

Climate change mitigation Policy Progression Indicator (C-PPI)

--a tool for measuring progression of climate change mitigation at the national level

ver.4: What can we learn from **6** Outcome Indicators that measure climate mitigation progress of the G20 countries?

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See our website <http://www-iam.nies.go.jp/climatepolicy/cppi/index.html>

Summary

The aim of this paper is to utilize the six Outcome Indicators developed in our previous discussion papers to measure the progress of GHG emission mitigation policies of the G20 countries. The indicators are listed in Table i and were chosen to measure progress in achieving four common intermediary goals that need to be addressed by all countries.

Table i. Six Outcome Indicators and corresponding equity considerations

Goals	Outcome indicators	Equity consideration
Goal 1. Decarbonization of energy	1. CO ₂ emission/Total Primary Energy Supply(TPES)	Developed countries should aim at lower levels than developing countries.
	2. Renewable energy supply/TPES	Developed countries should aim at higher levels than developing countries.
Goal 2. Improvement of energy efficiency	3. Final energy consumption / Gross Domestic Products (GDP)	Developed countries should aim at lower levels than developing countries
Goal 3. Minimizing the demand for energy service	4. Final energy consumption / capita	Developing countries could increase the rate up to a certain level, and then start declining it.
Goal 4: Non-CO ₂ gases and sequestration by forests	5. Non-CO ₂ GHGs / capita	Geographic and climatic circumstances shall be taken into account.
	6. Rate of change of forest coverage	Geographic circumstances shall be taken into account.

Obtaining the data on population and energy use for all G20 countries was initially expected to be difficult, but most of the data were actually available in various sources. Although the Outcome Indicators were created to consider equity between developed and less developed countries (Table i), only Goals 2 and 3 (Indicators 3 and 4) were observed to need such consideration. The other goals and indicators reflected other initial circumstances of the various countries.

The Outcome Indicators were effective in visualizing the progress of each country toward achieving its respective goals in the past decade. Some countries have made more progress than others, presumably by implementing relevant policies. Analyses of these countries' submitted Nationally Determined Contributions (NDCs) for years around 2025-2030 suggested that the levels are ambitious enough in some areas in some countries, but more could be done in other areas. It will be worthwhile to study each country more closely and determine under which goals they could make additional efforts to develop more ambitious emission reduction targets.

The next step for the C-PPI project is to focus on the previously developed Action Indicators for the G20 countries. The indicators consist of 37 policies that are effective in improving levels under one of the four goals. The Outcome Indicators identified countries that were able to perform well as compared to others. By searching for policies that enabled such improvements, these policies could be recommended as examples of success stories for other countries to follow.

1. Objective

The Paris Agreement calls for all countries to prepare, communicate, and maintain successive nationally determined contributions (NDCs) and pursue domestic mitigation measures with the aim of achieving the objectives of such contributions (Article 4.2). Emission targets are not legally binding by nature. Rather, countries are expected to follow a circular process of preparing NDCs, implementing policies and measures to fulfill them, and then periodically reviewing and evaluating whether they are making enough progress to achieve them, with the ultimate long-term goal of balancing anthropogenic emissions and sequestrations of greenhouse gases (GHGs). Thus, methodologies to assess policy implementation have become increasingly important, especially for the post-2020 period.

The Climate change mitigation Policy Progression Indicator (C-PPI) is a tool developed to measure progress towards climate change mitigation at the national level. Our earlier discussion papers (ver. 1,2, and 3) explain the C-PPI's structure in detail. (<http://www-iam.nies.go.jp/climatepolicy/cppi/index.html>). This paper utilizes one of the two types of developed indicators, Outcome Indicators, to assess progress in GHG emission mitigation efforts in G20 member countries. The six Outcome Indicators encompass four intermediate goals that need to be shared by all countries if the world is going to achieve net-zero GHG emissions by the end of this century.

