ASIAN BOND MARKETS INITIATIVE BRIEF No. 10

Mitigating the Data Gap in Greenhouse Gas Emissions Calculation for Small and Medium-Sized Enterprises

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Introduction

The Asian Bond Markets Initiative (ABMI) Brief series aims to provide insights on regional bond markets in ASEAN+3, their development, and other topics under the ABMI to issuers, investors, market intermediaries, regulatory authorities and policymakers, academia, and other interested parties. This brief focuses on sustainable finance, which is one of the pillars of the ABMI Medium-Term Road Map, 2023–2026.[1]

With the growing trend of sustainability disclosure, calculating and reporting greenhouse gas (GHG) emissions has become increasingly critical. As global awareness of climate change intensifies, stakeholders —including customers, investors, and regulators—are demanding greater transparency and accountability in sustainability practices. The Sustainability Disclosure Standards of the International Financial Reporting Standards (IFRS) Foundation, published in June 2023, recommend disclosing GHG emissions in three categories: (i) Scope 1 for direct GHG emissions that are owned or controlled by an organization; (ii) Scope 2 for indirect GHG emissions that are generated outside the organizational boundary but consumed within the boundary, such as purchased electricity; and (iii) Scope 3 for all other indirect emissions that occur from sources that are not owned or controlled by the entity but are part of its upstream or downstream value chain. For small and medium-sized enterprises (SMEs), the scope of GHG emissions reporting may not be as great as that of large organizations and their reporting may not be

KEY TAKEAWAYS

- The importance of greenhouse gas (GHG) emissions calculation for small and medium-sized enterprises (SMEs) extends beyond ongoing regulatory compliance.
- SMEs, which often have resource and capacity constraints, need support to address data gaps and the technical complexity of emissions calculation.
- For SMEs, it is practical to consider the estimation approach for their GHG emissions calculation. Leveraging accounting data to estimate activities is practical and cost-effective.
- The common use of the estimation approach underscores the need to enhance databases to account for emission factors, especially country-specific ones.
- Utilizing technology is the key for SMEs' emissions calculation. Start-ups are emerging that can support standardized GHG emissions calculation and data collection.
- In addition to public support, large corporations and financial institutions can play a pivotal role in providing SMEs with capacity support and affordable technology platforms for data gathering.

[1] This ABMI Brief was produced by ABMF Secretariat, led by Satoru Yamadera, advisor, Economic Research and Development Impact Department, Asian Development Bank (ADB). The brief was written by Satoru Yamadera; Thinh Ngoc Tran, financial market specialist (climate financing), Sectors Group, ADB; and Mikko Marl V. Diaz, consultant (research analyst), ADB. A presentation to ABMF members in October 2024 laid the foundation for this brief. ASEAN+3 refers to the 10 members of the Association of Southeast Asian Nations (ASEAN) plus the People's Republic of China, Japan, and the Republic of Korea.

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mandated by regulations; however, regardless of regulatory requirements, it is likely that SMEs participating in global value chains will face pressure from large buyers to "voluntarily" calculate their Scope 3 emissions. Likewise, banks will ask SMEs to submit emissions information because banks also need to calculate their financed emissions under Scope 3 reporting requirements.

Due to their limited resources, SMEs encounter several challenges in measuring GHG emissions, including data gaps and limited analytical capability. Thus, it is necessary to establish a common understanding of how to approach the issue through appropriate and practical estimation methodologies. Available technology solutions should also be leveraged to help bridge these gaps. This brief highlights how to mitigate the challenges faced by SMEs in terms of GHG emissions calculation. The brief seeks to incentivize policymakers to support the implementation of GHG emissions disclosure under the IFRS Sustainability Disclosure Standards set by the International Sustainability Standards Board. It also examines key data requirements for GHG emissions calculation, such as emission factors (EFs), and reviews the progress of the Association of Southeast Asian Nations (ASEAN) Member States (AMS) in setting country-specific EFs. In addition, the brief provides key recommendations from market practitioners on the standardization of the GHG emissions calculation process, laying the foundation needed to enhance climate-related disclosure.

The Importance of Greenhouse Gas Emissions Calculation for Small and Medium-Sized Enterprises

The importance of GHG emissions calculation and reporting for SMEs extends beyond regulatory compliance. It encompasses financial advantages, enhanced supply chain relationships, and improved sustainability risk management. By engaging in robust GHG accounting, SMEs can increase their access to green financing, meet the demands of larger companies for Scope 3 emissions data, and proactively manage climate-related risks. Despite these benefits, SMEs often face challenges such as resource constraints and data collection difficulties, which need to be addressed to fully utilize the benefits of GHG reporting. This discussion sets the stage for a detailed analysis of the benefits and challenges of GHG emissions calculation and reporting for SMEs.

