



# Meeting conditional targets in nationally determined contributions of developing countries: Renewable energy targets and required investment of GGGI member and partner countries

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## ABSTRACT

Under the Paris Agreement, countries submitted nationally determined contributions (NDCs) including their GHG emission reduction targets and mitigation measures. Around 175 Parties have mentioned in their NDCs to reduce energy sector emissions by increasing the share of renewable energy in the energy mix. Dissemination of renewable energy requires substantial investment and low and middle-income developing countries tend to present conditional targets assuming external support, therefore essential to estimate how much funding developing countries require and explore how they attract international investment to meet their renewable energy targets. This study examines contributions to carbon mitigation and necessary investment for expansion of renewable energy in Global Green Growth Institute (GGGI) member countries by analyzing their NDCs and national energy plans. It is estimated that the 27 GGGI member and partner countries analyzed in this study would conditionally reduce at least 5058 MtCO<sub>2eq</sub> of GHG by 2030 and increase the cumulative renewable energy generation capacity up to around 356,184 MW by 2030. To accomplish these pledges, an investment of at least US\$258 billion will be required by 2030: US\$98–260 billion for solar photovoltaics (PV); US\$76–139 billion for wind energy; US\$57–330 billion for hydropower; US\$10–23 billion for bioenergy; and US\$16–45 billion for geothermal.

## 1. Introduction

After long discussion on the post-Kyoto framework for climate change, the Paris Agreement was adopted by 195 countries at the 21st session of the Conference of the Parties (COP 21) to the United Nations Framework Convention on Climate Change (UNFCCC) in December 2015, and came into force on November 4, 2016, with the ratification of 74 Parties accounting 59% of the total global greenhouse gas (GHG) emissions (UNFCCC, 2016a). In contrast with Kyoto protocol, which imposed binding GHG emission reduction targets on only 37 industrialized countries under the principle of common but differentiated responsibilities (CBDR), the Paris Agreement creates a regime that includes emissions reduction targets for all signatories. For this purpose, it requires each country to present intended nationally determined contribution (INDC) which contain post-2020 national action plans that the country intends to take to tackle the climate change (UNFCCC, 2016b). INDC of a country converts to binding nationally determined

contribution (NDC) when the country ratifies the Paris Agreement. As of January 2018, 166 INDCs of 194 Parties including 28 EU member states and 139 NDCs of 167 Parties have been submitted to the UNFCCC secretariat.

Although NDCs cover both mitigation and adaptation, mitigation targets and the measures to achieve them are a central part in NDCs (Rogelj et al., 2016), due to their central role to achieving the objective of the Paris Agreement, to limit the global average temperature increase to “well below 2°C” while “pursuing efforts to limit the increase to 1.5 °C” (UNFCCC, 2016b). Two patterns are conspicuous among the mitigation plans described in the communicated NDCs. First, among various measures to reduce GHG emissions, one of the most common measures is promotion of renewable energy. Out of 194 Parties submitting their INDCs, 193 Parties (99.5%) have pledged to reduce the GHG emissions in energy sector including transportation and buildings.<sup>1</sup> In particular, 176 Parties (91%) have mentioned that they would increase the share of renewable energy as a way to reduce energy sector

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<sup>1</sup> Besides energy sector, land-use, land-use change and forestry (LULUCF, 80%), waste management (77%), agriculture (74%) and industrial process (62%) are the main sectors that the Parties have pledged their mitigation contribution.

emissions. Second, low and middle-income developing countries tend to set mitigation targets that were either entirely conditional (targets requiring international support, in the form of climate finance, technology transfer or capacity building) or a were a mix of conditional and unconditional targets. To reduce GHG emissions is, in general, costly and to expand renewable energy requires substantial investment due to the high upfront costs (Betzold, 2016). Thus, it is difficult for many developing countries to implement effective mitigation policies in the renewable energy sector with only their domestic resources, and this situation is reflected in the setting of targets conditional on external assistance.

While many developing countries are willing and ready to meet the more ambitious conditional targets, many will only be able to if they can get international financial and technological assistance. In addition, the principles of historical responsibility and CBDR enshrined in the UNFCCC obligate developed countries to help support climate change action by developing countries. While NDCs contain a variety of conditional targets, the Paris Agreement itself does not outline the support needed by developing countries or the support pledged by developed countries. In this regard, it is essential to estimate how much funding developing countries require to reach their conditional renewable energy targets and explore how they can attract international investment.

As part of such an effort, this study examines overall GHG emissions mitigation and necessary investment for renewable energy expansion in Global Green Growth Institute (GGGI) member countries by analyzing their NDCs and national energy plans. GGGI is a young international organization that works to support and promote a sustainable and inclusive model of economic growth, defined as green growth, in its member countries. Since GGGI particularly focuses on rooting the concept of green growth in developing countries and emerging economies, most of its member countries are developing countries with conditional or combined targets in their NDCs. Additionally, GGGI as part of its green growth-related efforts, supports its member countries across a wide range of climate-related activities, including in renewable energy expansion and access to climate finance. Therefore, GGGI member countries and the role of GGGI in supporting developing country access to domestic and international sources of climate finance present interesting case studies that are potentially scalable to other developing countries.