2. C-PPI Outcome Indicators

The purpose of the Outcome Indicators is to assess the status of countries with respect to their achievement of actual GHG emissions reductions by comparing emissions data with those of other countries as well as by comparing each country's current data with its own past data. These indicators show the actual status of energy use and emissions independent of any policy efforts taken by the countries.

Although GHG emission sources vary from one country to another and factors behind emission growth and reduction differ tremendously among countries, four common goals need to be shared by all countries if the world is going to achieve the long-term temperature increase goal of either 2 °C or 1.5 °C. Because fossil fuel combustion is the central issue that needs to be addressed to mitigate climate change in the long run, the first three goals are related to energy use: decarbonization of energy, improvement of energy efficiency, and minimizing demand for energy service. The fourth deals with non-CO₂ GHG gases and land-use change. The six Outcome Indicators were chosen to reflect progress towards these four intermediate goals (Table 1).

Table 1. The six Outcome Indicators and the corresponding equity considerations

Goals	Outcome indicators	Equity consideration
Goal 1. Decarbonization of energy	1. CO ₂ emission/Total Primary Energy Supply(TPES)	Developed countries should aim at lower levels than developing countries.
	2. Renewable energy supply/TPES	Developed countries should aim at higher levels than developing countries.
Goal 2. Improvement of energy efficiency	3. Final energy consumption / Gross Domestic Products (GDP)	Developed countries should aim at lower levels than developing countries
Goal 3. Minimizing the demand for energy service	4. Final energy consumption / capita	Developing countries could increase the rate up to a certain level, and then start declining it.
Goal 4: Non-CO ₂ gases and sequestration by forests	5. non-CO ₂ GHGs / capita	Geographic and climatic circumstances shall be taken into account.
	6. Rate of change of forest coverage	Geographic circumstances shall be taken into account.

The indicators measure two timeframes. The first timeframe, PS, represents a time between the past (P, such as a decade ago) and the current status (S, today). The second timeframe, SF, represents a time between the current status (today) and the future (F, such as a decade from now). The year 2005 was selected as P, 2015 as S, and 2025 as F, for this study. The C-PPI will be updated and recalculated every 5 years; consequently, the three time reference points (P, S, and F) will shift by 5 years at each assessment.

3. Methodology

3-1 Categorization of G20 countries

The G20 countries together generate about 80% of global GHG emissions. Taking a close look at these countries' progress towards developing low emission economies is useful not only because of their absolute share of emissions within the global total, but also because other countries may see the G20 countries as examples. Even though the G20 countries are considered to be relatively economically powerful, there are wide gaps among the countries in terms of level of economic development. To see the relationship between level of economic development and level of achievement on the six Outcome Indicators, we categorized the G20 countries into three groups on the basis of per capita GDP in 2010 (Table 2). Korea, Mexico and Turkey are OECD countries, but categorization in this study was conducted simply by per capita GDP. Differences that could be observed among the three groups need to be taken into account from equity perspective when we make any assessments over level of achievement.

Table 2. Categorization of G20 countries

Group (per capita GDP in 2010)	Countries
1 Wealthy (more than US\$35,000)	Australia, Canada, France, Germany, Italy, Japan, United Kingdom, United States
2 Medium (between US\$ 10,000 and 22,000)	Argentina, Brazil, Rep. of Korea, Russian Federation, Saudi Arabia, Turkey
3. Emerging economy (less than US\$8,000)	China, India, Indonesia, Mexico, South Africa

Note: GDP is in real term, using average exchange rate of 2010)

3-2 Calculation of indicators

Data availability was expected to be problematic at the start of the study, but most of data required to calculate the six indicators were available online. For data that were unavailable, current conditions were assumed to continue into the future or a common value was shared among countries that had a similar level of economic development.

CO₂ and other GHG emission data for past years were obtained from the OECD website (OECD, 2017a). Submissions of NDCs were used to fix emissions for the year 2025 (UNFCCC, 2017). CO₂ emissions include only those from fossil fuel combustion.

Population data for past years and estimates for the year 2025 were obtained from the World Bank (2017a).

