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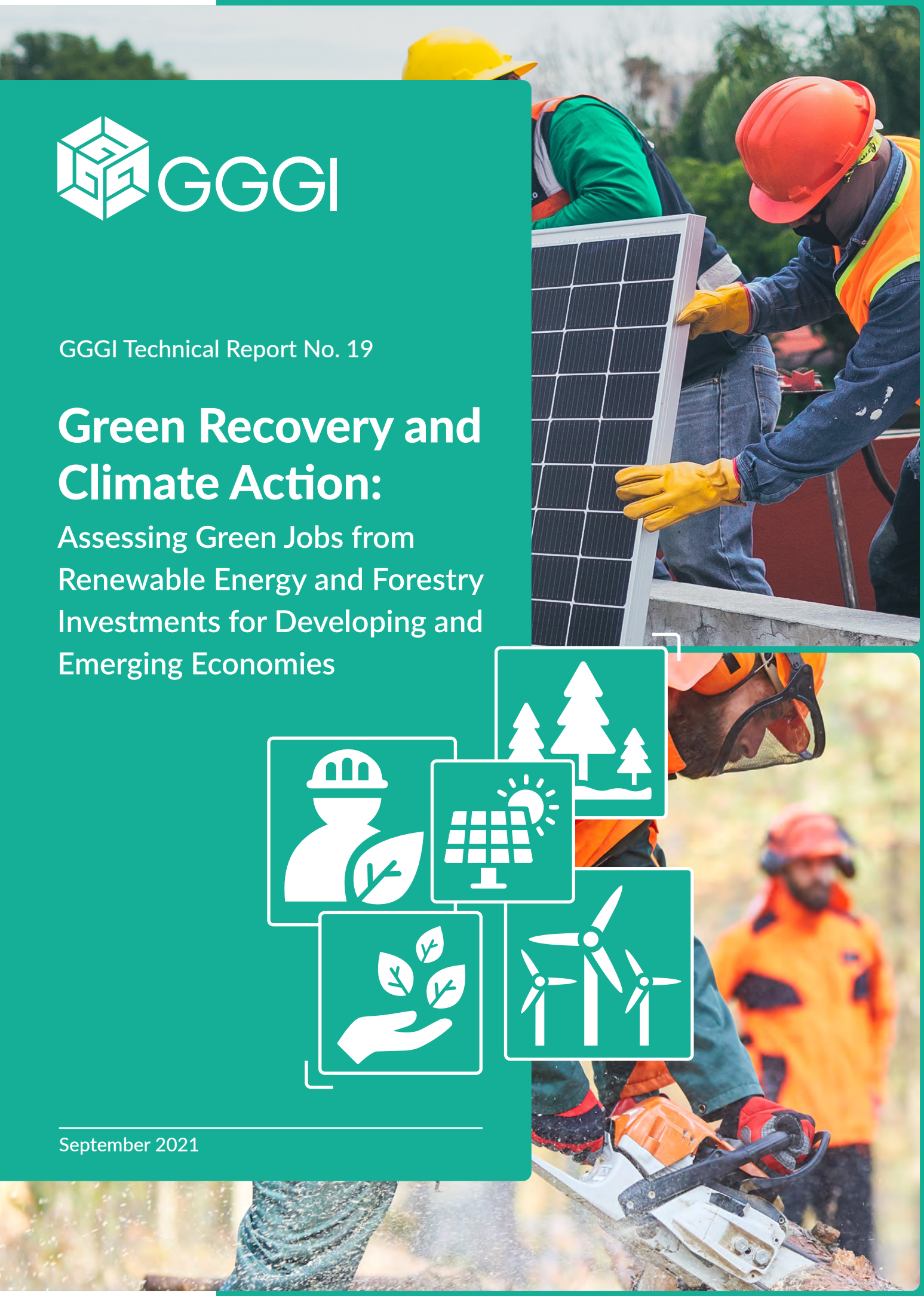
Green Recovery and Climate Action:

Assessing Green Jobs from Renewable Energy and Forestry Investments for Developing and Emerging Economies



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Annexes

Executive Summary

This study assessed the employment co-benefits of implementing targets related to renewable energy (RE) and forestry set in the Nationally Determined Contributions (NDCs) under the Paris Agreement in GGGI Member developing and emerging economies. Quantitative NDC targets related to RE were found for 27 countries related to five RE technologies, namely 1) solar photovoltaic, 2) onshore wind, 3) biomass, 4) geo-thermal, and 5) hydropower. Quantitative NDC targets related to forestry were found for 14 countries related to 10 forest management approaches, namely 1) afforestation, reforestation, and desertification control; 2) improvement of productivity of existing planted forests; 3) watershed improvement; 4) indigenous forest management; 5) forest conservation; 6) agroforestry; 7) fire management; 8) urban and peri-urban forestry; 9) skill improvement of forestry and wood industry workers; and 10) management and conservation of protected areas and buffer zones.

The study uses employment factors (EFs) to estimate the number of direct job-years generated as a result of investments in RE and forestry to achieve the NDCs. Indirect and induced job-years could not be estimated, but earlier studies show these figures can be significant; as much as two to three times the direct job-years, particularly for RE. EFs, particularly in the RE sectors, were obtained from an extensive literature review and subsequently adjusted for each country under study to account for national labor market conditions and changes over time (learning rates). RE job-years are estimated separately for four stages in the value chain: 1) construction and installation, 2) manufacturing, 3) operation and maintenance, and 4) fuel production.

This study concludes that for the 27 GGGI Member emerging and developing economies that had quantifiable RE targets in their NDCs, implementation of these commitments would lead to more than 10 million job-years for the 11-year period until 2030. The majority of these employment co-benefits, well over 4 million job-years, are situated in just three emerging economies with large energy sectors and ambitious NDC targets: Indonesia, Mexico, and Vietnam. Some least developed countries (LDCs) have substantial numbers of employment co-benefits as well—particularly Cambodia, Ethiopia, Lao PDR, Myanmar, and Nepal—but these are dominated by hydropower-linked targets.