Key Benefits for Small and Medium-Sized Enterprises

Operational improvements and better access to finance. GHG emissions calculation and reporting can significantly impact the financial health of SMEs by revealing inefficiencies and opportunities for cost savings. Through better measurement of GHG emissions and the adoption of sustainable practices, SMEs can identify areas where energy and resource use can be optimized, leading to significant reductions in operational expenses.[2]

ASEAN+3 Bond Market Forum

The ASEAN+3 Bond Market Forum (ABMF) was established in 2010 under the Asian Bond Markets Initiative by the ASEAN+3 Finance Ministers, with a mandate to support the development of regional local currency bond markets. Since then, ABMF has acted as a platform for dialogue among public and private sector stakeholders in regional bond markets and promoted the exchange and evaluation of ideas among finance ministries, securities regulators, securities exchanges, depositories, custodian banks, underwriters, and other market intermediary organizations. ABMF discussion outcomes have helped to address common issues and formulate policy recommendations.

The Asian Development Bank publishes the ASEAN+3 Bond Market Guide series, which was created and is updated by ABMF, for interested parties. The economy-level bond market guides serve as reference material to learn more about individual regional markets' development, help address misperceptions, and disseminate regional bond market information to a larger audience. ABMF has proposed, agreed on, and helped implement the ASEAN+3 Multi-Currency Bond Issuance Framework as one practical initiative toward harmonizing the professional bond markets in ASEAN+3 member economies.

As part of the ABMI Medium-Term Road Map, 2023–2026, ABMF received the mandate to support regional efforts on sustainable finance, using its platform to facilitate dialogue between public and private sector institutions, advocates, and policymakers. ABMF is now including sustainable finance subjects in all its publication series.

[2] World Economic Forum. 2024. *SMEs Should Link Growth with Environmental Sustainability*. https://www.weforum.org/agenda/2024/09/net-zero-environmental-sustainability-smes-benefits/.

Furthermore, investors and financial institutions are increasingly prioritizing environmental, social, and governance (ESG) criteria, and companies with robust GHG reporting practices are more likely to attract investment, including green financing opportunities such as green loans, grants, or incentives specifically designed for businesses with sustainability commitments.[3]

Competitive advantages in supply chains and financing. In the context of supply chain GHG accounting, particularly for Scope 3 emissions, SMEs play a crucial role. Large corporations are under pressure to report their entire value chain's emissions, which include the emissions of their suppliers.[4] Financial institutions are also required to report their financed emissions. If SMEs can demonstrate the necessary emissions-tracking capability, they may be able to engage and secure good business relationships with larger corporations and financial institutions that must comply with international disclosure standards. In addition, SMEs can potentially increase customer loyalty and sales by enhancing their reputation for being pro-sustainability.[5]

Regulation compliance and risk management. Early adaptation to GHG emissions calculation allows SMEs to adjust to the changing sustainability regulatory landscape. Policymakers, including those in the European Union and across Asia and the Pacific, are gradually mandating comprehensive ESG disclosures, such as the European Union's Corporate Sustainability Reporting Directive and the IFRS Sustainability Disclosure Standards set by the International Sustainability Standards Board. Companies are required to measure and disclose their carbon footprints to avoid potential penalties.[6] Proactively managing GHG emissions not only minimizes legal risks but also enhances companies' ability to adapt to evolving standards, reducing exposure to future regulatory liabilities.[7] Furthermore, staying ahead of regulatory changes can provide a competitive advantage, allowing compliant companies to avoid sudden and costly operational adjustments.

Typical Challenges for SMEs

Despite their pivotal role in the global economy, SMEs encounter challenges that limit their ability to engage fully in GHG accounting.

Resource and expertise constraints. Compared to larger corporations, SMEs operate with limited financial and human resources, hindering their ability to invest in specialized tools and personnel for GHG accounting and sustainability data gathering—processes that can be highly challenging and costly for SMEs.[8] This scarcity of expertise makes it difficult for SMEs to navigate complex GHG reporting processes, identify relevant sources of emissions, and accurately measure and manage these emissions. Limited financial resources also constrain SMEs' ability to invest in external consultants or advanced tools necessary for accurate GHG assessment, potentially leading to inaccuracies in reporting and a lack of confidence in the data provided.

Technical complexity and data gaps. The technical complexity and data gaps involved in GHG emissions calculation are another significant hurdle for SMEs. Such calculation involves tracking emissions, which can be technically challenging for SMEs. Meanwhile, calculating Scope 3 emissions requires capturing data across the up and down streams of value chains, meaning that SMEs involved in value chains may be asked to conduct the same level of data collection efforts as large companies. This can entail compiling data in multiple offline spreadsheets or mapping data and inputting it into systems manually, thus creating a huge operational burden for SMEs.

Differences in the regulatory landscape of climate disclosure. Different countries and regions have varying GHG reporting requirements, which can be

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[3] World Economic Forum. 2023. *Emissions Measurement in Supply Chains: Business Realities and Challenges*. https://www3.weforum.org/docs/WEF_Emissions_Measurement_in_Supply_Chains_2023.pdf.

[4] Bain & Co. 2023. *Operations and Supply Chain Decarbonization: Lower Emissions, Higher Performance*. https://www.bain.com/insights/operations-and-supply-chain-decarbonization-lower-emissions-higher-performance-ceo-sustainability-guide-2023/.