Data for the primary energy supply as well as the supply of renewable energy for past years were from OECD (2017b). Renewable energy in this study included large-scale hydropower. Estimated future data were from the World Energy Outlook 2015 (IEA, 2015) for countries that were considered in that report.

For countries that were not in the report, we used data from other countries in the same economic development grouping (Table 2) to estimate the growth of the energy supply between 2015 and 2025. Prospects for renewable energy were also found in the NDC submissions of many countries.

Per capita energy consumption data for past years were obtained from World Bank (2017b). A similar methodology as that used to estimate energy supply was used to estimate future changes in per capita energy consumption.

World Bank (2017c) data were used for gross domestic product (GDP) for past years, and future GDP estimates were from OECD (2017c).

Data for forest coverage in past years were found in World Bank (2017d). The current level was assumed to continue for future estimates unless otherwise stated in the NDC submission of the country.

4. Results

4-1 Goal 1 Decarbonization of energy

Two Outcome Indicators measure progress under Goal 1.

Indicator 1 is CO₂ emission per total primary energy supply (Figure 1), with a downward trend being anticipated for all countries. Notably, there is little difference between the absolute levels of the three groups, meaning the intensity of carbon in the energy supply is not very related to the level of economic development. In the past decade, improvements were observed in Australia, France, Turkey, Russia, and Indonesia. It would be worthwhile to see if the improvements were a result of successful policy implementations. A notable worsening of the rate is evident in Japan after 2011 because of the severe earthquake and tsunami that led Japan to halt operations at all of its nuclear power plants.

There is a difference in the future targets of Group 1 and those of the other groups. Countries in Group 1 aim at improving (decreasing) the rate towards 2025, but the target is an increased rate in many countries in the other two groups. This projected increase is mainly due to the rapid increase in energy demand in these countries and the fact that coal-fired power plants are expected to be used to meet the demand. Countries in Groups 2 and 3 could aim at more stringent NDCs if they were able to obtain support to introduce non-fossil fuel energy sources to meet their growing energy demand.

Indicator 2 is the share of renewable energy within the total energy supply (Figure 2). An upward trend is anticipated for all countries. Again, there is little difference between the absolute levels of the three groups, which means that the potential for renewable energy use is determined more by geological or other circumstances than by level of economic development.

In the past decade, improvements were observed in Italy, Germany, and the United Kingdom. These improvements were clearly due to policies that pushed the rapid introduction of renewable energy sources, as was analyzed in our previous discussion paper. Meanwhile, a worsening trend was observed in Brazil, India, and China. For these countries, the rate is decreasing because new coal-fired power plants are being built to meet an increasing demand for energy. Renewable energy facilities are also increasing, but pace of increase in energy demand was faster than the renewable energy deployment rate, and the rest had to be met by fossil fuel fire power plants. A reduction in the use of traditional biomass is another reason for the decreasing rate in China and India.

Most countries in all groups aim at improving the rate by 2025. As the cost of renewable energy declines, the actual rates could surpass some of modest target rates.

Figure 1. Outcome Indicator 1: CO₂ emission (tCO₂) /total energy supply (tonne oil equivalent (toe))

