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Strategic Corporate Scope 2 Emission Disclosure: Evidence from Science-Based Targets

Working Paper Results, November 2025

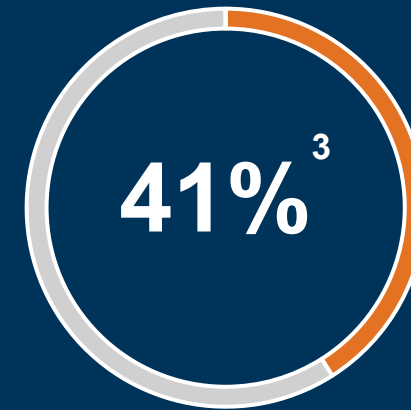
Two numbers that illustrate the relevance of corporate electricity procurement

Corporate electricity consumption is highly relevant for climate change ...



Share of corporate electricity consumption of global GHG emissions

... which companies increasingly recognize



Share of global market cap of companies with science-based targets

1. Schäfer et al., 2025

2. With validated or committed SBTi targets. End of 2024. <https://sciencebasedtargets.org/news/227-jump-in-companies-setting-comprehensive-climate-targets-as-corporate-climate-planning-accelerates>

There are two options to account for emissions from electricity procurement



Market-based method:

Emission factors based on **specific procurement choices**

E.g.: Buying „100% renewable“ power can report 0 gCO₂/kwh



Location-based method:

Emission factors based on **specific regional boundaries**
(e.g., country-specific)

E.g.: Norwegian company can report ~0 gCO₂/kwh

Current accounting guidelines (SBTi, GHG, CSRD)

Companies can **flexibly select one method** to set and track emission reduction targets

Scope 2 emission guidelines allow considerable discretion to corporates in methodology choice – but there is limited evidence how they use it

Literature overview

Current **scope 2 emission methodology grants considerable discretion** in selecting their methodology for target setting and tracking (Glenk, 2025):

- Potentially resulting in **biased and difficult to compare** reported emissions (Brandner et al., 2019; Klaaßen and Stoll, 2021; Paris et al, 2024)
- Potentially resulting in **double-counting of emissions** on the aggregate reporting level (Ma and Duan, 2024; Stachelscheid&Dutzi, 2025)

Research gap

Limited empirical evidence:

“The options to choose different Scope 2 accounting methods for science-based climate targets and possible implications for double-counting, especially on European level, represent another interesting field for further research.” (Stachelscheid & Dutzi, 2025)

Research questions

RQ1 Do companies preferentially **select** between location- and market-based scope 2 accounting to minimize reported emissions?

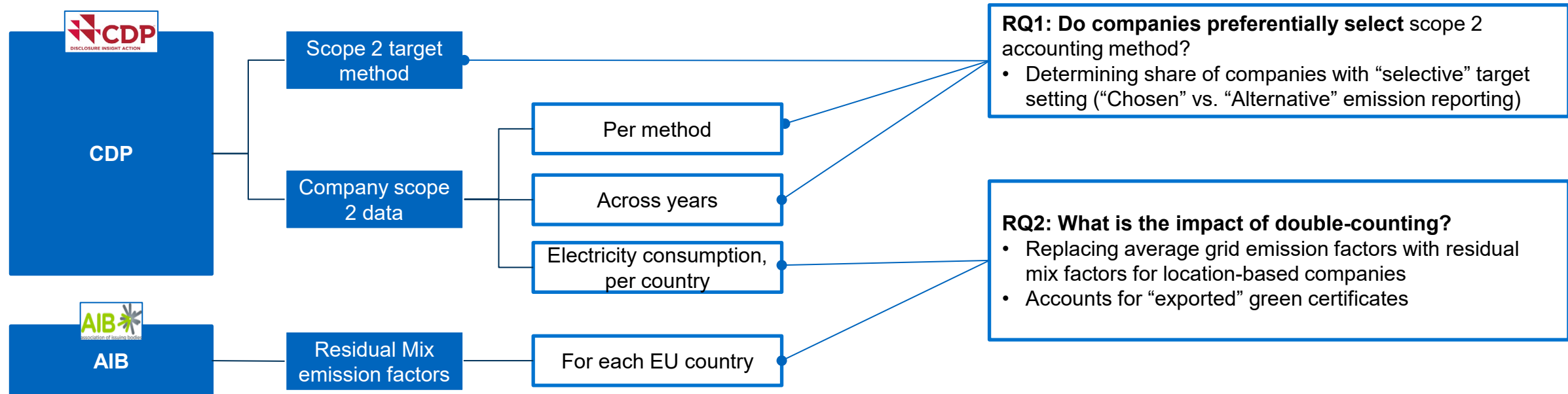
RQ2 What are the implications for **double-counting** based on current scope 2 accounting guidelines and corporate accounting practices?