[5] International Organization for Standardization. 2024. *Building a Sustainable Path to ESG Reporting*. https://www.iso.org/climate-change/esg-reporting.

[6] Effective 5 January 2023, the European Union's Corporate Sustainability Reporting Directive requires companies to report on their GHG emissions. This includes calculating and disclosing Scope 1, 2, and 3 emissions.

[7] United States Environmental Protection Agency. 2010. *Managing Supply Chain Greenhouse Gas Emissions*. https://www.epa.gov/sites/default/files/2015-07/documents/managing_supplychain_ghg.pdf.

[8] S. Gorgels, M. Priem, T. Blagoeva, A. Martinelle, and G. Milanesi. 2022. *Annual Report on European SMEs 2021/2022: SMEs and Environmental Sustainability: Background Document*. https://op.europa.eu/en/publication-detail/-/publication/c45665ad-fd9a-11ec-b94a-01aa75ed71a1/language-en.

Box: Key Steps for Greenhouse Gas Emissions Calculation and Reporting

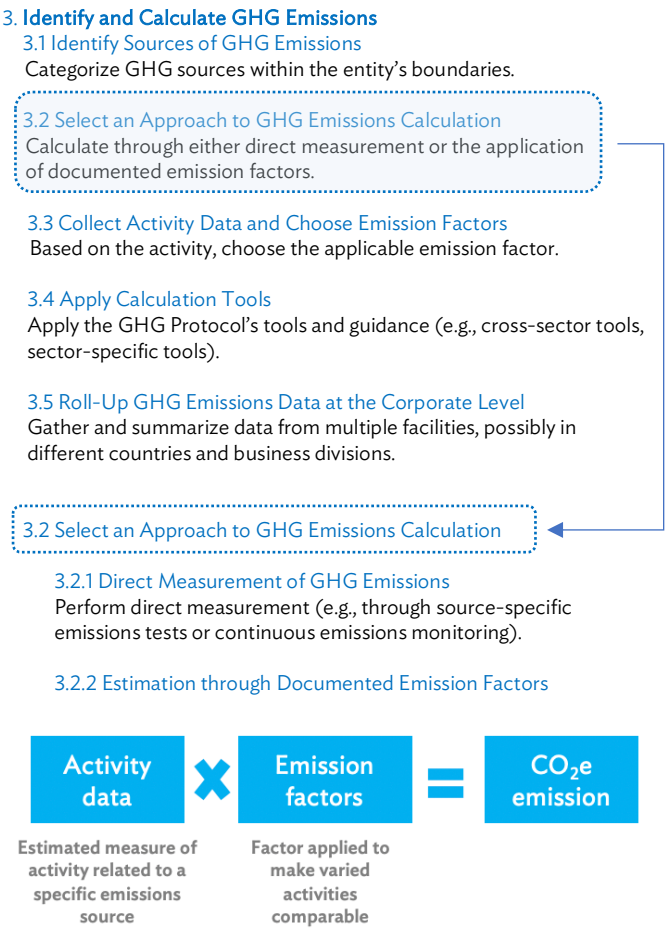
1 **Set Organizational Boundaries**
Determine which parts of the organization will be included in the GHG inventory, under either a control approach or an equity share approach. [a]

2 **Set Operational Boundaries**
Identify which operations and activities will be included in the GHG inventory. This involves categorizing emissions as either Scope 1, 2, or 3 to ensure all relevant emission sources are accounted for.

3 **Identify and Calculate GHG Emissions**
Identify all relevant sources of emissions within the defined boundaries, gather data on activity levels, and apply appropriate emission factors to calculate GHG emissions.

4 **Track Emissions**
Track emissions over time by developing a base year, setting reduction targets, and aiming to reduce gross emissions within the inventory boundary.

5 **Report and Verify**
Report on information gathered and tracked, which can be verified by third parties to enhance its creditability.



CO_2e = carbon dioxide equivalent, GHG = greenhouse gas.
[a] Under the GHG Protocol, organizations can use either the control approach (accounting for emissions from operations under either financial or operational control) or the equity share approach (accounting for emissions according to the share of ownership). The choice of approach will affect how emissions are consolidated and reported.
Source: Authors' compilation based on KPMG. 2024. *GHG Emissions Reporting Handbook*; https://kpmg.com/us/en/frv/reference-library/2024/handbook-ghg-emissions-reporting.html. Greenhouse Gas Protocol. 2004. *Corporate Accounting and Reporting Standard, Revised Edition*; https://ghgprotocol.org/corporate-standard.

implemented through different time frames and scopes. Requirements may vary depending on the country as global value chains encompass various countries with potentially different standards; thus, Scope 3 emissions calculation will inevitably be complex. The lack of a standardized framework for data requirements increases the challenges and burden for SMEs, and understanding and applying these diverse frameworks demands substantial time and specialized expertise that SMEs may not possess.[9]

[9] Organisation for Economic Co-operation and Development 2024. *Financing SMEs and Entrepreneurs 2024: An OECD Scoreboard.* https://www.oecd.org/content/dam/oecd/en/publications/reports/2024/03/financing-smes-and-entrepreneurs-2024_015c0c26/fa521246-en.pdf.