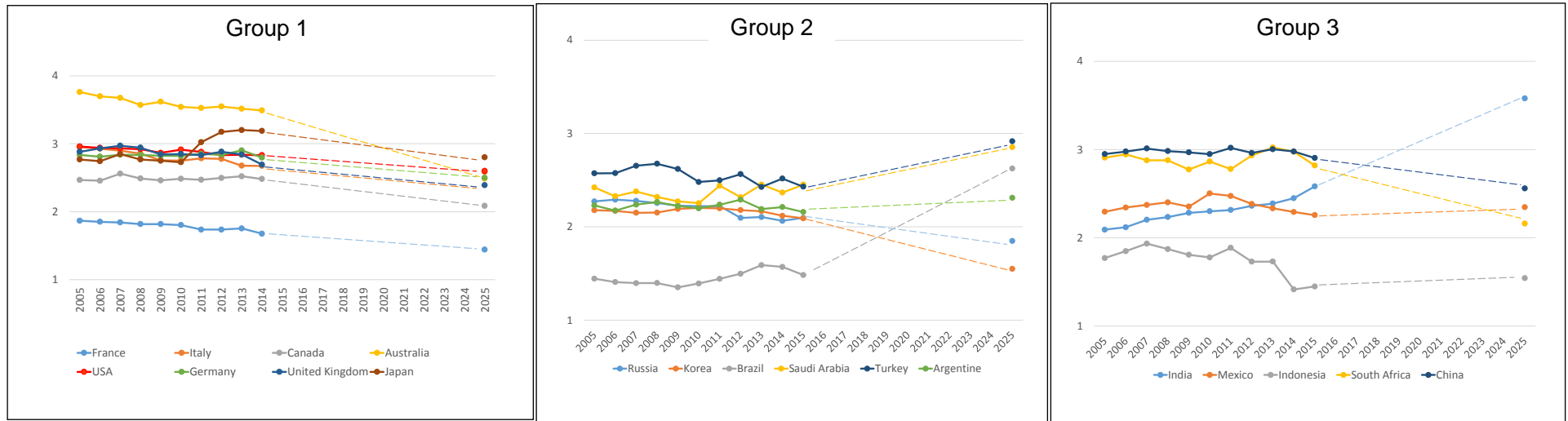
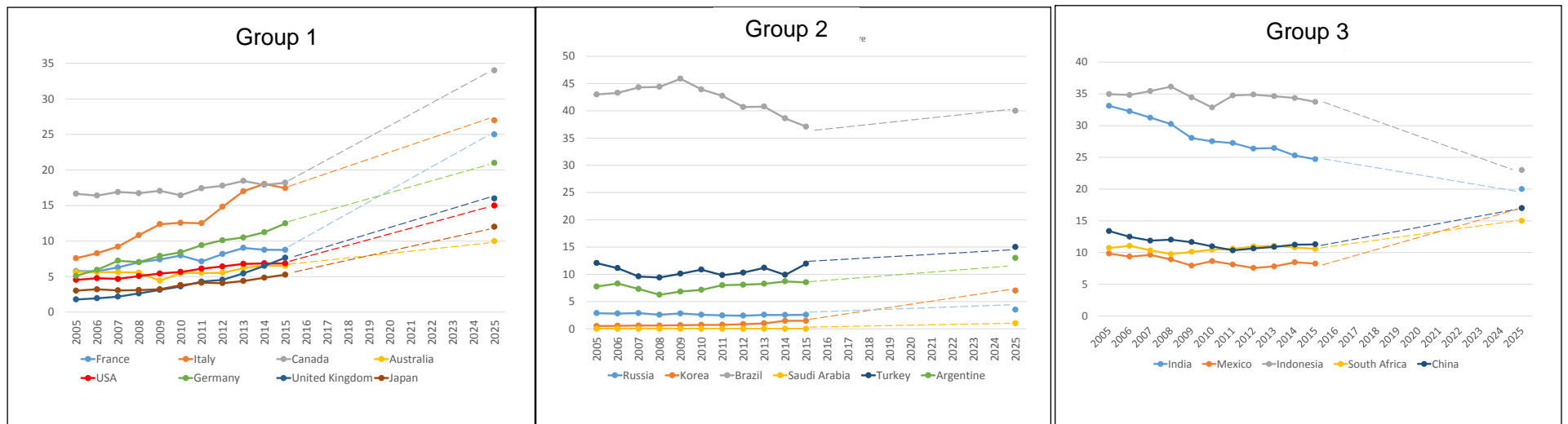


Figure 2. Outcome Indicator 2: Renewable energy supply/total energy supply (%)



4-2 Goal 2 Improvements of energy efficiency

Indicator 3, final energy consumption per GDP, measures progress for Goal 2 (Figure 3), with a downward trend anticipated for all countries. Unlike the indicators for Goal 1, there is a striking difference between the levels of Group 1 and those in the other two groups. Group 1 has lower energy consumption per GDP, whereas Groups 2 and 3 are at a similar but much higher level. This means that the wealthiest countries are clearly doing better in terms of utilization of energy in the most efficient manner, but those in Group 2, although relatively wealthier than those in Group 3, do not appear to be putting much effort into improving energy efficiency.

