# Global Database of National GHG Inventory (GHGI) Capacity in Developing Countries

## Development and Assessment of GHGI Capacity Indices

*Key findings, methodology, assessment, and suggestions for future work*

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In collaboration with:

# 1. Key findings

1. Around half of developing countries are in better GHGI capacity status than the other half. The latter will require stronger capacity building actions to implement the Paris Agreement's Enhanced Transparency Framework (ETF).

2. Developing countries improved their GHGI capacity status as they submitted more GHGIs.

3. Latin America and Europe had the highest GHGI capacity status as a region, followed by Asia and Africa. Caribbean and the Pacific regions had, on average, low GHGI capacity.

4. Almost all regions have model countries for others to emulate. The model countries could improve their GHGI capacity status from low to high.

5. Basic national conditions enabled the top GHGI capacity status countries to maintain their high status, including sound government effectiveness, financial condition and statistical and scientific capacity

6. Low GHGI capacity countries require institutional structures, where multiple entities can actively engage, and systems for continuous improvements are in place.

7. Lack of financial resources is unlikely the only reason why some developing countries could not perform well in GHGI submissions. Decent statistical and scientific capacity may have more of influence on performance for some developing countries.

8. Lack of country-specific emission factors (EFs) is a persistent challenge for the majority of developing countries, while other aspects of the quality of GHGIs improved.

9. Data collection efforts need to be strengthened for a more comprehensive global assessment of GHGI capacity.

## 2. Introduction

This document describes the key findings, research methods, assessment results, and suggestions for future work resulting from the compilation of the **Global Database of National GHG Inventory Capacity in Developing Countries**. Principle to this research was the creation of two GHG inventory capacity indices, *GHGI Capacity* and *GHGI Applied*. The two indices can be used to assess the evolving capacity of developing countries to prepare national GHGIs under the United Nations Framework Convention on Climate Change (UNFCCC). *GHGI Capacity* represents the inherent capacity of countries, and is calculated by the sum of three weighted dimensions of nine (9) indicators. These dimensions are labeled as country context, institutional structure, and technical skills and knowledge of individuals. *GHGI Applied* represents the country's capacity that was actually performed through submitted GHGIs. It can be measured by scoring seven (7) indicators of the quality of submitted GHGIs: Promptness, transparency, accuracy, completeness, time-series, recalculation and key category assessment, and uncertainty analysis. By assessing *GHGI Capacity* and *GHGI Applied* for 133 developing countries and across three (3) GHGI submissions, we can trace the evolution of GHGI capacity worldwide in an explicit and quantifiable manner. The assessment results can then inform where and in which dimensions of GHGI capacity additional improvements may be needed in a country to realize the UNFCCC reporting requirements, including under the Paris Agreement's Enhanced Transparency Framework (ETF).

# 3. Methodology

## Data Sources

The core data sources for this research were national communications (NCs) and biennial update reports (BURs), which both include GHGI reporting sections, of non-Annex I countries to the UNFCCC. We refer to non-Annex 1 countries as developing countries within this assessment. Out of 154 developing countries as of March 15, 2019 (UNFCCC, 2019a), 133 countries were selected for the assessment for two reasons. First, they had submitted GHGIs at least twice, namely GHGI1 and GHGI2, as part of their first and second NC. Second, their NCs and BURs were available on-line on the UNFCCC website (UNFCCC, 2019b and 2019c). Of the 133 sample countries, 69 countries had also submitted a more recent GHGI, namely GHGI3+, as part of either their latest NC (NC3, 4 or 5), their latest BUR (BUR1, 2 or 3), or as both their latest NC and BUR. In sum, 369 GHGI reporting sections were assessed for constructing *GHGI Capacity* and *GHGI Applied* for GHGI1, 2 and 3+ across six regions: Africa, Asia, Caribbean, Europe, Latin America, and the Pacific (see Table 1).

**Table 1:** Regional distribution of number of countries and number of GHGIs used in the assessment

| Region | No. Countries | | | No. GHG inventories | | |
|--------|-------|-------|--------|-------|-------|--------|
|        | GHGI1 | GHGI2 | GHGI3+ | GHGI1 | GHGI2 | GHGI3+ |
| Africa | 46 | 46 | 22 | 46 | 46 | 29 |
| Asia   | 31 | 31 | 20 | 31 | 31 | 30 |
| Cari.  | 12 | 12 | 4  | 12 | 12 | 5  |
| Europe | 11 | 11 | 9  | 11 | 11 | 14 |
| LA     | 20 | 20 | 14 | 20 | 20 | 25 |
| Pacif. | 13 | 13 | 0  | 13 | 13 | 0  |
| Total  | 133 | 133 | 69 | 133 | 133 | 103 |

In general, GHGI1, GHGI2 and GHGI3+ were submitted across three distinct GHGI reporting time-periods for GHG1 (1997-2007), GHG2 (2008-2014) and GHGI3+ (2015-2019). In some cases, countries did not fall into these GHGI submission ranges.

Other non-GHGI data sources from the World Bank Group and the UNFCCC were also used for *GHGI Capacity* as follows:

World Bank Group
- Government Effectiveness (2019)
- GDP per capita (2019)
- Researchers in R&D (per million people) (2019)
- Statistical Capacity Indicator (2019)

UNFCCC
- Nominated experts of UNFCCC (2020)

## Steps to develop two indices: *GHGI Capacity* and *GHGI Applied*

The research methodology for constructing the two GHGI capacity indices, *GHGI Capacity* and *GHGI Applied,* expands on Umemiya, et al. (2017), which analyzed GHGI capacity in Asian developing countries. The approach used attributes a value to the GHGI capacity of a country by scoring and combining a set of indicators. The aggregated index score can then be compared across countries and different GHGI submissions. Two notable differences between Umemiya et al. (2017) and the method presented here are: *GHGI Capacity* was compared against *GHGI Applied* to examine the relationship between inherent GHGI capacity (*GHGI Capacity*) and the capacity that was actually performed through submitted GHGIs (*GHGI Applied*) and the geographical scope was expanded worldwide to cover all regions (i.e. Africa, Asia, Caribbean, Europe, Latin America and the Pacific).