Guidance on Greenhouse Gas Emissions Calculation and Emissions Factors

GHG Emissions Calculation: General Guidance

To help organizations systematically track and manage their emissions, the GHG Protocol categorizes GHG emissions into three scopes and provides a systematic approach to their measurement.[10] Scope 1 refers to direct GHG emissions that are owned or controlled by an organization. Scope 2 comprises indirect GHG emissions that are generated outside the organizational boundary but consumed within it (e.g., purchased electricity).[11] Scope 3 emissions include all other indirect emissions occurring from sources that are not owned or controlled by the entity, but are a part of its (upstream and downstream) value chain. Scope 3 is further broken down into 15 categories.[12]

The **Box** on page 4 summarizes a structured process for GHG emissions calculation and reporting that comprises five steps: (i) setting organizational boundaries, (ii) setting operational boundaries, (iii) identifying and calculating GHG emissions, (iv) tracking emissions, and (v) reporting and verifying. The box provides additional specific guidance for step "(iii) identifying and calculating GHG emissions."

Whereas GHG emissions can be measured using direct measurement with minimal uncertainty, this approach might be unavailable or prohibitively expensive for SMEs.[13] While direct measurement of GHG emissions allows for continuous monitoring and immediate detection of emission changes, implementing a direct measurement system is costly and complex. Therefore, the estimation approach, using documented EFs, offers SMEs a cost-effective and straightforward method for estimating emissions. This highlights the importance of establishing a credible database on EFs, including the development of country-specific EFs.

International Guidance on Country-Specific Emission Factors

The Intergovernmental Panel on Climate Change (IPCC) defines an EF as "a coefficient that quantifies the emissions or removals of a gas per unit activity." The IPCC's 2006 Guidelines for National Greenhouse Gas Inventories (2006 Guidelines) and the 2019 Refinement to the Guidelines for National Greenhouse Gas Inventories (2019 Refinement) provide default EFs based on a sample of measurement data, averaged to develop a representative rate of emissions for a given activity level under a given set of operating conditions.[14]

The IPCC estimates emissions based on tiers of methodological complexity that depend on data availability. Tier 1 is the most basic method and utilizes the default EFs provided in the IPCC's 2006 Guidelines and 2019 Refinement. The Tier 2 method uses more detailed methodologies and employs country- and technology-specific EFs and/or regional EFs, which requires data with a certain level of disaggregation. The Tier 3 method uses models, data from surveys, and direct measurements.[15] Ideally, the Tier 1 method is used for categories with low impact on the inventory; the Tier 2 method is used for categories with significant impact on the inventory, as much as the national circumstances allow; and the Tier 3 method is used in categories with very high impact on the inventory.

However, the lack of available data, including country-specific EFs, limits the adoption of the Tier 1 method for emissions calculations. Nevertheless, the Tier 1 method is still valid as it provides feasible calculation methodologies without unwarranted costs. The IPCC provides the Emissions Factor Database, which is broken down into four main categories: (i) energy; (ii) industrial processes and product use; (iii) agriculture, forestry, and other land use; and (iv) waste. **Table 1** provides a list of reference sources for EFs.

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[10] The GHG Protocol is the most widely used framework for GHG emissions measurement. It was formed in 1998 as a partnership between the World Resources Institute and the World Business Council for Sustainable Development.

[11] KPMG. 2024. *GHG Emissions Reporting Handbook*. https://kpmg.com/us/en/frv/reference-library/2024/handbook-ghg-emissions-reporting.html.

[12] These categories comprise (i) purchased goods and services, (ii) capital goods, (iii) fuel- and energy-related activities, (iv) upstream transportation and distribution, (v) waste generated in operations, (vi) business travel, (vii) employee commuting, (viii) upstream leased assets, (ix) downstream transportation and distribution, (x) processing of sold products, (xi) use of sold products, (xii) end-of-life treatment of sold products, (xiii) downstream leased assets, (xiv) franchises, and (xv) investments.

[13] Greenhouse Gas Protocol. 2004. *Corporate Accounting and Reporting Standard, Revised Edition*. https://ghgprotocol.org/corporate-standard.

[14] IPCC. 2006. *2006 IPCC Guidelines for National Greenhouse Gas Inventories*; https://www.ipcc-nggip.iges.or.jp/public/2006gl/. IPCC. 2019. *2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories*. https://www.ipcc-nggip.iges.or.jp/public/2019rf/index.html.

[15] Cambodia's General Directorate of Administration for Nature Conservation and Protection. 2019. *National GHG Emissions Inventory Report*. https://unfccc.int/sites/default/files/resource/National_GHG_Inventory_Cambodia.pdf.