I employ a quantitative approach using CDP and AIB data

Primary Data sources

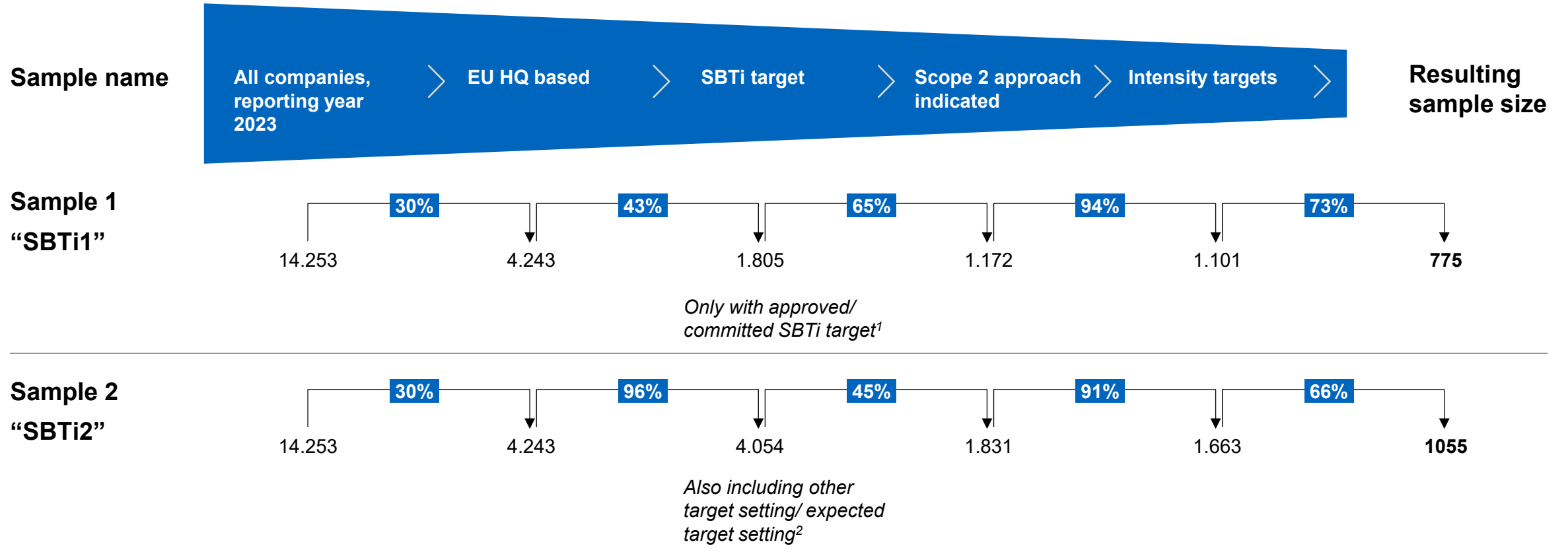


Link to Research Question



Case study with focus on **European companies with SBTi targets**, due to **availability of reliable residual mix calculations**

From the initial dataset of >14.000 datapoints I create two samples, that differ in their SBTi target validation