Three key steps were involved in developing *GHGI Capacity* and *GHGI Applied*, they include:

1. **Defining the indices**
   a. *GHGI Capacity*
   b. *GHGI Applied*
   c. Expert review
   d. Unavailable data sources and indicators

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**2.** **Creating *GHGI Capacity* and *GHGI Applied***

    **a.** Data collection

        **i.** GHGI

        **ii.** Non-GHGI sources

    **b.** Data scoring

    **c.** Data aggregation

**3. Creating GHGI capacity status categories**

1. Defining the indices

The research team first defined the dimensions of GHGI capacity, for which a preliminary list of criteria and indicators were elaborated based on existing literature (IPCC, 2006 and 2019; IGES, 2019; EPA, 2016 and 2019; UNFCCC, 2014 and 2018; Kawanishi and Fujikura, 2018; Umemiya et al., 2017; Damasa and Elsayed, 2013). Four external experts then reviewed this list. After incorporating expert input, the finalized list of GHGI capacity indices dimensions, criteria, indicators, and data sources were generated for two indices: *GHGI Capacity* and *GHGI Applied* (see Table 2 and Table 3).

1.a *GHGI Capacity*

For this research, *GHGI Capacity* consists of three broad dimensions: 1) *Country Context*, 2) *Institutional Structure*, and 3) *Technical Skills and Knowledge*. *Country context* describes the basic development and demographic conditions a country has for preparing GHGIs, e.g. Gross Domestic Product (GDP), national statistical and scientific capacity. This dimension represents capacity within a country at a system level that is expected to exist regardless of the emergence of climate change issues, including preparation of GHGIs. *Institutional Structure* is a measure of national management systems that specifically influence or allocate for preparing a GHGI, e.g. national climate change policy, institutional roles and responsibilities. Finally, *Technical Skills and Knowledge* measures the capabilities of individuals operating within the institutional structure or country context, necessary for preparing a GHGI, e.g. GHGI compiler understanding of methods or reporting requirements. We assume these three dimensions, combined, represent a country's *GHGI Capacity* at a given point in time:

[*GHGI Capacity*] = [*Country Context*] + [*Institutional Structure*] + [*Technical Skills and Knowledge*]

Each dimension is disaggregated into criteria as the constitutive elements of the dimension. Then, each criterion was assigned indicators as a measure of the criterion (see Table 2).

**Table 2:** *GHGI Capacity* dimensions, criteria, criteria description, and indicator data source

| Dimension | Criteria | Criteria Description | Indicator (Data Source) |
|---|---|---|---|
| 1. Country context | Government effectiveness | The extent of credibility of the government's commitment to policies | Government effectiveness indicator (World Bank, 2019a) |
| | Financial condition | The extent of financial resources available for policies, including for the environment and climate change | GDP per capita (World Bank, 2019b) |
| | Statistical capacity | The extent of availability of quality statistical data | Overall statistical capacity indicator (World Bank, 2019c) |
| | Scientific capacity | The extent of availability of quality scientific data and information | Number of researchers in R&D per millions people (World Bank, 2019d) |
| 2. Institutional structure | Political setting | The extent of legal arrangements for compiling GHGIs under the UNFCCC | Existence of legal/formal arrangements for climate change policies (GHGI) |
| | Coordination | The extent of coordination at the government level for compiling GHGIs | Existence of a single overall coordination body (GHGI) |
| | Interaction of multiple organizations | The extent of involvement of line ministries, agencies and other actors in inventory compilation process | Existence of institutional arrangements involved with line ministries, agencies and other actors (GHGI) |

| | Continuous compilation and improvement | The level of activeness of on-going inventory compilation process and improvement | Existence of QA/QC plan/arrangements and improvement plan (GHGI) |
|---|---|---|---|
| 3. Technical Skills & Knowledge | Understanding of IPCC methods | The extent of technical understanding of inventory compilers and associated staff on IPCC methods | Number of nominated experts to the UNFCCC (UNFCCC, 2020) |

*1.b GHGI Applied*

To examine the relationship of *GHGI Capacity* with the country's applied GHGI capacity that is actually performed through submitted GHGIs we also developed a *GHGI Applied* index. For this index, applied capacity (a single dimension) was examined through a separate set of 5 criteria and 7 indicators (see Table 3).   Essentially, *GHGI Applied* is a measure of the quality of GHGIs, following the principles of the IPCC, e.g. transparency, completeness, consistency, and accuracy (IPCC, 2006). IPCC's quality principle of comparability was not considered, as information provided within submitted GHGIs was insufficient to do so.

**Table 3:** *GHGI Applied* dimension, criteria, criteria description, and indicator data source

| Dimension | Criteria | Criteria Description | Indicator (Data Source) |
|---|---|---|---|
| Applied capacity | Promptness of reporting | The promptness of GHGI submissions by the government | Gap between the latest reporting year and the submission year (GHGI) |
| | Transparency | The level of clarity on understanding how GHGIs were compiled | Level of information provided for methodologies in each sector (GHGI) |
| | Accuracy | The extent of efforts made to remove bias from estimated data | Proportion of country-specific emission/removal factors used in each sector (GHGI) |
| | | | Conductance of key category analysis (KCA) and uncertainty assessment (UA) (GHGI) |

| | | |
|---|---|---|
| Completeness | The coverage of reporting for all relevant categories | Proportion of categories being reported with numerical data in each sector (GHGI) |
| Consistency | The extent of efforts made to estimate data with the same method and data sources and for different years | Application of recalculation (GHGI)<br><br>Availability of consistent annual time-series emissions data (GHGI) |

1.c. Expert review

Four external experts, who have engaged with GHGI preparation in developing countries, reviewed the proposed method to express, in their expert judgment, whether it would likely produce information representative of GHGI capacity. Specifically, the experts were asked to respond to these three points: 1) Review the overall appropriateness of draft methodology in meeting research objectives, 2) Review proposed dimensions, criteria, indicators, and data sources, and describe alternative indicators that could be used and whose data are publicly available, and 3) Provide views on the importance of each dimension to the overall GHGI capacity of a country within *GHGI Capacity* by allocating a total of 100 points across each dimension. The average allocated points (Table 4) were used as weighting of *GHGI Capacity* dimensions (see section 2.c). The research team then incorporated this expert opinion and finalized the methodology.