Table 1: Reference Sources for Emission Factors

Source	Description
IPCC: Emission Factor Database	Provides default emission factors for Tier 1 methodology but may not be representative of national circumstances
EMEP/EEA; Emission Inventory Guidebook 2023	Has useful defaults for crosschecking; may not be representative of progress in country-specific or key category estimates
US EPA: GHG Emission Factors Hub [a]	Has useful defaults for crosschecking; may not be representative of progress in country-specific or key category estimates
OECD: International Emission Factor databases	Useful defaults for crosschecking; may not be representative of progress in country-specific or key category estimates
IEA	IEA GHG CO2 Emissions Database
GHG Protocol	Third-party databases on the GHG Protocol website
Country-specific data from international or national peer-reviewed journals	Reliable when factors are representative and standard methods are used
Emissions-regulating authorities' records and papers, pollution release data, and transfer registries	Information from specific trade associations, sector-specific and up-to-date; quality assurance and quality control is needed to check for bias in data and ensure test conditions and measurement standards
EFs and other estimation parameters for other countries	Appropriate for inventory use; useful as defaults or for checking; may not be representative of progress in country-specific or key category estimates

EF = emission factor, EMEP/EEA = European Monitoring and Evaluation Program/European Environment Agency, GHG = greenhouse gas, IEA = International Energy Agency, IPCC = Intergovernmental Panel on Climate Change, OECD = Organisation for Economic Co-operation and Development, US EPA = United States Environmental Protection Agency.
[a] As of the date of this brief, the most recent version of the Emission Factors Hub is February 2024.
Source: Authors' compilation based on IPCC. 2019. *2019 Refinement to the Guidelines for National Greenhouse Gas Inventories. Chapter 2: Approaches to Data Collection (Table 2.2 [Updated] Potential Sources of Emission Factors)*.

Country-Specific Emission Factors in ASEAN Member States

The common use of the estimation approach underscores the need to enhance EF databases, especially for country-specific EFs. Estimating emissions using documented EFs is generally less expensive and less resource-intensive than direct measurement methods. Applying EFs is straightforward and does not require specialized equipment or extensive training. However, EFs may not capture operational specificities, leading to potential inaccuracies. Desktop research conducted by ABMF Secretariat found that many AMS are at the early stage of developing their country-specific EFs. According to the latest Biennial Update Reports submitted by AMS to the United Nations Framework Convention on Climate Change, the Tier 1 method and default EFs are widely used to calculate GHG inventory in most AMS given the lack of country-specific EFs. Having said that, certain progress has been made to develop country-specific EFs in some selected subcategories (e.g., cement production, livestock, land, and forestry) where country-level statistics or plant-level data are available.

Table 2 summarizes the overall status of each AMS based on its Biennial Update Reports submitted to the United Nations Framework Convention on Climate Change and other relevant publications collected by ABMF Secretariat. Singapore is leading among all AMS, with available EFs in selected subcategories.

Table 2: Status of Development of Country-Specific Emission Factors in ASEAN Member States

AMS	Focal Authority	Availability of Country-Specific Emission Factors				Notes
		Energy	IPPU	AFOLU	Waste	
Brunei Darussalam	National Council on Climate Change	Default EFs in 2006 IPCC	Default EFs in 2006 IPCC	Default EFs in 2006 IPCC	Default EFs in 2006 IPCC	Brunei Darussalam's latest (second) national communication to the UNFCCC submitted for the year 2017 indicated the use of default EFs, as CSEFs have yet to be developed.
Cambodia	Department of Climate Change	Default EFs in 2006 IPCC	Cement production	Forestry	Default EFs in 2006 IPCC	Cambodia's BUR submitted to the UNFCCC in 2020 highlighted the availability of CSEFs in subcategories such as cement production (IPPU) and forestry (AFOLU). Also, cement production plants using CSEFs accounted for two-thirds of total national cement plants in Cambodia.
Indonesia	Ministry of Environment	Default EFs in 2006 IPCC	Cement; ammonia production	Livestock (enteric fermentation, manure management)	Default EFs in 2006 IPCC	Based on the latest Indonesia BUR (BUR3) submitted in 2021.
Lao People's Democratic Republic	Department of Climate Change	Default EFs in 2006 IPCC	Default EFs in 2006 IPCC	Default EFs in 2006 IPCC	Default EFs in 2006 IPCC	Based on the Lao People's Democratic Republic's first BUR (BUR1) submitted in 2020, which indicated the use of Tier 1 methodology and default EFs since the CSEFs were not available.
Malaysia	Ministry of Natural Resources and Environmental Sustainability	Default EFs in 2006 IPCC	Cement production	Land use (forest land; remaining cropland)	Palm oil mill effluent (methane emissions)	Malaysia's BUR4, submitted in 2021, indicated the use of Tier 1 methodology and default EFs for almost all categories, except some subcategories with country- or plant-specific EFs. Malaysia plans to develop CSEFs for prioritized subcategories such as (i) energy industries and road transport (energy); (ii) refrigeration and stationary air conditioning, and non-energy products from fuels and solvent (IPPU); (iii) rice cultivation, soil organic carbon, and dead organic matter in forests (AFOLU); and (iv) solid waste disposal, industrial wastewater treatment, and discharge (waste).