The total number of NDC RE-related jobs in LDCs is not high; for example, only 400,000 job-years in Ethiopia, all from hydropower. However, achieving SDG7 (affordable and clean energy) would yield a million job-years for Ethiopia from solar PV, wind, and biomass energy. For Small Island Developing States (SIDS), while the job-year numbers are not high as the labor markets are small, the share of RE jobs can still be high. For instance, for Tonga, the estimated 2100 job-years represent double the current labor force in the electricity generation sector.

This study concludes that for the 14 GGGI Member emerging and developing economies that had quantifiable forest-related targets in their NDCs, implementation of these commitments would lead to some 30–40 million job-years over the 11-year period until 2030. About half of these forest-related employment co-benefits accrue to just one large emerging economy, Indonesia. A significant number of LDCs also have a high potential for forest-related employment, such as Burkina Faso, Cambodia, Lao PDR, Myanmar, Nepal, and Senegal, where potential job-years are approximately 0.5–1 million per country.

Forestry investments are critical for climate adaptation and have large employment co-benefits. The forest sector provides employment opportunities for a climate-vulnerable rural population and is relevant both for climate mitigation and adaptation. Another key rural sector is agriculture; for many developing countries, where a large share of the population is (self-)employed in agriculture, climate-smart agriculture is a critical sector of the economy for green recovery and for employment co-benefits from climate action. While we were unable to include agriculture in this study due to a lack of available EF data, we plan to conduct a more detailed follow-up study using input-output (I-O) modeling to address the climate-employment nexus as related to agriculture.

Prioritize green recovery for developing and emerging economies. Green recovery spending is still insufficient to match the severity of the economic and climate crisis, estimated as only 21% of all recovery spending by the summer of 2021, and the overwhelming majority of this green spending is in OECD countries. Consequently, increasing efforts and resources for a green recovery should be prioritized, particularly in Africa, Latin America, and Asia-Pacific, where the COVID-19 crisis has exacerbated social inequalities the most. Given the limited fiscal space and high levels of current indebtedness, priority should be given to financial resources that do not further increase the governments' indebtedness, such as green bonds, debt-for-nature or debt-for-climate swaps, private sector investment, and blended public-private investments that take maximum advantage of green ODA and climate finance.

Both RE and forestry offer significant opportunities for green job creation in developing and emerging economies. Forest-related investments can generate 300–600 direct job-years per million USD invested, while RE investments can generate 10–50 direct job-years per million USD. Forest-related investments are thus more labor-intensive that than RE investments by a factor of 15. However, RE according to the literature could generate 2 to 3 times more indirect and induced jobs. In addition, RE investments produce more jobs than their fossil-fuel alternatives for every million USD invested.

Figure ES 1. Job creation potential in the energy and forestry sectors.

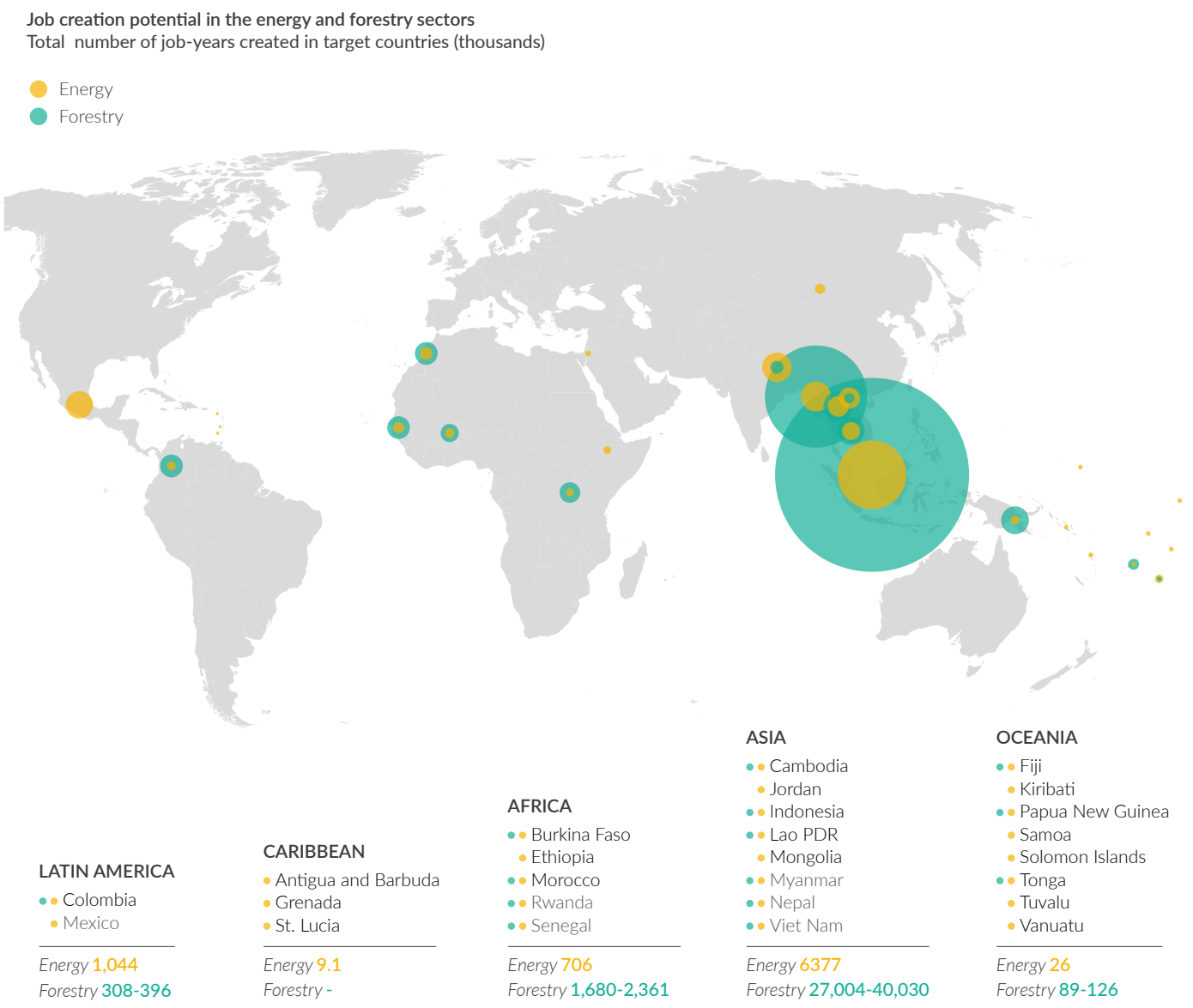


Figure ES 2. Jobs created in the energy sector when reaching the NDC energy generation targets.