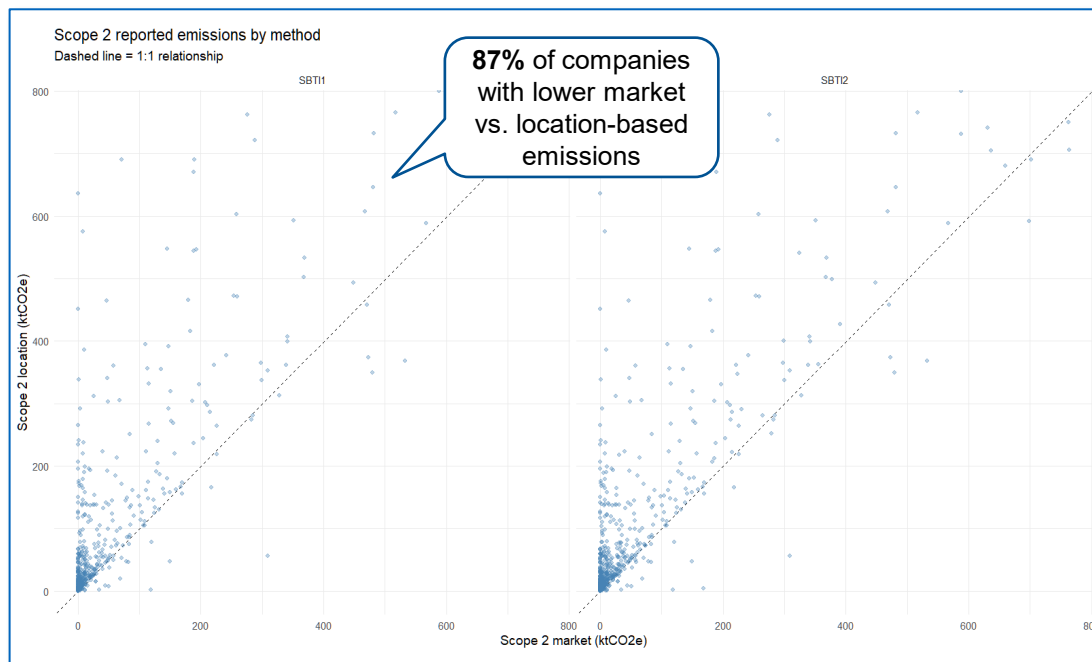


Explanation	Limit scope on AIB area for residual mix correction	Additional filters applied to remove duplicates, exclude electric utilities, and additional sanity checks ³

1. Includes the following responses to C4.1a_C2: Yes, and this target has been approved by the Science Based Targets initiative; Yes, we consider this a science-based target, and we have committed to seek validation of this target by the Science Based Targets initiative in the next two years; Yes, we consider this a science-based target, and the target is currently being reviewed by the Science Based Targets initiative
 2. Includes the following responses to C4.1a_C2: Everything from Sample 1; Yes, we consider this a science-based target, but we have not committed to seek validation of this target by the Science Based Targets initiative within the next two years ; No, but we anticipate setting one in the next two years ; No, but we are reporting another target that is science-based
 3. Excluding companies with more than 50% deviation of scope 2 emissions for 2023 reported in Refinitiv; Excluding companies where electricity related scope 2 emissions (calculated based on country level electricity consumption and grid emission factors) are >1,05x total scope 2 reported location based emissions

RQ1: Sample companies mostly show lower market vs. location-based emissions ...

Scope 2 emission by accounting approach



Reported market-based emission lower than location-based emissions for most companies

Coding of “Selective” variable

To assess whether companies selectively choose the scope 2 methodology that lowers their reported emissions, I define the “**Selectivity**” variable as follows (Depoers et al., 2016):

$$\text{Selectivity}_i = \begin{cases} \text{Yes,} & \text{if } \text{Emissions}_i^{\text{Chosen}} < \text{Emissions}_i^{\text{Alternative}}, \\ \text{No,} & \text{if } \text{Emissions}_i^{\text{Chosen}} > \text{Emissions}_i^{\text{Alternative}}, \\ 0, & \text{if } \left| \frac{\text{Emissions}_i^{\text{Chosen}} - \text{Emissions}_i^{\text{Alternative}}}{\text{Emissions}_i^{\text{Alternative}}} \right| \leq 0.025. \end{cases}$$

RQ1: Sample companies mostly show lower market vs. location-based emissions ...