continued on next page

Table 2 continued

AMS	Focal Authority	Availability of Country-Specific Emission Factors				Notes
		Energy	IPPU	AFOLU	Waste	
Philippines	Climate Change Commission (CCC)	Default EFs in 2006 IPCC	Default EFs in 2006 IPCC	Default EFs in 2006 IPCC; CSEFs for rice cultivation and forestry	Default EFs in 2006 IPCC	No available CSEFs have been found via public disclosure yet. Per the CCC, the Philippines has used CSEFs for rice cultivation and forestry.
Singapore	Singapore Emission Factors Registry	Oil and natural gas	Cement; semiconductors; petrochemical and carbon production	Land (forest land; settlement)	Various sub-categories (e.g., food waste, material waste)	Based on Singapore's latest BUR (BUR5), submitted in 2022, CSEFs will be developed in phases, with an initial baseline database comprising data collected and consolidated from various government agencies. The database was launched in October 2024.
Thailand	Office of Natural Resources and Environmental Policy and Planning (ONEP)	Default EFs in 2006 IPCC	Cement industry	Default EFs in 2006 IPPC except for livestock; rice cultivation; and land use, land use change, and forestry	Solid waste disposal	The latest BUR (BUR4) was submitted in December 2022. As the focal point, ONEP has worked with other lead agencies in various subcategories to develop CSEFs.
Viet Nam	Ministry of Natural Resources and Environment (MONRE)	No CSEFs in BUR3; Decision 2626 (released in 2022) includes sub-categories that follow Tier 2 of 2006 IPCC	No CSEFs in BUR3; Decision 2626 (released in 2022) includes subcategories that follow Tier 2 of 2006 IPCC	BUR3's only CSEF was for continuously flooded rice fields; Decision 2626 (released in 2022) includes subcategories that follow Tier 2 of 2006 IPCC	No CSEFs in BUR3; Decision 2626 (released in 2022) includes sub-categories that follow Tier 2 of 2006 IPCC	Viet Nam's latest BUR (BUR3), submitted in 2020, included only one CSEF for continuously flooded rice fields with organic amendments (AFOLU). MONRE's Decision No. 2626/QD-BTNMT, released in October 2022, indicated some available EFs using Tier 2 methodology in selected subcategories.

AFOLU = agriculture, forestry, and other land use; AMS = Association of Southeast Asian Nations member state; ASEAN = Association of Southeast Asian Nations, BUR = Biennial Update, Report; CSEF = country-specific emission factor; EF = emission factor; IPCC = Intergovernmental Panel on Climate Change; IPPU = industrial processes and product use; UNFCCC = United Nations Framework Convention on Climate Change.

Notes: Shaded columns indicate not released yet or partially released in some subcategories. The summarized information in this table is intended to provide an overview on the status of each AMS in developing CSEFs. The information was mostly collected from publications in English, such as BURs submitted to the UNFCCC and other relevant publications, with certain limitations in accessing the available information in each AMS' national language. Readers should bear in mind the general purpose of this summary and the potential for incomplete information related to EFs.

Sources: Authors' compilation based on ABMF Secretariat research, BURs submitted to the UNFCCC, and other relevant publications.

Table 3: Grid Emission Factors in Association of Southeast Asian Nations Member States

AMS	Year Released	Grid EFs (tCO_2/MWh)	Source and Notes
Brunei Darussalam	2020	0.5784	Asian Transport Outlook
Cambodia	2012	0.5338	IGES
Indonesia	2021	0.7848	Climate Transparency Report
Lao PDR	2023	0.5048	Asian Transport Outlook
Malaysia	2021	0.7580	MEIH
Philippines	2017	0.7122	DOE
Singapore	2022	0.4168	EMA
Thailand	2021	0.4401	GMO
Viet Nam	2022	0.6766	MONRE (launched in 2024)

AMS = Association of Southeast Asian Nations member state, DOE = Department of Energy (Philippines), EF = emission factor, EMA = Energy Market Authority (Singapore), GMO = Greenhouse Gas Management Organization (Thailand), IGES = Institute for Global Environmental Strategies, Lao PDR = Lao People's Democratic Republic, MEIH = Malaysia Energy Information Hub, MONRE = Ministry of Natural Resources and Environment (Viet Nam), tCO_2/MWh = tons of carbon dioxide per megawatt-hour.
Source: Authors' compilation based on various public sources.

It also launched a database of country-specific EFs (the Singapore Emission Factors Registry) in October 2024. Cambodia, Indonesia, Malaysia, the Philippines, Thailand, and Viet Nam have also developed country-specific EFs in selected subcategories.