In the past decade, improvements have been observed in many countries, particularly in the United States, Canada, Australia, Russia, Argentina, China, India, and Indonesia. On the other hand, improvements were almost stalled in recent years in some countries such as Japan, France, Korea, Turkey, and Mexico. Unstable trends were seen in some countries, such as Australia, Saudi Arabia, Russia, and South Africa. This instability could be at least partially due to fluctuations in the exchange rate against the US dollar, which alter the ratio independent of actual improvements in energy efficiency. It is worthwhile to see if the differences between countries were due to implementation of relevant policies.

The future target rates in all countries are expected to improve, but the speed of improvement is too slow to achieve the long-term target. Countries in all groups could, and should, aim at more ambitious targets. For instance, countries in Group 2 and 3 could enjoy twice or three times as much GDP without increasing their energy use if they achieved the Group 1 countries' current level by 2025.

4-3 Goal 3 Minimizing the demand for energy service

Indicator 4, per capita final energy consumption, measures progress for Goal 3 (Figure 4), and a downward trend is anticipated for all countries. Generally speaking, there is a huge gap between the absolute levels of consumption in Groups 1 and 2 as compared with those in Group 3. This means that energy use per person in some Group 2 countries has already reached the level of countries in Group 1, whereas per capita consumption of energy is still relatively small in almost all of the countries in Group 3.

In the past decade, improvements were observed in all Group 1 countries, but the level has been worsening in countries in Group 2 and 3. From an equity perspective, countries in Group 3 may have the right to increase their per capita energy use to materialize sustainable development, but this is not the case for countries in Groups 1 and 2. Note that the countries that have the worst performances compared to other countries within the same group are resource rich. The United States, Canada, Australia, Saudi Arabia, Russia, and South Africa, are countries that have much fossil fuel reserves, leading to bearing stronger political objections against setting limits on energy use. Thus, these countries have relatively more potential than other countries in their respective groups to increase their rate of improvement on this indicator.

Looking to the future, most countries have aimed at targets that either make the situation worse or make negligible improvements. All countries, particularly those in Groups 1 and 2, need to set more ambitious targets to minimize the per capita use of energy. All countries in Group 1 should consider targeting the Italian level in 2025. On the one hand, countries such as Japan and Germany expect downward trend in their respective population sizes, and will have harder time improving "per-capita" type of indicator. It would be important for these countries to develop shrinking communities in a sustainable way. On the other hand, many countries in Group 3 foresee additional population increase in the future. It is an advantage to improve rating of this indicator, but should be aware that improving the rating by population increase is not a solution to the climate change problem.

Figure 3. Outcome Indicator 3: Final energy consumption/GDP (toe/thousand USD)