**Table 4:** Weights expressed by external experts (n=4) for each of the three dimensions in proportion to the overall *GHGI Capacity* given as 1

| *GHGI Capacity* Dimension | Average assigned weights |
|---|---|
| 1. Country Context | 0.31<br>(0.25-0.35) |
| 2. Institutional Structure | 0.44<br>(0.40-0.45) |
| 3. Technical Skills & Knowledge | 0.25<br>(0.20-0.30) |
| Total weighting | 1 |

## 1.d Unavailable data sources and indicators

Expert review also highlighted criteria, indicators and/or data sources that would have further strengthened the research methodology, however, at this point in time these data sets were either not available or not producible within the scope of this research effort. In no particular order, these included:

- Disaggregated information regarding the employment type(s) within institutional arrangements or GHGI compilation teams (e.g. national staff, national consultant or international consultant);
- Disaggregated information regarding the source and allocation of GHGI compilation and reporting funding (e.g. international vs. domestic, and GHGI versus other aspects of climate change reporting); and
- Information on results of capacity building programs that delivered GHGI measurement, reporting, or verification training of individuals by country (e.g. monitoring and evaluation (M&E) of international development GHGI MRV training interventions).

## 2. Creating *GHGI Capacity* and *GHGI Applied*

## 2.a Data collection

Data were then collected from GHGIs and non-GHGI sources.

## 2.a.i GHGIs

Four (4) indicators for *GHGI Capacity* and all seven (7) indicators of *GHGI Applied* were derived from a country's submitted GHGI.

To collect data from submitted GHGIs, the research team developed a template for data collection and scoring. The template was created to make data collection as consistent as possible among researchers. Along with data collection fields, the template also included scoring guidance for researchers to accurately apply scoring criteria (see Table 5). This scoring guidance was important to ensure reproducibility of results and quality control across desk-review researchers. Scoring was made in three levels between 0 and 1, with 1 representing the maximum score and 0 representing the lowest, for 4 indicators

of *GHGI Capacity* and 5 indicators of *GHGI Applied*. For the remaining 2 indicators for *GHGI Applied*, 'Gap between the latest reporting year and the submission year ' and 'Proportion of country-specific emission/removal factors used in each sector ', actual numbers were collected and then normalized in order to garner a score between 0 and 1.

**Table 5:** Example of scoring guidance for desk-review researchers to apply within the data collection template (Example indictor displayed here: Political Setting – the existence of legal/formal arrangements for climate change policies)

| Indicator | Score | Score Description | Guidance to researchers | Example |
|---|---|---|---|---|
| Political Setting | 1 | GHG inventory or NC/BUR system or institutional arrangements defined by law/regulation | At least (1), legal and specific to GHGI or NC/BUR, key word search for law, policy, plan, institution | Prime Minister Decision XXX for GHG inventory or NC/BUR |
| | 0.5 | National climate change policy, action plan, etc. mentioned | At least (1), legal, but general to climate change - may be mitigation or adaptation related key word search for law, policy, plan, institution. Review not only a section of GHG inventory but also a section detailing institutional profile of government and a domestic MRV system. Make sure to check the introductory chapter description of institutional arrangements, "Foreword" and "Acknowledgements". | Climate Change Action Plan |
| | 0 | Others and no data | Does not include or Includes legal, but is not specific to climate. | Environmental Protection Legislation |

<u>Expert validation</u>

To validate the application of indicator data collection and scoring from GHGIs, a randomly selected sample size (n=9) of countries were compared with those of three external experts. As a result, no significant discrepancies in data collection and scoring were found between researchers and external experts. Several suggestions were made, including checking not only the main body of text, but also text within other report sections (e.g. attachments, acknowledgements or forward), as these were identified to also contain information on matters related to policy developments or further explanation on the use of tier 2 and 3 methods. Researchers incorporated and applied these suggestions into final data collection.

2.a.ii Non-GHGI sources

World Bank Group data sets were downloaded and filtered for countries within this study from publically available websites.   The average annual indicator value was then calculated across each GHGI reporting time-period (see section 3, data sources).   In some cases, annual data were not available from the World Bank for each country or for the full range of years within each time period.   In these cases, averages are based on the data that were available for that country and within the specified range.

The historic UNFCCC data set for nominated experts included total number of experts for three specific years (2010, 2015, 2020).   Total number of experts was not known for 2005.   The current 2020 data set also allocated this total number across each country within our research sample. To correlate number of experts per country across each GHGI reporting time-period; we removed 4 outliers [1], calculated the trend and extrapolated for each country across each time period.

2.b. Data scoring

Except for the indicators derived from GHGIs with scores of 0 to 1, data were normalized in order to standardize the indicators expressed in different units into a score between 0 and 1. For this normalization, the minimum and maximum original values of each

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[1] The four outliers were from Brazil, Colombia, Egypt and Republic of Korea, as they had extremely high values for GHGI3.   For research purposes, they were removed before calculating the correlation across time and assigned a "1" for GHGI3 (GHGI1: 0.19, GHGI2: 0.59, and GHGI3: 1) during indicator scoring.

indicator were set across the three GHGI submissions (GHGI1, 2, and 3+) to capture variance not only across countries, but also across submissions ([1]). For the indicator of gap between the latest reporting year and the submission year for *GHGI Applied*, scaling was inversed, because a score should be higher for a smaller value of the indicator ([2]).