Another important piece of data is the grid EF, a critical metric in calculating GHG emissions from electricity consumption. This factor encompasses emissions from all electricity generation sources within the grid, including fossil fuels and renewable energy. The grid EF is essential for calculating Scope 2 emissions, which are the indirect emissions from the consumption of purchased electricity. (All AMS regularly release their grid EFs). **Table 3** provides an indicative list of grid EFs in each AMS, ranging from 0.39 to 0.78 tons of carbon dioxide per megawatt-hour.

Developing Activity Data for Estimations

As the page 4 **Box** shows, estimating GHG emissions necessitates collecting quantitative activity data such as fuel consumption, vehicle mileage, and the quantity of raw materials processed. Implementing real-time monitoring systems can enhance accuracy by continuously capturing data. Alternatively, existing records like utility bills, purchase invoices, and production logs can be utilized. In the absence of direct data, proxies such as industry averages, economic data, and accounting records may be employed.

For SMEs, leveraging accounting data is practical and cost-effective, as such data are typically well-documented and readily accessible. This approach enables activity estimation without the need for

specialized equipment or extensive training. However, such estimations involve assumptions that may not fully reflect actual conditions or the specific characteristics of certain processes or technologies. Additionally, relying solely on accounting data may hinder the identification of potential areas for cost and fuel consumption reductions, which is a significant benefit of comprehensive GHG emissions disclosure. In this regard, SMEs may consider as a next step the Science Based Targets initiative to set science-based GHG reduction targets.[16] The calculated emissions serve as a baseline for setting specific reduction targets. Companies are expected to develop and implement strategies to achieve these targets with proper monitoring over time.

Though it requires a commitment to action and resource investment, the long-term benefits can outweigh the costs.

Leveraging Technology to Address Data Gaps in GHG Emissions Calculation

SMEs face significant challenges in gathering data and calculating their GHG emissions. Advancements in technology offer promising solutions to help bridge data gaps, enabling SMEs to effectively and accurately measure, manage, and report their GHG emissions. Recent years have seen significant growth in technology start-ups offering tools and services to help businesses navigate their ESG regulations, measure and report GHG emissions and other environmental metrics, or even offer sustainability risk analyses.[17]

Advantages of technology adoption. A survey conducted in the United Kingdom and South Africa revealed that SMEs use several ways to leverage technology in enhancing their sustainability efforts by addressing information gaps.[18] Of these, the two most identified roles for technology are (i) helping SMEs track their energy consumption and emissions, and (ii) understanding how to reduce GHG emissions from their technology use. Organizations using automated digital solutions for GHG emissions measurement were 2.2 times more likely to measure emissions comprehensively and nearly 1.9 times more likely to meet their reduction goals.[19]

Efficient and consistent data collection through value chain. Innovative technology for GHG emissions calculation can be leveraged to streamline data collection, data management, and reporting. Unlike traditional methods relying on manual data entry, which can be time-consuming and prone to errors, advanced technologies offer automated, precise data collection, enhancing the accuracy and verifiability of emissions calculations. Regarding data collection, technologies such as the internet-of-things and blockchain platforms can support by directly measuring emissions and electricity consumption without errors, while also preventing fraud and data forgery, enabling digital tracking features for green bonds.[20]

In terms of measurement and reporting, utilizing carbon management software and life cycle inventory databases is essential for companies to measure their GHG emissions across the value chain.[21] Available

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[16] The Science Based Targets initiative is a collaboration among the Carbon Disclosure Project, the United Nations Global Compact, the World Resources Institute, and the World Wide Fund for Nature. It provides a framework for companies to set GHG emissions reduction targets in line with climate science. It offers a tailored standard specifically designed to assist SMEs in setting and achieving science-based GHG reduction targets.

[17] OECD. 2022. *Financing SMEs for Sustainability: Drivers, Constraints and Policies.* https://www.oecd.org/content/dam/oecd/en/publications/reports/2022/12/financing-smes-for-sustainability_19414952/a5e94d92-en.pdf.

[18] Sage, International Chamber of Commerce, and Oxford Economics. 2022. *The Climate Impact of SMEs: Evidence from the UK and South Africa.* https://www.sage.com/en-gb/-/media/files/company/documents/pdf/sustainability-and-society/sage-sme-climate-impact-report-2022.pdf.

[19] Boston Consulting Group. 2022. *Technology Is the Fast Track to Net Zero: Carbon Emissions Survey Report 2022*. https://web-assets.bcg.com/bf/f1/dc3a6786493fbd6b1615b24bd1ab/gamma-ai-emissions-slideshow-221019.pdf.

[20] For instance, innovative technology is being used in data collection by applying internet-of-things technology and a blockchain platform to automatically measure the volume of electricity consumed at buildings, calculate the volume of GHG-avoided emissions and energy reduction versus benchmarks, and disclose such data to investors. Japan Exchange Group. 2023. *Cooperation in the Issuance of Hitachi's Digital Green Bond.* News release. 16 November. https://www.jpx.co.jp/english/corporate/news/news-releases/0060/o4sio7000000273r-att/press_release_en.pdf.