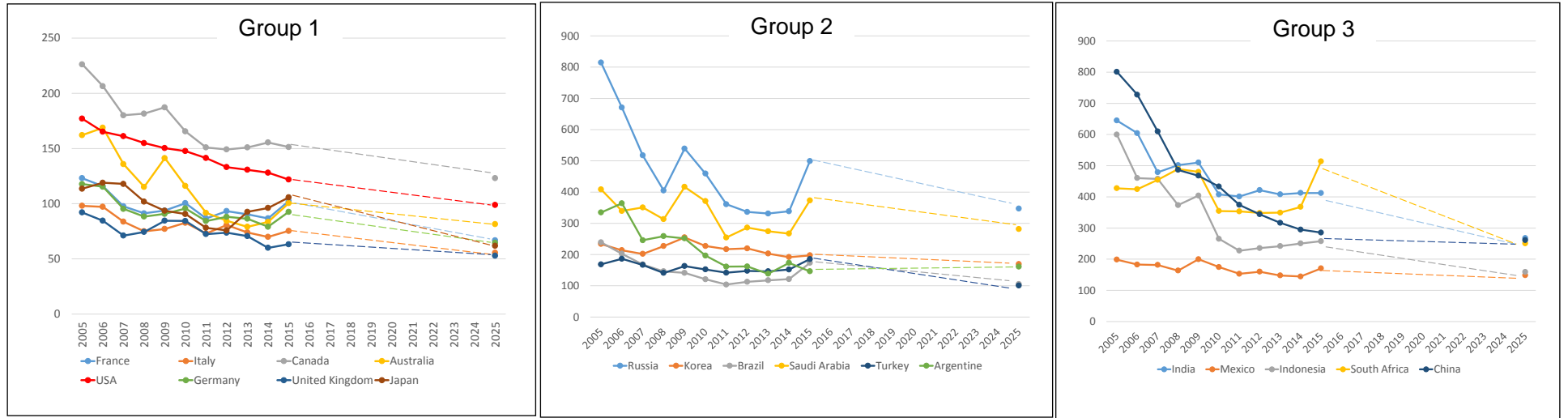
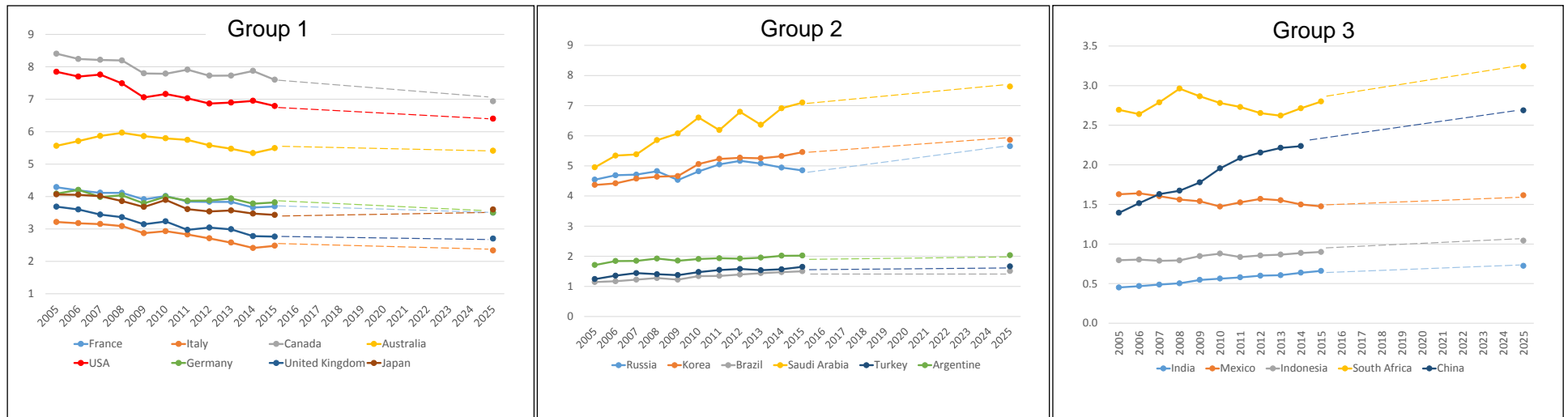


Figure 4. Outcome Indicator 4: Final energy consumption/capita (toe/capita)



4-4 Goal 4 Non-CO₂ gases and sequestration by forests

Two Outcome Indicators measure progress under Goal 4.

Indicator 5 looks at emissions of non-CO₂ GHGs such as methane and F-gases (Figure 5), and a downward trend is anticipated for all countries. Methane is emitted independent of the level of economic development of a country and is generally related to mining industries and agriculture. Australia, Canada, the United States, Russia, and Mexico all emit a great deal of fugitive methane from fossil fuel extraction sites and need to address this problem with relevant policies and technologies. Countries that rely on landfill sites in waste management sector are likely to emit more methane from the sector than other countries.