Selectivity Analysis

Table 1: Selectivity summary for SBT11

Selectivity flag 1	N	Mean Chosen	Mean Alternative	Mean Difference	% Diff of means
Yes	531	89,420	189,329	-99,908	-52.8
0	30	256,533	255,865	667	0.3
No	122	355,138	306,133	49,004	16.0
Total	683				

Table 2: Selectivity summary for SBT12

Selectivity flag 1	N	Mean Chosen	Mean Alternative	Mean Difference	% Diff of means
Yes	655	104,018	210,377	106,359	-50.6
0	38	246,253	246,106	147	0.1
No	181	295,289	256,395	38,894	15.2
Total	874				

Key Results

- 1** Majority of companies in both samples, preferentially select their scope 2 accounting approach (75-78%)
- 2** Companies that are selective “underreport” significantly more emissions, relative to the “overreporting” of companies that are not selective, both
 - 2a** absolutely, and
 - 2b** relatively

Project Outlook: Deep dive of selectivity share for each scope 2 methodology separately.

RQ2: Estimated double-counting impact can be calculated by merging company-level CDP with AIB data

Emission Calculation, scope 2 electricity-related

Market-based emissions for company i $E_{MB_i} = EF_{MB} * C_{MB_i} + EF_{RES} * [C_{total_i} - C_{MB_i}]$ (1)

Location-based emissions for company j, uncorrected $E_{LB_j} = EF_{AV} * C_{LB_j}$ (2)

Location-based emissions for company j, corrected $E_{LB_{corr_j}} = EF_{RES} * C_{LB_j}$ (3)

Aggregate reported emissions, adjusted

$$E_{agg} = \sum_{i=0}^n E_{MB_i} + \sum_{j=0}^k [E_{LB_{corr_j}} - E_{LB_j}]$$
 (4)

$$= \sum_{i=0}^n E_{MB_i} + \sum_{j=0}^k [C_{LB_j} * (EF_{RES} - EF_{AV})]$$
 (5)

with EF being the emission factor for market-based (MB) and average-grid (AV) and residual mix (RES) consumption. C being electricity consumption for companies reporting the market-based (MB) or location-based (LB) method.

“Corrected” location-based scope 2 electricity emission

Data Sources

- 1 **# of companies choosing location-based method:**
 CDP questionnaire, answers to question C4.1 (SBTi targets) and C7.9b (total emission performance)
- 2 **Electricity consumption per company per country:**
 CDP questionnaire, answers to question C8.2g
- 3 **Residual emission factor per country:** AIB residual mix calculations
- 4 **Average grid emission factor per country:** AIB physical emission grid factor

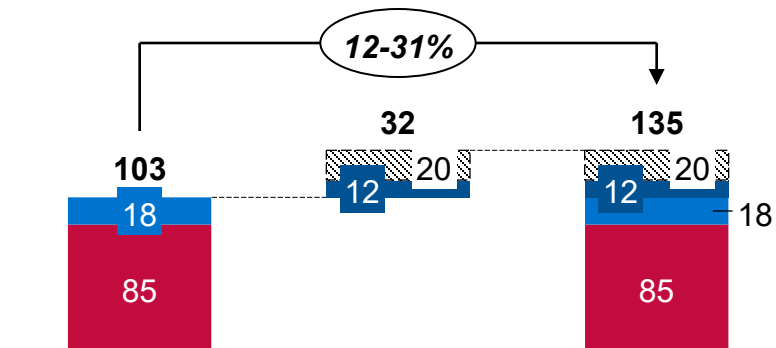


RQ2: Overall impact of double-counting under current scope 2 reporting guidelines up to 42% increase of reported emissions