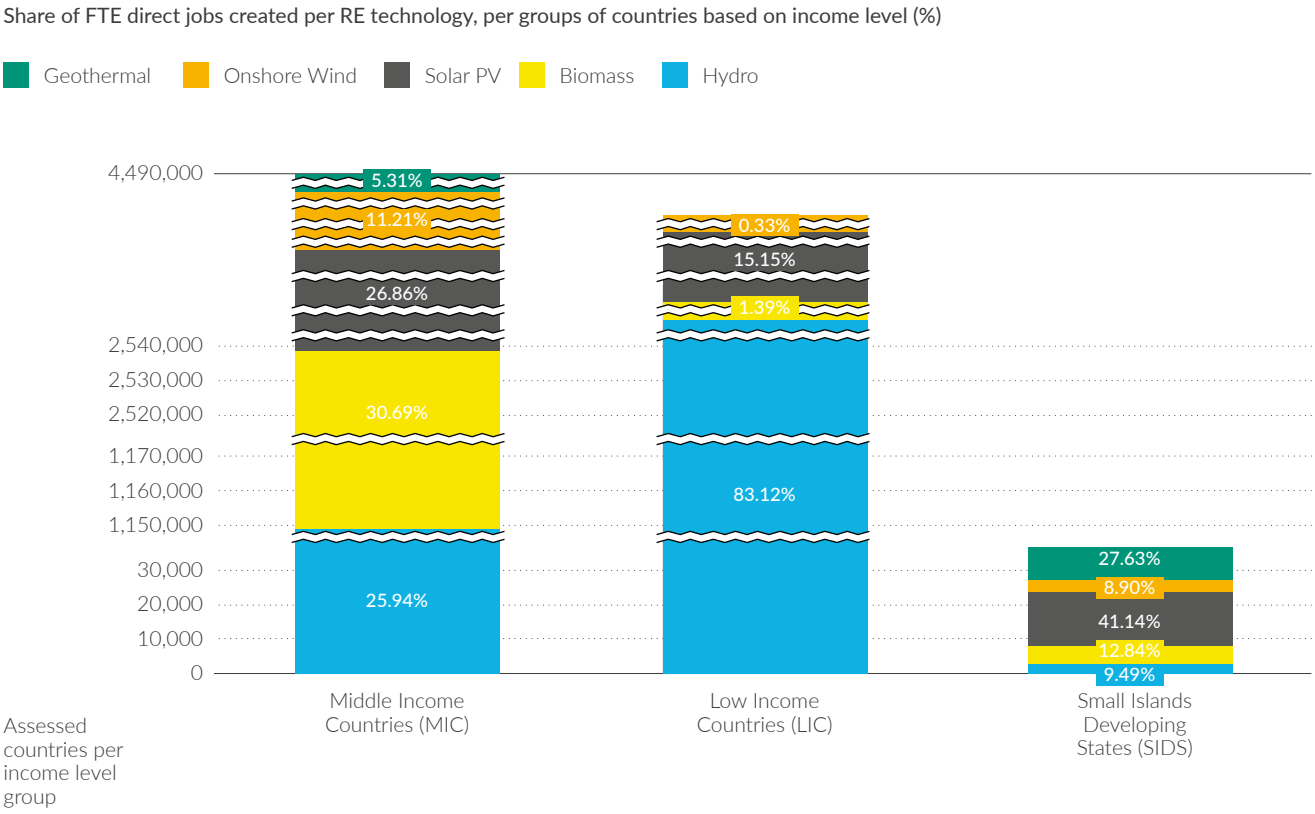
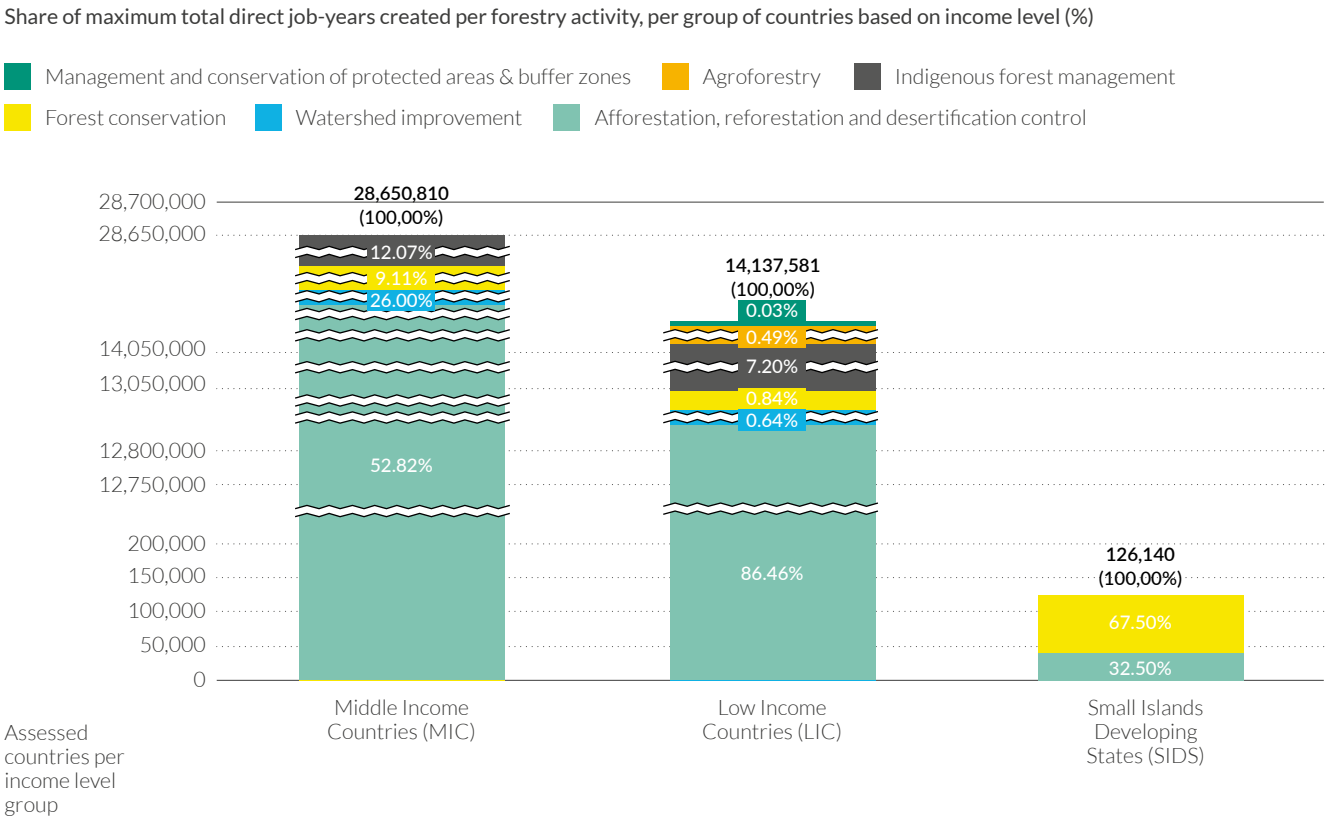