[1] Example of normalizing GDP per capita:

Normalized GDP per capita = (Actual value – Minimum value (GHGI1, 2, 3+))/ (Maximum value (GHGI1, 2, 3+) – Minimum value (GHGI1, 2, 3+))

[2] Example of normalizing gap between the latest reporting year and the submission year:

Normalized gap = (Maximum value (GHGI1, 2, 3+) - actual value)/ (Maximum value (GHGI1, 2, 3+) – Minimum value (GHGI1, 2, 3+))

When both the latest NC and the latest BUR were available for GHGI3+, the better GHGI submission score between the two was chosen to represent GHGI3+ within the database.

2.c. Data aggregation

For *GHGI Capacity*, the average indicator scores for each dimension were weighted, based on the experts review (see Table 4), and then aggregated ([3]).

[3] Application of weighting for *GHGI Capacity:*

*GHGI Capacity* = 0.31 × average indicator scores for *Country Context* + 0.44 × average indicator scores for *Institutional Structure* + 0.25 × *Technical Skills and Knowledge*

For *GHGI Applied*, because this index only contained one dimension, average indicator scores were calculated without weighting.

## 3. Creating GHGI capacity status categories

*GHGI Capacity* scores were then divided into four equally distributed categories and assigned four overarching description of GHGI capacity status categories: Limited,

Intermediate, Good and Very Good (see Table 6). The cut-off points were calculated using quartiles from the distribution of *GHGI Capacity* scores across countries and over three GHGI submissions (GHGI1, 2, and 3+). In addition, the status category of "Not submitted" was used when countries did not submit GHGI3+.

**Table 6:** GHGI capacity status categories and the associated *GHGI Capacity* score range defining the 4 quartiles

| GHGI Capacity status categories | Score |
|---|---|
| Limited | 0.169 and below |
| Intermediate | 0.170-0.256 |
| Good | 0.257-0.350 |
| Very good | 0.351 and above |

# 4. Assessment results

An initial assessment of the Global Database of National GHG Inventory Capacity in Developing Countries was conducted.    Nine key findings resulted from the assessment:

**Key finding #1: Around half of developing countries are in better GHGI capacity status than the other half. The latter require stronger capacity building actions to implement the ETF.**

- Out of the 133 developing countries, which submitted at least two GHGIs at the time of this assessment, half of them (n=64) were in higher capacity status ("Good" or "Very good") than the other half, when they submitted their most recent inventory (GHGI3+) (Figure 1). The other half (n=69) was either in a lower capacity status ("Limited" or "Intermediate") for GHGI3+ or they did not submit a GHGI3+.

- When we compared the quality of submitted GHGIs of the two groups, GHGIs of the countries with higher GHGI capacity status had better quality than those of the countries with lower status (Figure 2).
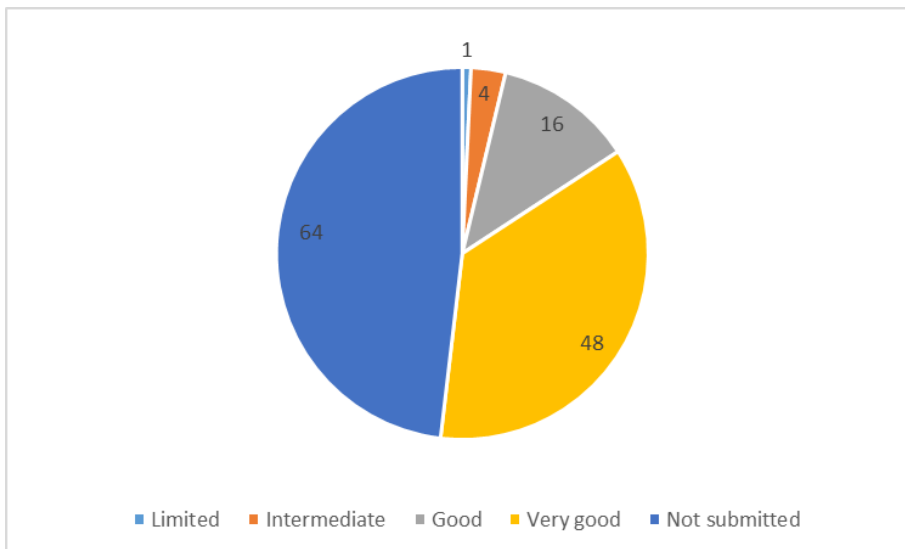
Legend: ■ Limited   ■ Intermediate   ■ Good   ■ Very good   ■ Not submitted

**Figure 1:** Distribution of developing countries with different GHGI capacity status for their latest GHGIs (GHGI3+). Values displayed within the chart indicate number of countries
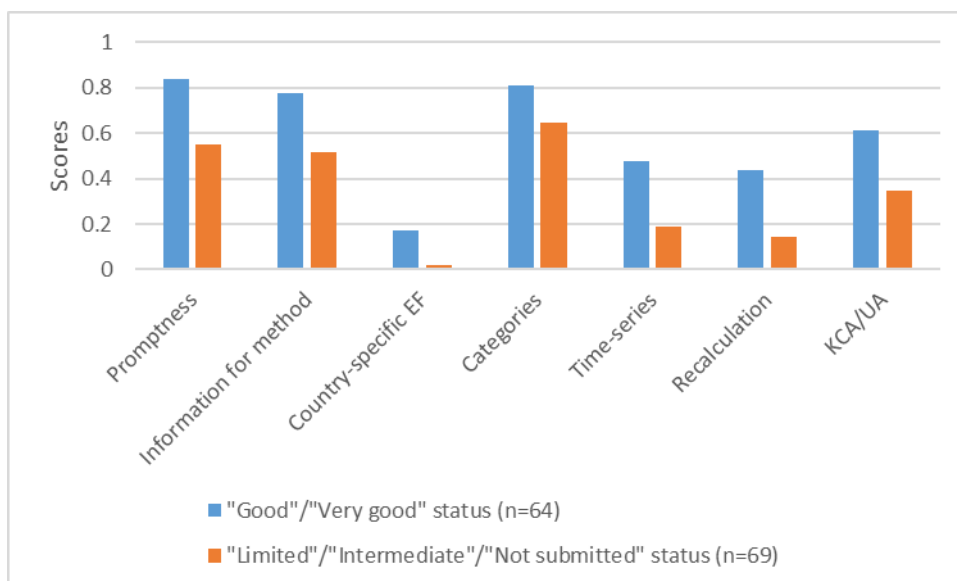
**Figure 2:** Comparison of average scores for 7 indicators within *GHGI Applied* between high status (classified in the assessment as "Good" and "Very good") and low status ("Limited" and "Intermediate") countries for their latest GHGIs (GHGI3+)