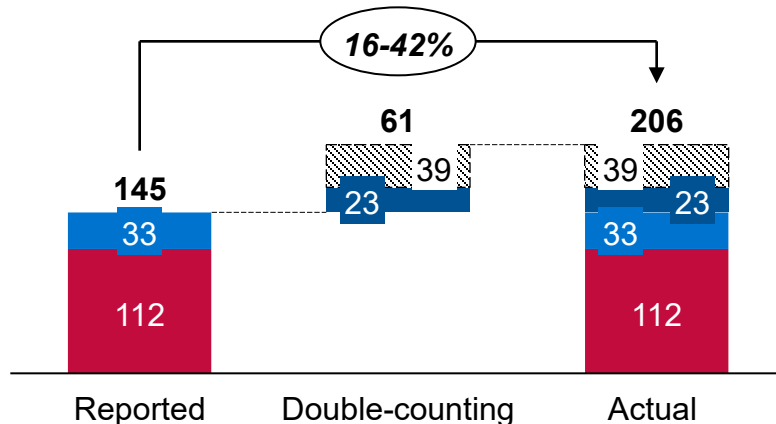
"On-top"
 Double-counting
 Location reported
 Market reported

Emission adjustments, sample aggregates in Mt CO₂e

SBTi1



SBTi2



Key Insights

- Current corporate emission reports **underreport up to 42% of actual emission**
- Calculation reflects **estimation of double-counting impact under "status quo"** reporting practices (Emission increase vary with # of companies that choose location-based approach)

My findings directly informs the discussion on scope 2 accounting reforms

 Considered in this paper

Key findings

Implications for scope 2 accounting options

RQ1

Majority of **companies preferentially select** scope 2 accounting method ...

RQ2

... leading to **significant double-counting impact** (up to 42% in my sample) of reported emissions with current location based guidelines

	Market-based	Location-based	Double-counting?	Considerations
Status Quo	Yes	Yes, with average grid factors	✓	<ul style="list-style-type: none"> Risk of double-counting, if companies preferentially select reporting method (Bjorn et al., 2025; Bösch, 2025)
Alternative 1	Yes	No	✗	<ul style="list-style-type: none"> Avoids double-counting Concerns re. additionality & representation of carbon inventory (Kemper et al., 2025; Stachelscheid & Dutzi, 2025)
Alternative 2	No	Yes	✗	<ul style="list-style-type: none"> No incentives for companies to decarbonize individually (Bjorn et al., 2025)
Alternative 3	Yes	Yes, with residual mix factors	✗	<ul style="list-style-type: none"> Second-order effects of companies migrating to market-based approach¹

1. E.g., increase in emission factor for residual actors without dedicated green electricity mix; liquidity and price effects on EAC market.

My findings contribute to the carbon accounting literature and informs ongoing revisions of major accounting guidelines

Literature

- **Provides empirical evidence on preferential use** of flexible scope 2 accounting options for sample companies and extent of double-counting impact

Market participants

- Informs **ongoing revision of accounting guidelines and corporate green claims** (e.g., SBTi until 2026, GHG until 2027)
- **Advises investors to be diligent on scope 2 method selection** and detects comparability as key issue and requirement in scope 2 guidance revisions (Gillenwater, 2022)

Limitations & further research

- **Likely underestimates true double counting** due to residual mix data availability
- **Does not include estimation of “second-order” effects** when applying residual mix factors for location-based accounting (e.g., market liquidity of RECs; “undetected” emission shift/increase to remaining users of grid electricity¹)

Looking forward to your feedback!

1. Full disclosure regimes (e.g., in Austria) could mitigate such an effect.

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Backup

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21



RQ2: Using residual mix factors in significant upward adjustment of scope 2 emissions on firm level

Additional estimation

For location-based reporters:

- Replace average grid emission factor with residual mix factor
- Accounts for “export” of green certificates



Emission adjustment on firm level, kt

Backup

Corrected location-based scope 2 emissions can be calculated by merging company-level CDP with AIB data

Emission Calculation, scope 2 electricity-related

$$E_{Lb} = E_{Firm} + C_{Grid} + E_{Firm} + C_{Grid} - C_{Grid} \quad (1)$$

$$E_{Lb} = E_{Firm} + C_{Grid} \quad (2)$$

$$E_{Lb} = E_{Firm} + C_{Grid} \quad (3)$$

$$E_{Adj} = \sum_{i=1}^n E_{Lb,i} + \sum_{j=1}^m E_{Firm,j} - E_{Lb,i} \quad (4)$$