Figure ES 3. Jobs created in the forestry sector when reaching the NDC forestry targets.



1. Accelerating Climate Action during the COVID-19 Pandemic

As of mid-2021, the world is still in the grip of the COVID-19 pandemic. While in some developed countries vaccinations are reaching a level where society and the economy can loosen restrictions, in many developing countries, new waves and more infectious variants are leading to increased restrictions or outright lockdowns. Vaccine access for most developing countries is still problematic, and with a second year of serious economic downturn, the priority for many governments is a recovery to reboot employment, but the high level of indebtedness severely limits the ability of developing country governments to invest in an economic recovery.

In the meantime, the climate crisis has not taken a year off, and there are recurring signs indicating change is faster than predicted. Further, according to the UN's assessment in early 2021, climate action to date is far below what would be required to implement the Paris Agreement and limit global warming to less than 2 degrees Celsius.

Possibly the most encouraging sign in 2020 was the flurry of net-zero or carbon neutrality announcements by governments, as well as the private sector, mostly pledging carbon neutrality by 2050. If these pledges are credibly implemented, they would put achieving the Paris Agreement within reach.

Consequently, there is now an intense focus on short-term actions that can chart a credible path to NetZero 2050. The Intergovernmental Panel on Climate Change (IPCC) indicated that it would require a global GHG emissions reduction of 45% by 2030 to be on track.[1] In mid-2021, a group of major economies — including Canada, the EU, Japan, the US, and the UK—announced 2030 targets at this level. Other key countries, like China and South Korea, have not yet set such targets.

Once set, the 2030 targets and 2050 pledges must be supported by credible action plans. In this regard, the funding mobilized to recover from the pandemic offers a unique opportunity to Build Back Better; that is, recover from the pandemic in a way that accelerates the green transformation, particularly climate action for achieving NetZero net zero emissions by 2050.

Wealthy countries mobilized over USD 16 trillion in stimulus funding by summer 2021, but only 21% of was considered green recovery spending by observers.[i] It was notable, however, that the green share of the stimulus funding increased significantly between the early rounds in 2020 and the more recent packages announced in late 2020/early 2021. Of the more recently announced stimulus packages, an increasing share has been green, particularly in the EU, Canada, South Korea, and the US.

Developing country governments have not been able to allocate stimulus funding to a pandemic recovery as G20 countries have, due to fiscal limitations and high levels of indebtedness. In most cases, they have struggled with the immediate loss of government revenue as a result of the pandemic-induced economic crisis. Their high level of indebtedness, combined with much higher levels of interest rates, effectively prevents developing countries from mobilizing the large volumes of stimulus funding seen in G20 economies. Efforts to recover from the pandemic in these countries will have to rely to a larger extent on the private sector and on public sources, like green ODA and climate finance.

Employment through Climate Action

As a result of the economic crisis, high levels of unemployment, and mounting levels of social unrest, many developing country governments understandably have a single-minded focus on social and economic improvement. Unfortunately, climate change and a green transformation have taken a back seat, despite numerous recommendations from a large number of think tanks and international organizations that climate action is urgent and thus Building Back Better is a necessity.

This report aims to support Building Back Better in developing and emerging economies by assessing the employment benefits of two important areas of climate action:

1. RE investments in line with the most recent NDC targets; and

2. Forestry-related investments in line with the most recent NDC targets.

There are many reports that have assessed the employment benefits of RE development in developed countries, as well as global assessments, but very few deal explicitly with developing and emerging economies.

GGGI published a study in 2020 that assessed the direct, indirect, and induced employment in the energy sector in Indonesia, Mexico, and Rwanda[2]. This report expands this analysis to include all GGGI Member developing and emerging economies that have RE-related targets in their NDCs under the Paris Agreement. For this new and larger group of countries, the analysis is limited to the direct employment related to different sources of RE through a detailed and novel assessment of EFs.

In addition, this report makes a first assessment of the direct employment impacts of investments in forestry in line with the forest-related NDC targets. While initially intending to assess the employment impacts of both climate-smart agriculture and forest-related investments—as these are critical sectors for developing and emerging economies—it was not feasible to assess agriculture-related investments through the same approach using EFs. A more detailed I-O analysis of climate-related employment in the agriculture and food system will be the subject of a follow-up project. This report assesses the forest-related employment through climate action in line with the NDCs for 14 developing and emerging economies, which we believe to be the first study for this sector that addresses developing countries in detail.

We do recognize that the report addresses two groups of countries with quite different needs and opportunities, namely emerging economies, or middle-income countries (MICs), and the most vulnerable countries, particularly LDCs and SIDS.