**Key finding #2: Developing countries improved their GHGI capacity status as they submitted more GHGIs.**

- Globally, GHGI capacity status improved across submissions, excluding 64 countries that did not submit GHGI3+. 58 countries or 44% of our sample countries were in "Limited" status for GHGI1. A single country of this 44% remained in same status for GHGI3+, while 48 countries (36%) became of "Very good" status for GHGI3+ (Figure 3).

- We found that improvements tended to be more significant between GHGI2 and GHGI3+ than between GHGI1 and GHGI2.

- There were some exceptions of countries that experienced decreasing trends of GHGI capacity status. 11 and 3 countries exhibited lowering trends of GHGI capacity status between GHGI1 and GHGI2 and GHGI2 and GHGI3+, respectively. The main reason for this lowering trend was an observed decrease within the institutional structure dimension of *GHGI Capacity*. Two countries also had decreased scores in the country context dimension, but this influence to overall capacity status was minor.
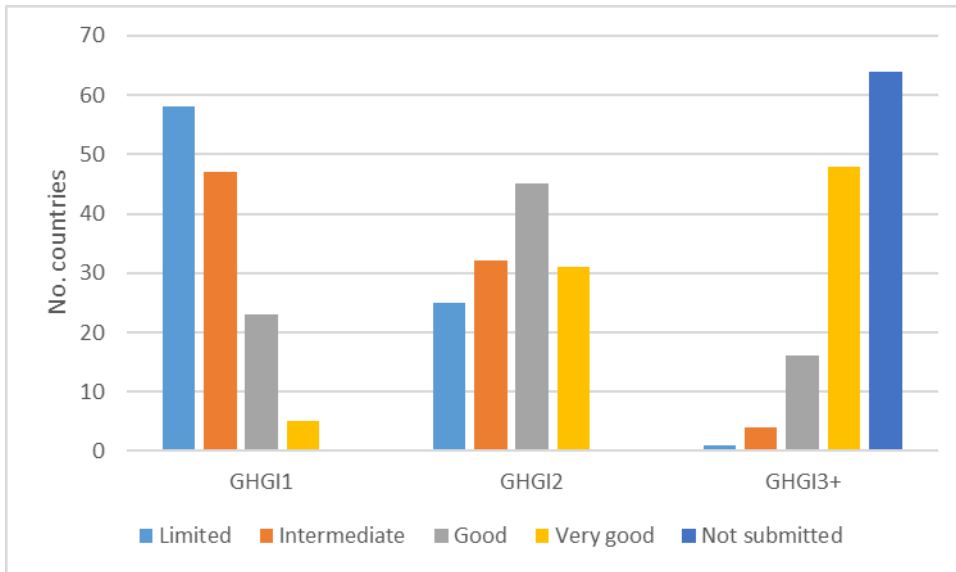
**Figure 3:** Distribution of developing countries with different GHGI capacity status across GHGI submissions

**Key finding #3: Latin America and Europe had the highest GHGI capacity status as a region, followed by Asia and Africa. Caribbean and the Pacific regions had, on average, low GHGI capacity.**

- 80% of countries in Europe and Latin America were already either in "Good" or "Very good" status for GHGI2. More than 50% of countries then became "Very good" status for GHGI3+ in these regions (Table 7).

- 57% of countries in Africa were in "Limited" status for GHGI1. But, no countries were in the same status for GHGI3+, and many countries became in either "Good" or "Very good" (42%). However, 52% of African countries did not yet submit GHGI3+ at the time of this assessment.

- Asian countries generally had the similar trend with Africa, but their improvements were on a faster pace. 61% of countries were in either "Good" or "Very good" for GHGI3+. 35% of countries did not submit GHGI3+.

- Caribbean and the Pacific countries had, on average, the lowest GHGI capacity status, and their capacity improvements were slower than any other regions. The majority (67%) or all of them (100%) did not submit GHGI3+ for Caribbean and the Pacific regions, respectively.

**Table 7:** Absolute number and proportion of countries in different GHGI capacity status across submissions by region

| Region | GHGI1 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Limited | | Intermediate | | Good | | Very good | |
| | Abs | % | Abs | % | Abs | % | Abs | % |
| All | 58 | 44% | 47 | 35% | 23 | 17% | 5 | 4% |
| Africa | 26 | 57% | 12 | 26% | 6 | 13% | 2 | 4% |
| Asia | 11 | 35% | 13 | 42% | 5 | 16% | 2 | 6% |
| Caribbean | 6 | 50% | 3 | 25% | 3 | 25% | 0 | 0% |
| Europe | 3 | 27% | 3 | 27% | 4 | 36% | 1 | 9% |
| Latin Americ | 3 | 15% | 12 | 60% | 5 | 25% | 0 | 0% |
| Pacific | 9 | 69% | 4 | 31% | 0 | 0% | 0 | 0% |

| Region | GHGI2 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Limited | | Intermediate | | Good | | Very good | |
| All | 25 | 19% | 32 | 24% | 45 | 34% | 31 | 23% |
| Africa | 11 | 24% | 12 | 26% | 17 | 37% | 6 | 13% |
| Asia | 3 | 10% | 9 | 29% | 10 | 32% | 9 | 29% |
| Caribbean | 1 | 8% | 4 | 33% | 4 | 33% | 3 | 25% |
| Europe | 2 | 18% | 0 | 0% | 2 | 18% | 7 | 64% |
| Latin Americ | 3 | 15% | 1 | 5% | 10 | 50% | 6 | 30% |
| Pacific | 5 | 38% | 6 | 46% | 2 | 15% | 0 | 0% |