This paper is organized as follows: Section 2 explores previous studies analyzing INDCs and NDCs; Section 3 describes the methodology used in this study, including data collection, assumptions for estimation of GHG emission reductions and investment in renewable energy; Section 4 outlines NDCs of GGGI member countries (and INDCs where they have not yet been converted to NDCs) and presents their GHG emissions reduction targets; Section 5 compiles renewable energy targets and estimates the investment needed to meet those targets, with a focus on GGGI member countries' conditional targets; Section 6 discusses how those countries can secure the funding and ways GGGI supports countries to access renewable energy finance; and Section 7 concludes with key findings and implications.

## 2. Trends of research on NDCs

Many international organizations and researchers have reviewed and analyzed INDCs and NDCs since the initial submission of INDCs before COP 21. The most frequent type of studies is evaluating the aggregate effect of NDCs at the global scale (Admiraal et al., 2015; Boyd et al., 2015; den Elzen et al., 2016; Rogelj et al., 2016; UNEP, 2016; UNFCCC, 2015, 2016c; Vandyck et al., 2016). In other words, they estimate overall GHG emissions if the NDCs are fully implemented and assess whether those contributions are sufficient to hold the average global temperature rise well below 2°C. The initial work of the UNFCCC Secretariat (2015) and the updated report (UNFCCC, 2016c) respectively review 119 INDCs communicated by 147 Parties including 28 EU member states by October 2015, and 161 INDCs communicated by 189

Parties by April 2016. Admiraal et al. (2015) assessed the mitigation components of the 74 INDCs, and Boyd et al. (2015) compared global emissions under various scenarios with 126 INDCs. Also, den Elzen et al. (2016) and Rogelj et al. (2016) assessed the mitigation potential of 79 INDCs and 160 INDCs respectively. Their common conclusion is that the GHG emission levels resulting from implementation of the current INDCs/NDCs are much lower than business-as-usual (BAU) scenarios, but higher than the levels required to keep the global average temperature increase below 2°C. They suggest, therefore, that enhanced long-term actions be undertaken to address climate change.

Some studies narrow the scope of analysis and focus on a group of countries (den Elzen et al., 2016; Höhne et al., 2017; Liu et al., 2017; Kuramochi et al., 2017; UNEP, 2016; van Soest et al., 2017). UNEP (2016) and den Elzen et al. (2016) evaluate the contributions of G20 countries to global GHG emissions reduction. According to den Elzen et al. (2016), G20 countries, in particular, Brazil, China, EU and the U.S., play an important role in global GHG mitigation efforts, but conclude that the global emission levels will be still higher in 2030 than they were in 2010. UNEP (2016) also states that while G20 members generally present ambitious mitigation measures, some countries have the potential to achieve greater reductions than their pledged INDC targets. Van Soest et al. (2017) compared GHG emission trajectories of 11 major economies including Brazil, Canada, China, EU, India, Japan, Mexico, Russia, South Korea, Turkey and the U.S., with the integrated assessment models (IAMs), cost-optimal 450 ppm CO<sub>2</sub>eq mitigation scenarios, and their NDCs. They found that some countries, such as Brazil, Canada, EU, Mexico (conditional NDC), South Korea and the U.S. have ambitious targets, but underscore that the NDCs of the 11 countries are insufficient to hold the increase in the global average temperature below 2°C, in general. Höhne et al. (2017) compared the pledges of China, EU, and the US, and concluded the EU made the most ambitious contribution in terms of GHG emission reductions. Liu et al. (2017) simulated GHG emissions of the EU, US, China and India under the three scenarios (BAU, INDC and API) and showed the differences in GHG emissions in 2020 and 2030 of each country depending on the scenarios. They concluded China and India would achieve the biggest GHG reduction under API scenario while the EU and the US would do under the INDC scenario.

Regarding costs of implementing NDCs, relatively few studies have been undertaken in comparison to evaluation of NDC pledges. Hof et al. (2017) calculated the annual abatement costs of achieving the GHG emission reduction targets in the NDCs using the IMAGE integrated assessment model. They estimated the global abatement costs of achieving unconditional NDCs at US\$135 billion by 2030, and US \$40–55 billion would be needed for full implementation of the additional conditional targets. However, they emphasized these figures are dependent on a range of socio-economic assumptions. Rai (2015) estimated US\$53.8 billion would be required annually between 2020 and 2030 to implement mitigation measures in the NDCs of the 48 Least Developed Countries (LDCs). Muñoz Cabré and Sokona (2016) focused on the energy sector and estimated the investment for unconditional renewable energy contributions included in the NDCs of African countries. Out of the 54 African countries, 28 countries pledged unconditional renewable energy targets in their NDCs. They estimated the cumulative renewable energy target of the 28 countries would increase renewable energy generation capacity to 102 GW or more, and require an investment of at least US\$241 billion to achieve the target.

Even though NDCs are a relatively new concept, many articles have been published. However, the analysis of NDCs tends to concentrate on the estimation of aggregate global mitigation effect and overall mitigation costs. In addition, research on the NDCs focused on low and middle-income developing countries emitting relatively lower level of GHGs is less common. First, most studies concentrating on limited sets of countries rather than global analysis have focused on developed countries and large economies such as those of the G20. Second, studies analyzing low and middle-income developing countries have their own

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