Emerging economies tend to have high per capita GHG emissions, a large share of coal in their power mix, and often a relatively low baseline of environmental policies or access to and investment in green technologies. These are key countries where a recovery from the pandemic should go hand in hand with a focus on climate change mitigation, particularly powering past coal, with a significant focus on RE investments to reduce GHG emissions. Many of these emerging economies also have important forest sectors, such as Indonesia and Colombia, where forests and other natural landscapes play a key role in both climate mitigation and adaptation. This study shows that forestry also offers significant employment opportunities to Build Back Better.

The most vulnerable countries, LDCs and SIDS, may be able to make net-zero commitments, but the priority of their interests is to increase the climate resilience of their economies—to adapt their forestry (and agriculture) sectors to cope with changing temperatures and increasing droughts and to increase the resilience of their infrastructure and buildings to manage increasing typhoons and hurricanes as well as rising sea levels. RE is still important in these countries, but the employment linked to investments specified in their NDCs is limited, as the emissions to reduce are also limited. In many of these countries, there are other reasons why accelerated investments in RE are a high priority, primarily linked to expanding sustainable energy access. This report shows that both sectors present great employment opportunities, and particularly the forest-related investments offer significant employment benefits for this group of countries.

i 21%, or USD 0.46 trillion categorized as "green" of USD 2.25 trillion recovery spending, out of a total of USD 16.71 trillion in stimulus spending, with most of this classified as "rescue" spending, according to the Global Recovery Observatory and Green Fiscal Policy Network.

Green Recovery

Since spring 2020, GGGI has focused on supporting its Members to green their recovery from the COVID-19 pandemic and now has green recovery-related work ongoing in more than 20 countries. Much of this work relates directly to the generation of employment opportunities, and we believe this report will be helpful for that work. Other projects focus on mobilizing green and climate finance for GGGI Members to finance a green recovery in a manner that does not increase the already high indebtedness of many of the most vulnerable countries.

GGGI has initiated a collaboration with Vivid Economics to apply and, if necessary, adapt the Greenness of Stimulus Index (GSI) for its Members. The GSI has to date been developed and used by Vivid Economics to assess the greenness of the stimulus funding allocated by G20 economies and some emerging economies. GSI is a useful tool that not only helps developing and emerging economies assess the greenness of the actions they have taken but also recommends how best to prioritize a green recovery going forward. In a first joint effort between GGGI and Vivid Economics, the GSI has been applied for Senegal, and in coming months it will be expanded to another group of GGGI Members where GGGI has ongoing green recovery work.

In summary, the aim of this report is to provide insights on the job creation potential of climate action and practical guidance for developing countries—both emerging economies and the most vulnerable countries—on ways and means to Build Back Better. While there is already a large volume of publications focused on developed economies or on generic green recovery arguments, this volume focuses on assessing the employment benefits of climate action in the RE and forest sectors, specifically those GGGI Member developing and emerging economies that have RE and forest targets in their NDCs.

2. Employment Opportunities of NDC Targets for GGGI Members

According to the International Labour Organization,[3] by the end of 2020, 8.8% of global working hours were lost relative to 2019, equivalent to 255 million full-time jobs. Working-hour losses were particularly high in Latin America and the Caribbean, Southern Europe, and Southern Asia. Working-hour losses in 2020 were approximately four times greater than during the global financial crisis in 2009. In the LDCs and SIDS, the employment, income, and food security of millions of traders, roadside vendors, small restaurant owners and workers, and other low-skilled workers in the hospitality sector are at risk. Many small island nations have experienced a drastic decline in revenue and employment from international tourism due to travel restrictions.

As governments develop their economic recovery packages, their primary aim is to boost economic activity and employment. Simultaneously, given the current climate emergency and the narrow window of opportunity for climate action, it is critical to incorporate green recovery measures to tackle the climate crisis while stimulating the economy and generating employment.

Recent studies[4] suggest that green stimulus measures have advantages over traditional fiscal stimulus measures (e.g., tax exemptions)[5] both in the short and long run. As underlined by Hepburn et al., 2020 the speed and ease of the implementation of measures to stimulate the economy are critical to ensure an immediate and effective response to sudden job losses[6]. At the same time, it is vital to consider whether the long-term impacts of recovery packages will lock the economy into carbon-intensive or low- or zero-carbon development pathways.

RE investments could deliver significant socioeconomic benefits both in the short and long term. In the short term, and particularly during an economic recession with high unemployment rates, RE creates many direct jobs during the manufacturing and distribution and construction and installation stages[7]—jobs that are much needed until the economy eventually returns to full capacity. In addition, RE technologies, such as wind and solar PV, are mature technologies that pass the “technology readiness” test.

Existing institutional and policy structures are in place in many countries that would allow an easy and fast implementation, which is particularly important during an economic recession with the profound need for shovel-ready measures. In the long term, RE investments provide improved air quality and health benefits, and in countries where RE replaces imported fossil fuels, the investments achieve enhanced security of energy supply, improved public budgets, and balance of payments.

Investments in natural capital, such as in the forestry sector, are another particularly relevant area for low-income countries. In many cases, rapid implementation is possible with low skills and training requirements and with short planning and procurement processes. Another advantage of investing in natural infrastructure in low-income countries, as a measure while we are still in the middle of the pandemic, is that workers can perform their tasks while meeting social distancing requirements[8]. Most importantly, investments in the forestry sector could deliver multiple benefits, including the enhancement of carbon sinks, water filtration, reduction of climate risks, biodiversity support, and sustainable flow of other ecosystem services.

Developing economic recovery policies and measures coincides with the first NDC revision cycle where the Parties to the Paris Agreement are currently submitting their revised NDCs. Aligning the NDC revision process with economic recovery plans could be a great opportunity for countries to address economic, employment, and climate objectives simultaneously. Investigating the employment implications of NDC climate actions and targets across sectors, particularly in RE and forestry, could provide important insights into 1) the type of climate actions with the highest employment creation potential, 2) the skills requirements and training needs for implementing these actions, 3) the suitability and readiness of the climate actions to be incorporated in countries' economic recovery plans, and 4) the significant employment benefits that could be generated by raising climate ambition and accelerating climate action.

Against this background, the **objectives** of the assessment are as follows:

1. Review and identify the **NDC targets** in the RE and forestry sectors as they have been reported by the countries in the NDC official documents.