Emissions of F-gases such as HFCs have a high global warming potential, but their share as a proportion of non-GHG emissions is small in most countries. More efforts could be made to reduce emissions in industrialized countries with a relatively high share of F-gases. The Kigali Amendment to the Montreal Protocol to protect ozone layer, adopted in 2016, was a success to phase down production of HFCs. Countries' F-gas emissions could be affected by such agreement outside the UNFCCC arena.

Most countries have not clarified future targets for non-CO₂ gases, so the estimates in Figure 5 for 2025 are tentative. All countries should be urged to report future targets for non-CO₂ GHG gases, separately from the total GHG emissions.

Indicator 6 deals with forest coverage (Figure 6). An upward trend, or retention of positive figures, is anticipated for all countries. The initial level of coverage rate differs from one country to another depending on climatic and other national circumstances, so the indicator monitors changes in the rate of coverage rather than the absolute size of forest area. There is no gap in the rating levels among the three groups.

In the past decade, sustenance of positive rates were observed in France, Italy, the United Kingdom, Turkey, China, and India. All of these countries have implemented policies to support forest conservation and enlargement of forest area. Meanwhile, continuation of negative rates was observed in Australia, Argentina, Brazil, Mexico, and Indonesia. These countries are still struggling to prevent further deforestation activities, both legal and illegal. Among these countries, only Australia succeeded in reversing its trend from deforestation to reforestation during this period.

All of the countries currently experiencing decreasing trends have set 2025 targets that reverse the trend. Many countries do not explicitly address targets for forest coverage by 2025. Based on limited information, almost no change is expected in countries such as Japan, Saudi Arabia, and South Africa. An increase of sequestration capacity is indispensable to reach net-zero emissions by the end of this century; thus, more attention should be paid to improve forest coverage rates moving into the future. Again, all countries should set separate NDCs for forest coverage.

Figure 5. Non-CO₂ GHG emission (tCO₂eq./capita)