| Region | GHGI3+ | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Limited | | Intermediate | | Good | | Very good | | Not submitted | |
| All | 1 | 1% | 4 | 3% | 16 | 12% | 48 | 36% | 64 | 48% |
| Africa | 0 | 0% | 3 | 7% | 3 | 7% | 16 | 35% | 24 | 52% |
| Asia | 1 | 3% | 0 | 0% | 6 | 19% | 13 | 42% | 11 | 35% |
| Caribbean | 0 | 0% | 1 | 8% | 2 | 17% | 1 | 8% | 8 | 67% |
| Europe | 0 | 0% | 0 | 0% | 1 | 9% | 8 | 73% | 2 | 18% |
| Latin Americ | 0 | 0% | 0 | 0% | 4 | 20% | 10 | 50% | 6 | 30% |
| Pacific | 0 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 13 | 100% |

**Key finding #4: Almost all regions have model countries for others to emulate. The model countries were countries that were able to improve their GHGI capacity status from low to high.**

- We identified five distinguished patterns of GHGI capacity status change across GHGI submissions. The types of patterns are based on the status change from GHGI1 to GHGI2 and/or GHGI3+, and whether or not GHGI3+ was submitted (Table 8).

- The "Improvement growth" group is a group of 46 countries, which improved their GHGI capacity status from low ("Limited" or "Intermediate") to high ("Good" or "Very good") across submissions. This was significantly owed to their improvements with respect to the institutional structure dimension, consisting of sound political setting, overall coordination, engagement of multiple entities and systems for continuous improvement (Figure 4).

- Every region, except for the Pacific region, had countries within this group. These countries can be considered as model countries for others to emulate (Figure 5).

**Table 8:** Five distinguished patterns of GHGI capacity status change

| Pattern name | No. Countries | GHGI capacity status | | GHGI3+ submit |
| --- | --- | --- | --- | --- |
| | | GHGI1 | GHGI2/GHGI3+ | |
| **Low Improvement** | 33 | Limited/Intermediate | Limited/Intermediate | No |
| **Low improvement growth** | 5 | | | Yes |
| **Improvement growth** | 46 | Limited/Intermediate | Good/Very good | Yes |
| **High stability** | 18 | Good/Very good | Good/Very good | Yes |
| **Others** | 31 | Other status changes | | No |

**Figure 4:** Averaged scores of the three *GHGI Capacity* dimensions, by groups of countries with the five patterns across submissions

**Figure 5:** Distribution of five distinguished patterns of GHGI capacity status change across submissions observed in developing countries by region. Values displayed within the charts indicate number of countries

**Key finding #5: Basic national conditions enabled the top GHGI capacity status countries to maintain their high status, including sound government effectiveness, financial condition and statistical and scientific capacity**

- Of the five distinguished patterns of GHGI capacity status change, the "High stability" group included 18 developing countries, which continuously had high GHGI capacity status from GHGI1 to GHGI3+.

- The common characteristics of countries within this group were that they had, on average, high scores in all of the three dimensions of *GHGI Capacity*, especially with respect to country context and technical knowledge and skills (Figure 4).

- Among the country context dimension, scores were higher for all of the four criteria than other groups (Figure 6). Of note, the sharp drop from GHGI2 to GHGI3+ for scientific capacity is largely due to unavailability of data for some countries for GHGI3+.
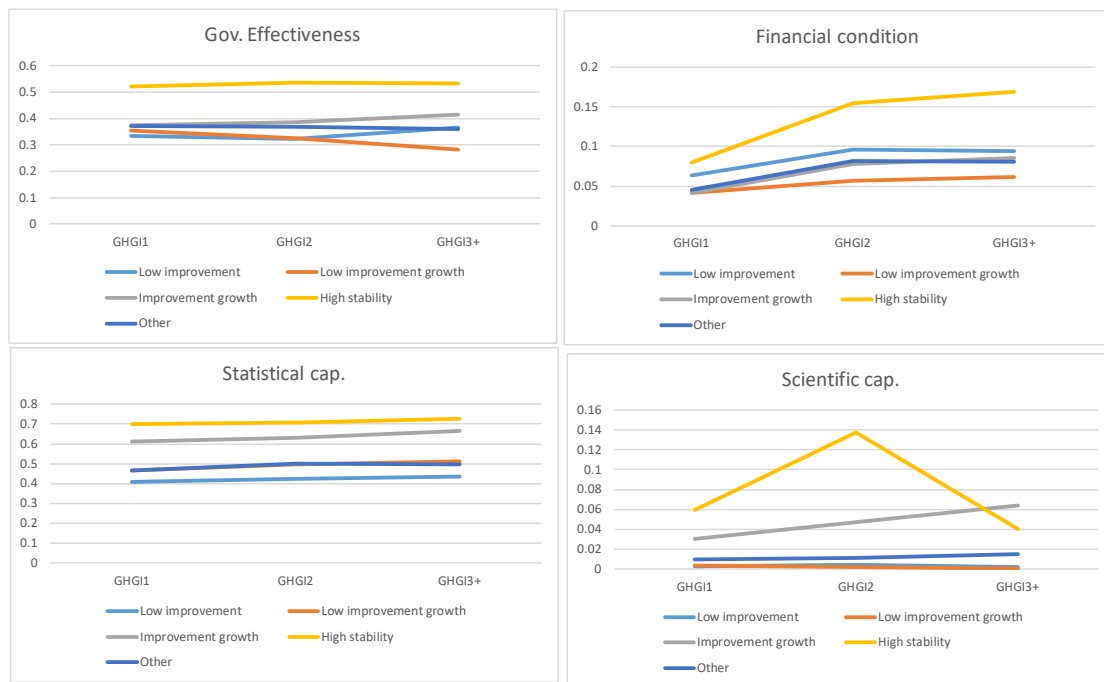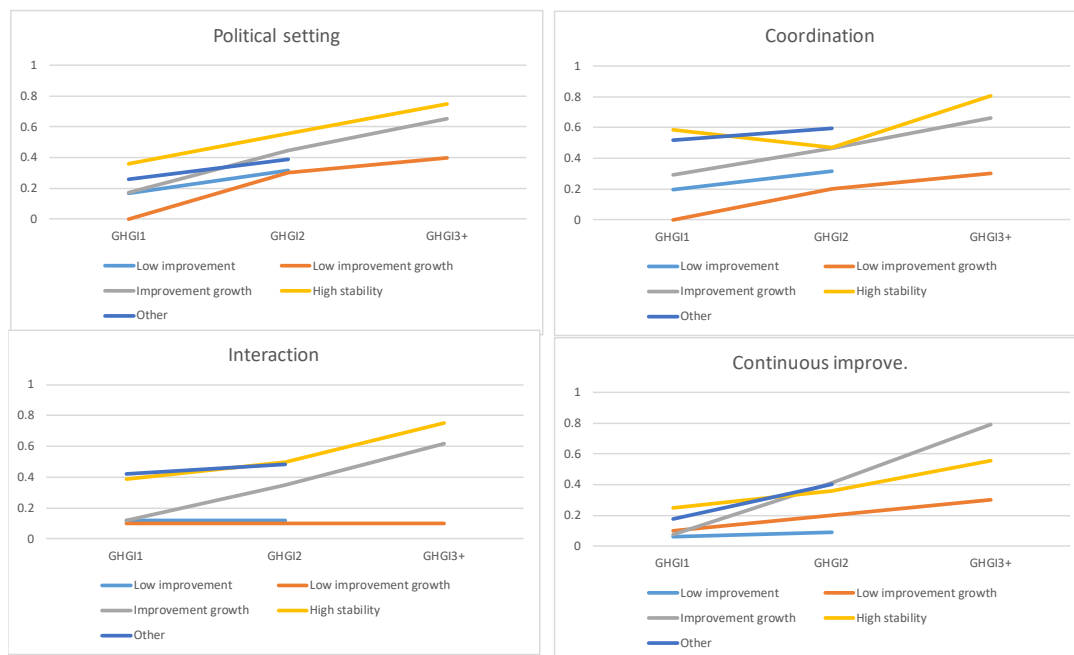