2. Identify the **most labor-intensive technologies and practices** in RE and forestry.

3. Assess the employment creation potential of countries' NDC RE and forestry targets.

4. Explore and identify the **human resources and skills required** for achieving the RE and forestry targets set in the NDCs.

5. Lastly, provide **recommendations** on how to align countries' economic recovery plans with NDCs with a focus on employment creation.

Review of NDC Targets

Countries were classified based on region and income level. The United Nations development classification[9] and World Bank income level classification[10] were used to categorize countries into three groups: MICs, LDCs, and SIDS.

The methodological approach was based on two main activities, namely extensive review of countries' NDC documents for identifying the reported RE and forestry targets and utilization of the EFs method to estimate the job creation potential of these targets.

The extensive NDC review included a search of the most updated NDCs that were submitted to the United Nations Framework Convention on Climate Change (UNFCCC)[11] up to June 2021. The review aimed to collect information reported in the NDCs on the following indicators: unconditional and conditional RE and forestry (mitigation and adaptation) targets and the investment requirements to achieve these targets.

Another factor that was considered while conducting the assessment was whether targets were reported as unconditional or conditional. Almost all reviewed NDCs stated that their targets were to be achieved unconditionally, without international support, or conditionally, relying on international support. However, among these targets, many NDCs were unable to clearly communicate their conditionality. Therefore, if a country's NDC does not clearly state whether a target is unconditional or conditional, assumptions were made based on further information found in the NDC. For example, when technical and financial support was mentioned as a requirement, and corresponding measures were reported to outpace a country's current ability to finance transformational change, then the reported targets were assumed to be conditional. In addition, the reported targets were considered conditional when the NDC included statements related to necessary financial instruments, like donation schemes, financial barriers experienced by relevant ministries, and financial needs and funding requirements in the energy and forestry sectors. Moreover, specifically for the energy sector, in cases where the conditionality was specified for the overall mitigation targets (rather than individual RE technology targets), the same proportion of conditionality was applied as was in the case of unconditional targets.

The review was expanded to other national documents that were related to the target setting in the RE and forestry sectors, such as national energy plans, national energy roadmaps, and national forestry and REDD+ strategies. In many cases, information was provided, confirmed, or validated by GGGI country offices and government counterparts. To track the progress of the target setting in these two sectors, in addition to the review of the updated NDCs, old/ first NDCs were also reviewed to identify old RE and forestry targets and compare them with the updated ones.

Lastly, in some cases, where the targets or investment requirements were not explicitly stated, certain assumptions were made, whenever possible, to estimate and infer the targets and/or the investment requirements. The main assumptions and specific calculations are summarized in the respective sectoral sections, and more details are included in Annex C.

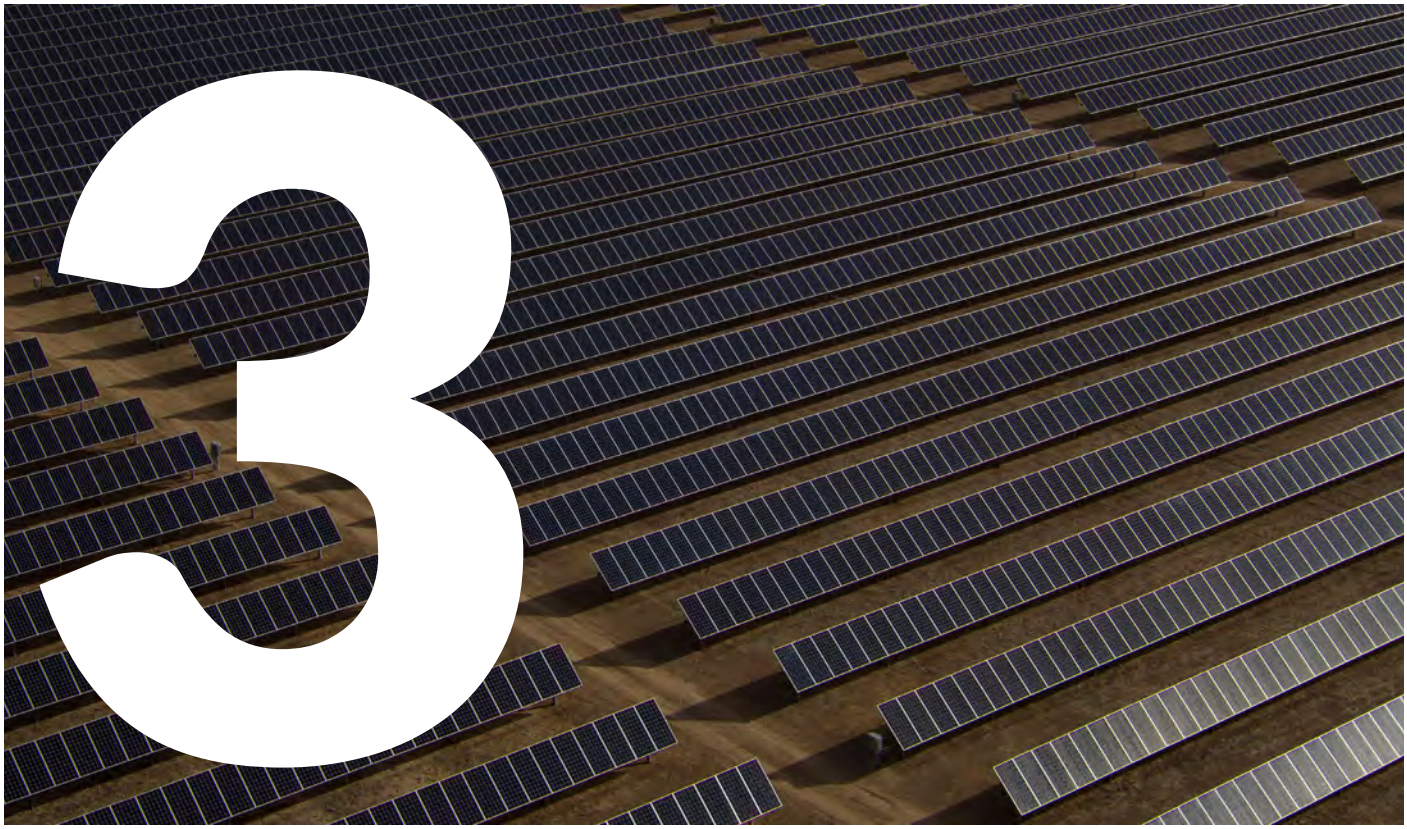
Employment Factors Approach

The study focuses on the assessment of **direct jobs** creation, which refers to the jobs that could be created directly in the RE industries and forestry sector. The assessment of *indirect* and *induced* jobs that could be created in the supply chain and other sectors of the economy is beyond the scope of this study. This would require country-specific data that can be normally derived from I-O tables or social accounting matrices (SAMs). However, most of the countries from our sample do not have available updated I-O tables or SAMs. The number of indirect and induced jobs could be significant, around two to three times more than direct jobs, based on previous studies[12].