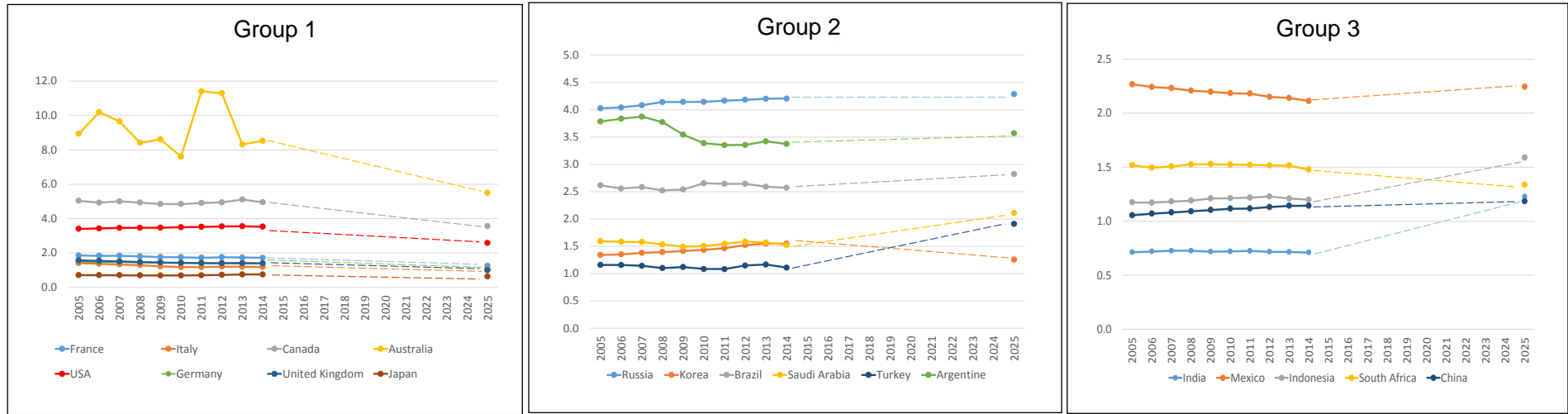
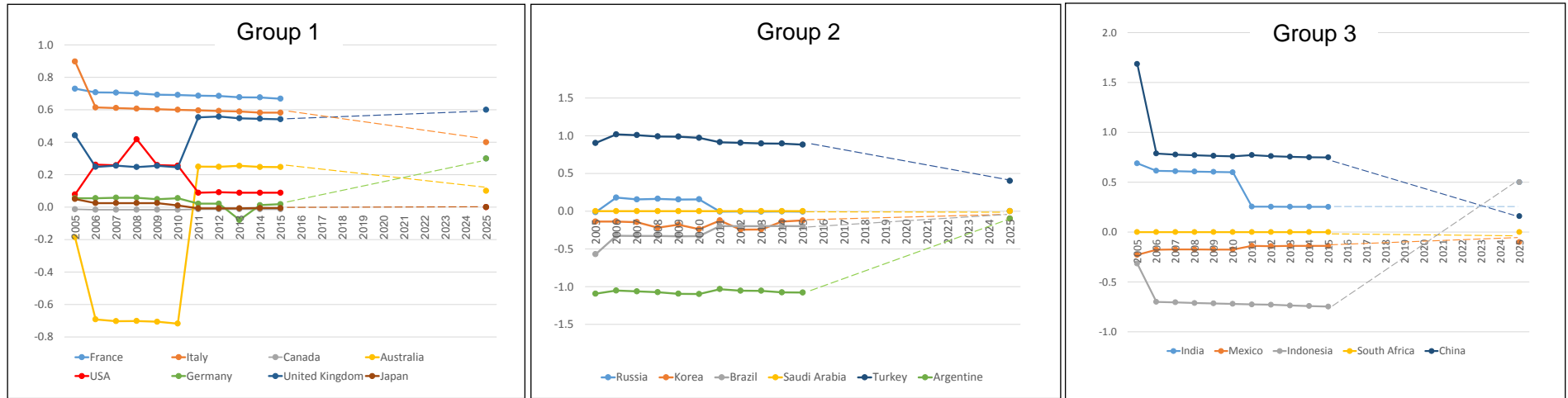


Figure 6. Change of forest coverage (%)



5. Conclusions

This paper uses six previously developed Outcome Indicators to evaluate the efforts of G20 countries to curb GHG emissions in the past decade and to assess their NDCs for the post-2020 period. Calculation of the indicators required basic data such as population and energy use, and the data were generally available in various sources.

All six of the Outcome Indicators were intended to consider equity between developed and less developed countries. However, the data showed that only Goals 2 and 3 (Indicators 3 and 4) were related to level of economic development. The other goals and indicators reflected differences in the countries' other initial circumstances, such as geology or resource endowment. For Goal 2 (Indicator 3), there was a gap between Groups 1 (wealthy countries) and 2 (medium-income countries), whereas a gap was found between Groups 2 and 3 (emerging economy countries) for Goal 3 (Indicator 4). This suggests that countries in Group 3 could improve their progress on the indicator 3, and countries in Group 2 could improve their progress on the indicator 4, respectively without undermining the level of economic development or lifestyle.

Analyses of these countries' submitted NDCs for years around 2025-2030 suggested that the levels are sufficiently ambitious in some areas, but more could be done in others. It will be worthwhile to observe each country more closely and see how each country could make additional efforts to develop more ambitious emission reduction targets related to the various goals.

The next step for the C-PPI project is to focus on the previously developed Action Indicators for the G20 countries. The indicators consist of 37 policies that are effective in improving levels under one of the four goals. The Outcome Indicators identified countries that were able to perform well as compared to others. By searching for policies that enabled such improvements, these policies could be recommended as examples of success stories for other countries to follow.

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