**Figure 6:** Averaged scores of the four *GHGI Capacity* country context criteria, by groups of countries with the five distinguished patterns of GHGI capacity status change across submissions

In collaboration with:

**Key finding #6: Low GHGI capacity status countries require institutional structures, where multiple entities can actively engage, and systems for continuous improvements are in place.**

- The major difference between the "Improvement growth" group and "Low improvement/Low improvement growth" groups was that while the former steadily improved their institutional structures across submissions, the latter had smaller increases (Figure 4).

- Within the institutional structures, "Low improvement/Low improvement growth" groups showed particularly weak scores with respect to interactions of multiple entities and systems for continuous improvements in inventory preparation processes. This group demonstrates a need to address these issues in order to improve the overall capacity (Figure 7).



**Figure 7:** Averaged scores of the four *GHGI Capacity* institutional structure criteria, by groups of countries with the five distinguished patterns of GHGI capacity status change across submissions

**Key finding #7: Lack of financial resources is unlikely the only reason why some developing countries could not perform well in GHGI submissions. Decent statistical and scientific capacity may have more of influence on performance for some developing countries.**

- Within the *GHGI Capacity* dimension of country context, averaged scores for the criteria of financial condition was higher for "Low improvement" group than "Improvement growth" group (Figure 6). This implies that lack of financial resources might not be the only reason why some developing countries could not perform well in GHGI submissions.

- The "Improvement growth" group had, on average, clearly higher scores in statistical and scientific capacity than "Low improvement" or "Low improvement growth" group. These may have stronger influence on GHGI capacity for some developing countries that struggled to perform well in GHGI submissions.

**Key finding #8: Lack of country-specific emission factors (EFs) is a persistent challenge for the majority of developing countries, while other aspects of the quality of GHGIs improved.**

