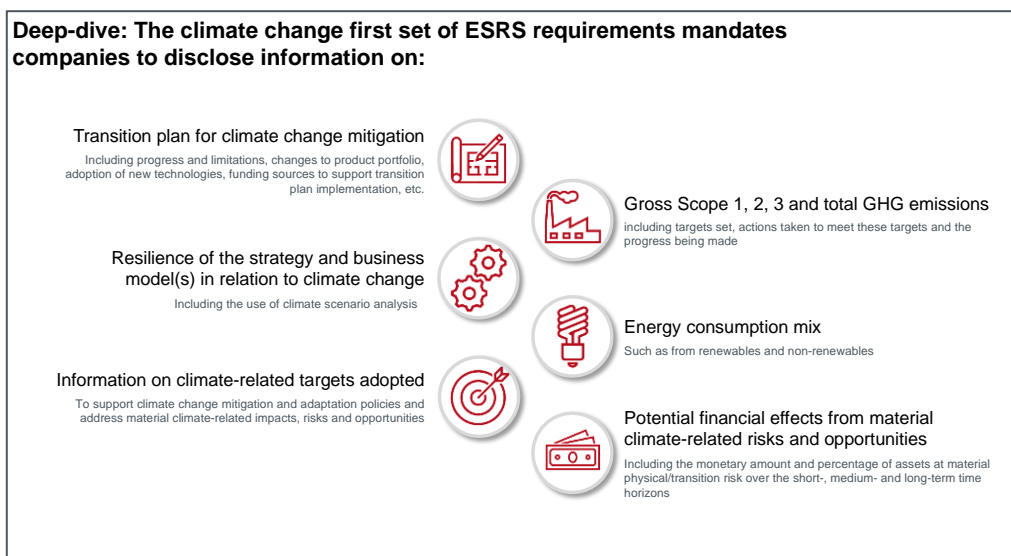
Source: CORE analysis, based on data from the European Commission and EFRAG

**Exhibit 5: The CSRD regulation timeline and the introduction of ESRS sets, 2023-2025.**



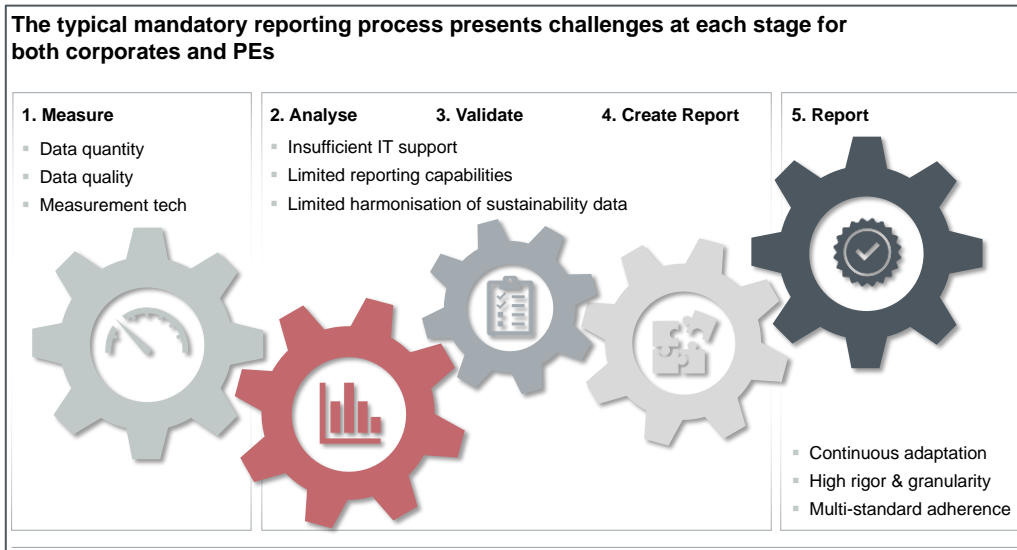
Source: based on data from the European Commission

**Exhibit 6: Deep-dive on the draft first set of ESRS on climate change requirements**



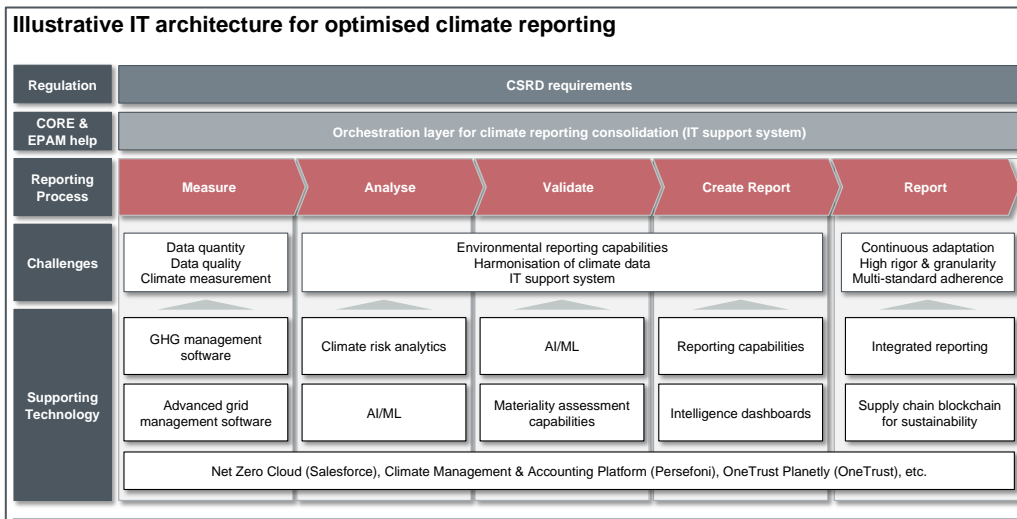
Source: CORE analysis, based on data from the EFRAG

**Exhibit 7: The typical sustainability disclosure process and the reporting challenges at each stage**



Source: CORE analysis

**Exhibit 8: The illustrative IT solution architecture for optimised climate reporting**



Source: CORE analysis

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Author

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### About COREresearch

As an independent technology think tank, we investigate the systematics of technology-driven transformations in industries with a high degree of IT involved in the value creation process. As part of our research activities, we analyse markets and technologies, address the structures, causes and mechanisms of technological change and curate results for clients and the public. Furthermore, we make available selected results of our interdisciplinary research in the form of comprehensive publications, case studies as well as lectures to a broader section of the public.

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