[21] Deloitte. 2023. *Challenges and Solutions in Measuring and Reporting Scope 3 Emissions*. https://www.deloitte.com/content/dam/assets-zone2/nl/en/docs/services/risk-advisory/2024/deloitte-nl-sustainability-challenges-in-measuring-and-reporting-scope-3-emissions.pdf.

carbon management software allows SMEs to seamlessly gather data, measure, manage, and generate their ESG or GHG emissions reports with minimal manual intervention.

Such features can reduce administrative burdens for SMEs. Going beyond measurement, technology adoption within secure data-sharing infrastructure further ensures the efficient and reliable sharing of emissions data along the value chain—including among investors, nongovernment organizations, and nonprofit organizations—promoting transparency, compliance, and strategic management.

Easier and more reliable analysis. To improve the accuracy, consistency, and transparency of emissions reporting, standardized GHG emissions calculation methodology must be applied consistently. It is critical to adopt the GHG Protocol and ISO 14064—which provides guidelines and requirements for quantifying, monitoring, reporting, and verifying GHG emissions and removals—and the IFRS Sustainability Disclosure Standards. Due to SMEs' limited resources, adoption of these practices may not be easy, but for now SMEs can utilize existing software to support their GHG accounting process. This would help align SMEs' GHG accounting with international best practices, with comparability of GHG data across different entities and time periods. Feedback from market practitioners to ABMF Secretariat has emphasized the importance of SMEs in conducting data collection and analysis wherever possible.[22] With the help of available analytical tools, they can adopt established standard practices, use consistent methodologies, maintain transparency, and complete documentation, though the initial results may not be perfect.

How to Support Further Use of Technologies for SMEs' Emissions Calculation

The adoption of technologies for GHG reporting by SMEs remains low. Many SMEs with limited budgets and technical expertise are unable to invest in and operate new technologies, such as internet-of-things infrastructure and cloud services (footnote 17). Besides, they may not know what technological solutions are available and what the potential benefits are. To accelerate technology adoption in SMEs, an awareness campaign highlighting successful cases of SMEs linking emissions tracking to actual cost reduction would be more influential. Public support should be considered, such as financial assistance, affordable tools tailored for SMEs, and an accommodative regulatory environment enabling gradual adoption without high upfront costs for SMEs. In addition, large corporations and financial institutions can play a pivotal role in providing capacity support and affordable technology platforms for data gathering.

In various countries, online platforms with calculation tools and resources have been established to help SMEs understand, measure, and reduce their carbon footprint. For instance, in Malaysia, Bank Negara Malaysia launched the Greening Value Chain program to assist and incentivize Malaysian SMEs in managing their carbon emissions. Through the program, SMEs in Malaysia are given access to technology partners' solutions, allowing them to measure GHG emissions and develop strategies to minimize their environmental impact. Likewise in Denmark, the Danish Business Authority and the Danish Energy Agency launched the Climate Compass tool, a free digital carbon footprint calculator, to help SMEs calculate their emissions based on the GHG Protocol using the latest data regularly updated by Danish authorities (footnote 9).

[22] In 2024, ABMF Secretariat held consultation workshops and meetings with various technology and data providers to collect market practitioners' feedback on the standardization of the GHG calculation process. A webinar on Innovative Technology and GHG Emissions Calculation was organized in May 2024 with the participation of technology solution providers for GHG emissions calculation and reporting such as East Ventures, Ewha Womans University, Galaxy Software Services, Hong Kong University of Science and Technology, Pantas, Thingspire, Zeroboard (Thailand), and Zuno Carbon. ABMF Secretariat also held bilateral meetings with data solution providers such as Climatiq and ESGpedia. Summarized feedback was shared at the 41st ABMF Meeting in Kuala Lumpur, Malaysia, in October 2024, which helped establish the basis for this brief.

Conclusion and Way Forward

The journey toward effective GHG emissions reporting is a collaborative effort that requires continuous improvement and active participation from all stakeholders. It is imperative for SMEs to continuously advance their capacity and awareness. By leveraging available resources and technological solutions, SMEs can address data gaps in GHG emissions calculation and reporting. This preparation is vital for meeting future reporting requirements, building competitive advantages within supply chains, and improving sustainability risk management.

Recognizing the challenges SMEs face—such as limited resources, data deficiencies, and the absence of country-specific EFs—it is important to emphasize progress over perfection in their GHG emissions reporting journey. Financial institutions and large corporations have a pivotal role in driving the entire value chain, including SMEs, toward robust GHG emissions calculation. Their mandates on GHG emissions reporting can significantly motivate SMEs to adopt comprehensive GHG accounting practices. By integrating these practices into their operations and supply chains, financial institutions and large corporations can foster a culture of sustainability and accountability among SMEs.

For emissions estimation, developing standardized EF databases, including country-specific granular EFs, is essential to enhance GHG calculation accuracy, consistency, and transparency. ABMF Secretariat will continue coordinating with relevant stakeholders to enhance the standardization of data and emissions calculation. This collaborative approach will ensure that all stakeholders contribute to global sustainability goals.

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