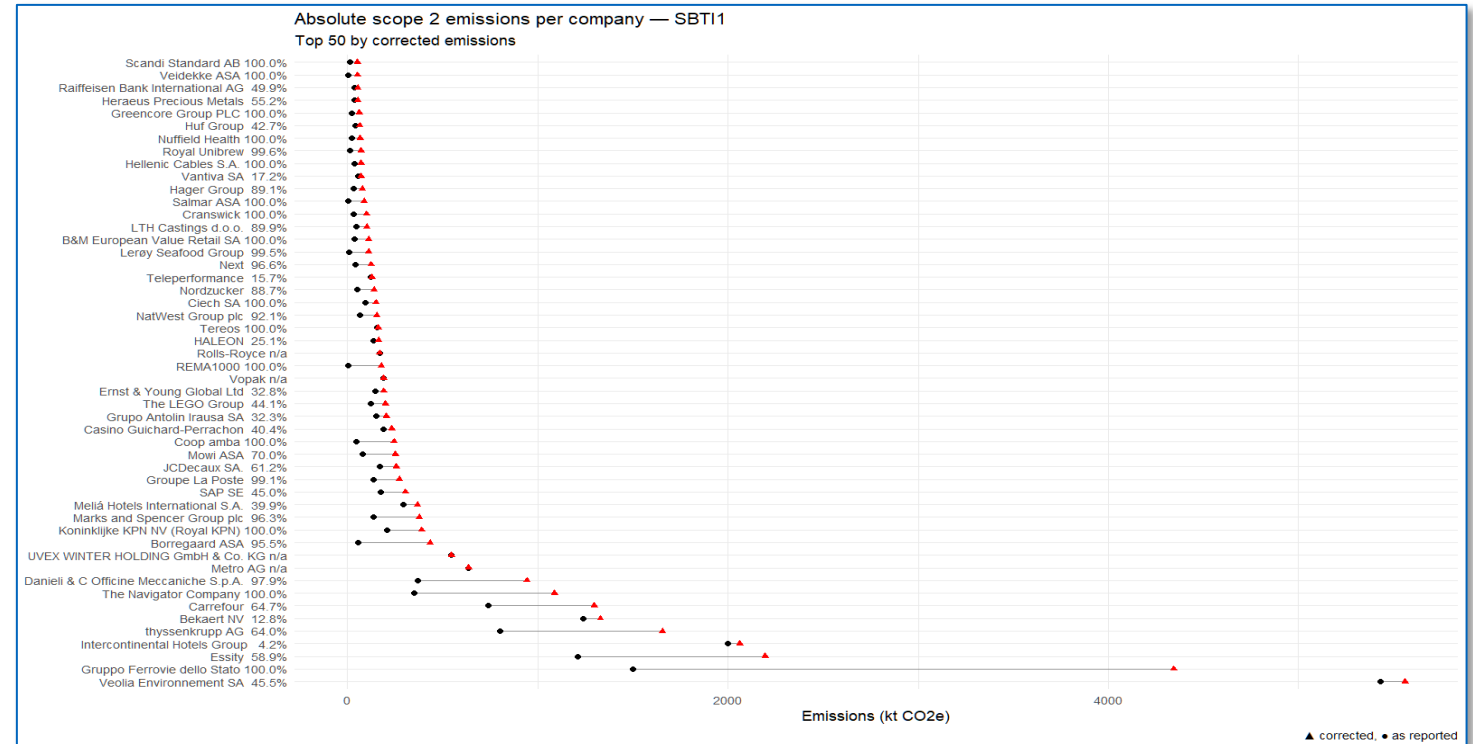
$$E_{Adj} = \sum_{i=1}^n E_{Lb,i} + \sum_{j=1}^m E_{Firm,j} - E_{Lb,i} \quad (5)$$

Data Sources

- 1 # of companies choosing location-based method: CDP questionnaire, answers to question C4.1 (SBTi target) and C7.0b (total emission performance)
- 2 Electricity consumption per company per country: CDP questionnaire, answers to question C8.2g
- 3 Residual emission factor per country: AIB residual mix calculations
- 4 Average grid emission factor per country: AIB physical emission grid factor

“Corrector” location-based scope 2 electricity emission

Details in Appendix



Mean relative adjustment per company of >2x, heterogeneously distributed