The assessment of the direct jobs in the RE and forestry sectors is based on the EFs approach, a relatively simple but widely applied and sound method. Applying the EFs approach has advantages regarding its simplicity, time requirements, and cost-effectiveness of its application, given that the labor intensity of specific technologies or practices under investigation is provided from previous studies.

The employment productivity of technologies, such as those in the RE sector, improves through technological advancements and enhanced capacity of the labor force. However, the process differs among countries, so careful utilization and adjustment of the EFs should be considered that reflect the differences across countries and different time horizons. These adjustments could be based on countries' labor productivity factors, as highlighted in other studies.[13]

Given that a relatively simple model based on EFs (which consider relatively few variables) was used to determine the employment creation potential of the selected countries' NDC RE and forestry targets, it should be noted that these employment results are indicative only, rather than being accurate projections. Therefore, the job creation values derived should be interpreted and approached with caution. On the other hand, this is the first study that aims to estimate the job creation potential of NDC targets of a number of low- and middle-income countries, thus providing useful insights and direction of the prospects of employment generation that could be driven by NDC implementation, particularly in the context of a green economic recovery.



3. Assessing Renewable Energy Employment in Developing and Emerging Economies

Compiling RE targets of NDCs

A total of 30 countries were reviewed, 16 of which mentioned quantifiable RE targets disaggregated by technology and, in most cases, by conditionality. For countries that lacked disaggregated RE targets, national reports/plans[ii] were reviewed to capture future RE deployment plans. Table 2 below presents the national RE targets for the target year (2025 or 2030) and the investment needs, and the corresponding estimated jobs created for each target is indicated in table 3.

After 2019, all NDC RE targets are reported as additional installed capacities. If NDCs indicated cumulative installed capacity targets, they were converted into net capacity additions/net installed capacity between 2020 and the target year by calculating the difference between the target capacity to be installed and the installed capacity in the country in 2019. The data on current RE capacity per country were retrieved from IRENA. Investment requirements and conditionality of a target are also considered in this assessment. In cases where investment requirements were reported as aggregated figures (under "mitigation" or "energy" as a whole), missing, or ambiguous, estimated investment requirements for each target were calculated by multiplying the technology's additional installed capacity by its cost factor. Cost factors were also taken from IRENA's cost database.

Nineteen NDCs were updated submissions that either indicated new targets for 2030 or, more commonly, built upon existing INDCs or NDCs with more ambitious energy targets. In fact, nine NDCs had enhanced targets by either increasing the magnitude of installed capacity of an existing target or by including new RE technologies as a means of contributing to their mitigation targets and actions. For Colombia, its previous NDC lacked details on mitigation actions, thus a comparison between updated and old targets was difficult. However, its NDC has been enhanced in that the targets have been comprehensively

ii National reports include National Electricity/Development Plans, NDC/RE Implementation Roadmaps and NDC Partnership Plans.

articulated with the conditionality implied. The rest of the NDCs have not presented quantifiable targets disaggregated by technology—therefore, disaggregated RE targets were collected from national reports included in the energy or NDC roadmaps[iii] or constructed based on information provided by the government. Fiji is an example where targets and conditionality are presented in an aggregated form, so the breakdown of the target was done with reference to the Fiji LEDS. The majority of such NDCs had similar ambiguity of targets in its previous NDCs, which made a comparison between old and new targets challenging. For Ethiopia, the targets were provided in terms of aggregated targets but did not address specific RE technologies nor any relevant national plans upon which the NDC was constructed. Some NDCs did allude to plans to make available a detailed roadmap/NDC implementation plan, which was not accessible at the time of the study. Similarly, Mongolia had no discrete targets disaggregated by technology, but the national documents that were referenced in the INDC were restated in the updated NDC. Therefore, it was assumed that the targets in the INDC remain unchanged in its updated NDC. As for Peru, Thailand, and the Philippines, information on the RE contributions was unavailable in both the NDC and referenced national reports. Consequently, these three countries have been excluded from tables A and B.

The study assessed job creation for RE technologies that were included in countries' NDC targets, namely solar photovoltaic (utility-scale), wind onshore, biomass, geothermal, and hydropower (large and small).[iv] Firstly, the study compiled EFs from the literature both for RE and fossil fuel–based energy technologies (i.e., oil, gas, and coal) for comparative purposes. Secondly, it utilized the EF approach to estimate the number of jobs that could be created if countries implement their NDC RE targets.

Energy Technologies and Employment Factors

Each stage of the value chain associated with an energy technology has been assessed separately—a general approach adopted by previous studies. Manufacturing, Construction and installation (C&I), and operation and maintenance (O&M) are stages of the value chain that apply to all energy technologies. Biomass and fossil fuels encompass an additional stage in relation to jobs that can be created by fuel production. The study considers and assesses the following job categories:

1. **Manufacturing jobs** encompass all jobs associated with the manufacturing process of a RE system. Similar to C&I, manufacturing the components of a power plant is relatively short compared to the lifetime of an energy system, so the jobs created are indicated as "job-years" or "job persons." Moreover, in many cases, various components of the energy systems (e.g., solar panels or blades) may have been imported and not produced within the country where the capacity is installed. Countries like small island states—particularly relevant to this study—rely on importing most, if not all, energy system components. Any jobs created in the manufacturing process of components that are imported by the host country are out of the scope of this study.