- Among the *GHGI Applied* criteria, the country-specific emission factors (EFs) used in estimation showed modest scores across submissions, even for the "High stability" group (Figure 8).
- Both "High stability" and "Improvement growth" groups performed better for promptness, time-series, recalculations and KCA/UA.
- There were no significant differences among groups with the five distinguished patterns of GHGI capacity status change for information provided for methodologies and categories reported with numerical data.
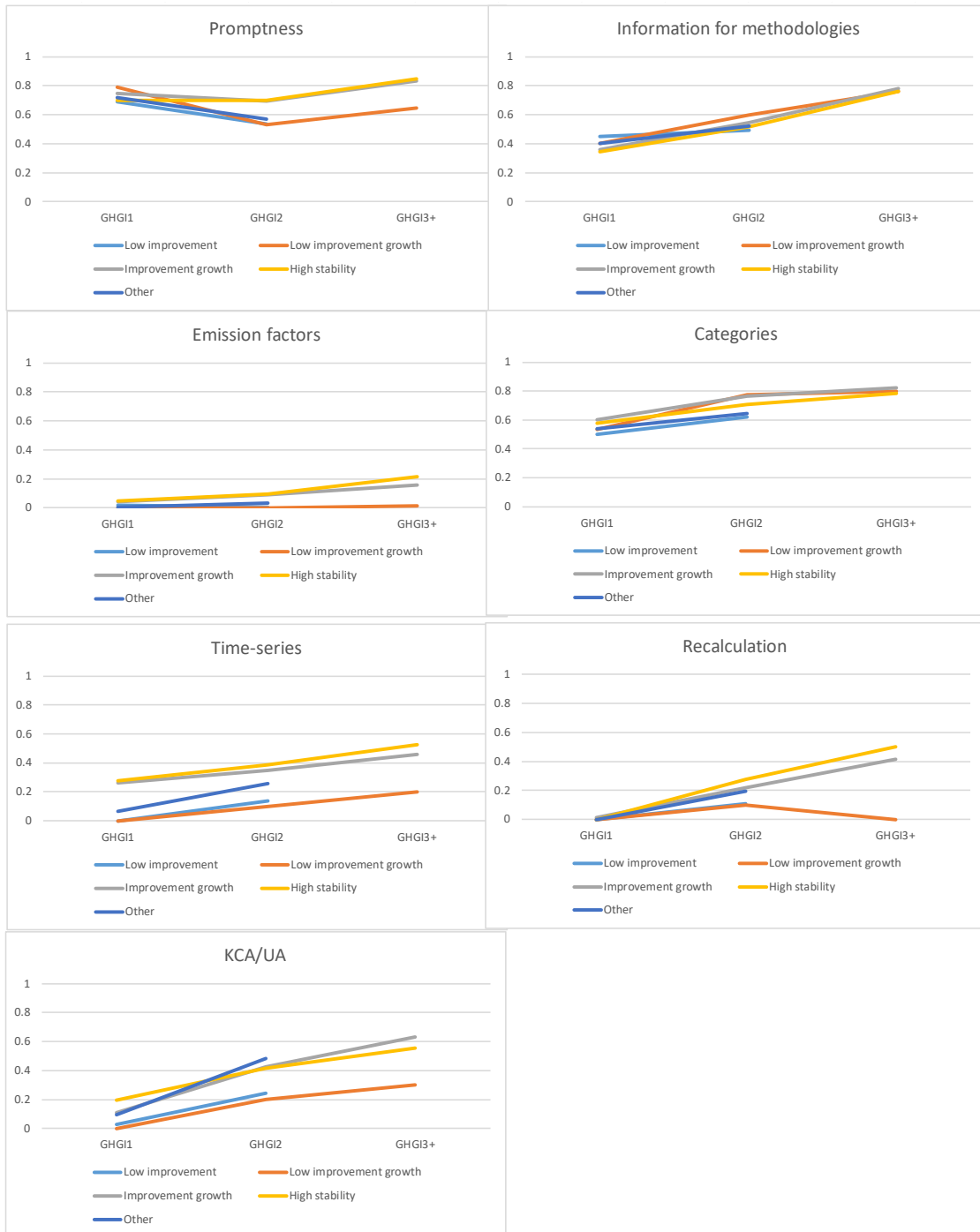
**Figure 8:** Averaged scores of the seven *GHG Applied* criteria, by groups of countries with the five distinguished patterns of GHGI capacity status change across submissions

**Key finding #9: Data collection efforts need to be strengthened for a more comprehensive global assessment of GHGI capacity.**

- This assessment was unable to fully develop indicators for the following three desired *GHGI Capacity* criteria recommended by external experts, due to a lack of publicly available indicator data sources:

    i) Dependence on international consultants vs. country staff,

    ii) Availability of domestic funding allocation, and

    iii) Access to capacity building programs. Additionally, data on the number of certified experts per country for GHGIs under the UNFCCC was only available for GHGI3+, therefore data within GHGI Capacity was extrapolated for earlier GHGI reporting time-periods.

- This assessment was based on publicly available data sources, including a country's submitted GHGI within their NC, BUR, or in some cases, full GHGI report. We recognize the possibility that a country's real situation with respect to various indicators used in the assessment may differ from what is reported.

- Fulfilling these important data gaps will allow for a more comprehensive future assessment. For example, there were 31 countries classified as an "Other" pattern in our assessment, which did not fall into any other pattern (Table 1Table 8). Although they exhibited a relatively high GHGI capacity, they did not perform well in their actual submissions. Further investigation of this group can be progressed, when more refined data become available.

# 5. Suggestions for Future Capacity Building Actions and Research

**For Donors:**

- **Overall direction of support:**
    - Prioritizing support for developing countries classified as "low improvement" and "others" in the assessment (Table 8)
    - Checking with the UNFCCC Consultative Group of Experts (CGE) if the low usage of country-specific emission factors (EFs) by developing countries is an issue to address, and if yes, how it should be addressed under the ETF

- **Monitoring and evaluation (M&E):**
    - Activating international discussions around developing a framework for monitoring GHGI capacity, including key criteria (outcomes) and indicators
    - Accelerating data collection efforts for monitoring GHGI capacity globally, improving both the level and efficiency for M&E to occur across programs of support
    - Researching and disseminating guidance for project-level M&E of GHG MRV capacity building actions

- **ETF implementation:**
    - Considering how developing countries with existing low GHGI capacity status should prepare for implementation of the ETF in 2024 and onwards, and how they should increase necessary capacity building actions, including access to support
    - Considering how to link the outcomes of capacity building needs identification by developing countries under the ETF with subsequent capacity building actions and support
    - Considering how to inform global stocktake of GHGI capacity status changes (or more broadly transparency, including GHGI) every five years

**For Implementing Agencies and Capacity Building Practitioners:**

- **Capacity building approaches:**
    - Tailoring innovative and effective approaches suitable for different groups of developing countries, which have demonstrated different capacity status patterns of change
    - Making use of the active roles of the regional GHGI capacity leader/model countries

- **Evidence-based practices:**
  - Evaluating historic and ongoing capacity building actions and support
  - Widely sharing good examples, which made significant contributions. Costs vs. resulting capacity might be an interesting topic to explore.

**For Researchers:**
  - Investigating country-specific case studies for each of the five distinguished patterns of GHGI capacity status changes
  - Investigating why countries classified as "others" did not perform well in GHGI submissions, even though they seemed to have good potential GHGI capacity
  - Global comparative study assessing the long-term impacts of historic capacity building interventions to evaluate what worked and what didn't work
  - Estimating realistic expectations of GHGI submissions from developing countries by 2024 under the ETF and implications for tracking implementations of NDCs

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