2. **C&I jobs** refer to jobs created through the construction and installation of an energy system. Considering that these jobs are created in the first few years of an energy system's lifetime, they are expressed as "job-years" or "job persons" needed to employ until the first operation of the energy system.

3. **O&M jobs** comprise the jobs created in operating and maintaining an energy system over its technical lifetime.

4. **Fuel production jobs** include jobs associated with the supply of fuel for electricity generation.

Jobs that are generated during the decommissioning process of retired power generation infrastructure and jobs generated from transmission and distribution processes are beyond the scope of this study and therefore not assessed. Moreover, this study aims to estimate the gross employment creation of RE technologies of the implementation of the national energy targets. Thus, particularly in countries with a high degree of electrification, any potential job losses in the fossil fuel-based sectors are not considered.

The EF is **the measure of jobs or job-years created per unit of installed capacity, unit of electricity generation, or unit of investment.** It is generally estimated based on data sources from broad industry surveys, model estimations (including I-O analysis) for specific RE projects and investments, or feasibility studies and technical literature specifications[14]. Therefore, EFs were deemed apt as the indicative measure of job creation in this study, given that specific variables (e.g., labor productivity and local share) are appropriately adjusted for each country.

Moreover, the employment impact per unit of installed capacity would differ by value chain stage, thus respective EF values for each technology and value chain stage should be collected to calculate the employment potential of NDC RE targets more accurately.

A total of **174 EF values** for all technologies and value chain stages were compiled from different employment and meta-analysis studies based on an extensive literature review[v] (see Annex A). Moreover, the original sources of each referenced EF were reviewed to note the year when the EF was generated and **the country in which the EF was generated** (henceforth labeled as **"origin country"**). This information is relevant in the EF adjustment calculations wherein differences in national and technological development over time and between countries are factored in. In cases where EF values lacked a definite year of data collection, the publication year of the study was taken as a replacement. This study only considered EF values generated

iii This includes IRENA roadmaps and the GGGI-supported Low Emission Development Strategy.

iv There are controversies around the sustainability of large hydropower, stemming from its hazardous environmental impact. There is no consensus on including large hydropower under RE, and GGGI does not include large hydropower (other than through run-of-river) in its RE work, but many developing country NDCs do have hydropower-related targets and, in some cases, do not differentiate between large- and small-scale hydropower. For this report both large and small hydropower are included in the analysis.

v Most of the values of the EFs are derived from meta-analysis studies; i.e., Rutovitz et al. 2015 and Cameron and van der Zwat 2015, with additions from other sources.

in 2009 or after as data before 2009 is scarce and considered outdated. Most studies were conducted in OECD countries with a high number of values in solar PV, solar thermal, and wind onshore (the origin countries). Given that there are multiple EFs available for each value chain stage per technology, an averaged[vi] EF value was computed for use in **the countries under analysis** (henceforth referred to as **"target country"**). As was the case in Rutovitz et al.[15] (2015), Cantore et al (2017)[78], and Ram et al.[13], (2020), EF values are subsequently adjusted by labor productivity and learning rates to account for technology maturity over time as well as labor productivity differences between origin and target countries. We also report results that involve the comparison of median EF values of RE technologies that are most often associated with the NDCs against those of fossil fuel–based technologies with the largest share in the electricity mix as of 2019–2020.

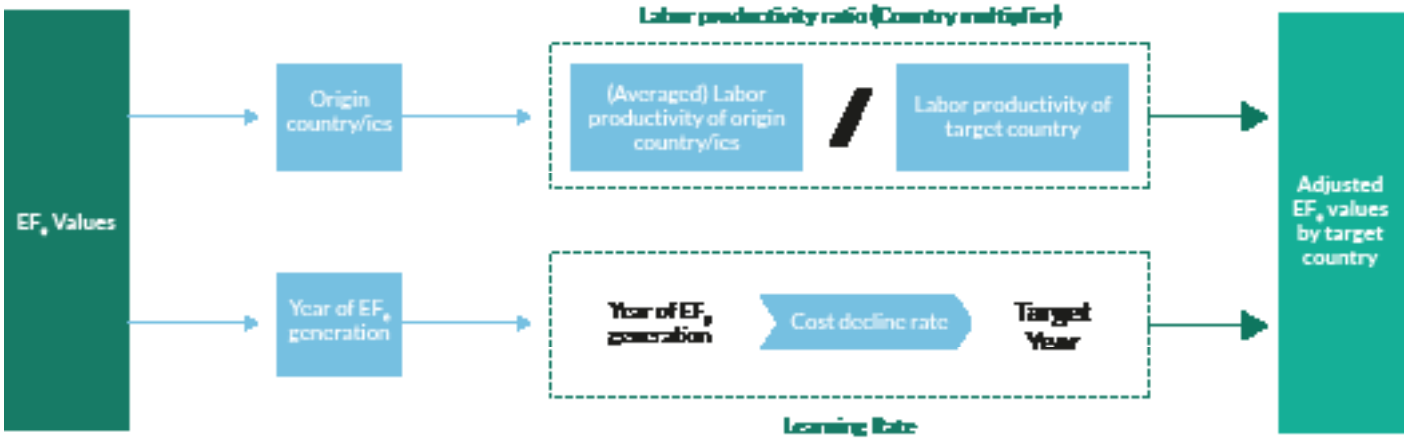
Labor Productivity

The number of jobs created per unit of capacity installed could differ, depending on the development stage of a country, which relates to labor productivity. Generally, a greater number of jobs would follow a lower cost of labor because labor becomes relatively affordable when compared to the mechanized means of production.

GDP per capita is often associated with average labor productivity and is used as a macroeconomic indicator that reflects the stage of economic development. Therefore, in accordance with Rutovitz et al.,[15] GDP per employed [16]person (excluding agriculture) was used as a proxy for labor productivity to reflect the different levels of labor productivity between origin and target countries. Labor productivity is expected to change over the period of NDC implementation (2020–2030), which has been reflected by incorporating projected GDP per capita growth rate up to 2030 in the adjustment calculation.

Multiple EFs generated from different countries exist for a single technology and value chain stage. Since EFs are averaged to derive a single EF value, labor productivity of each origin country should be adjusted to reflect that of the target country. This has been considered by averaging the labor productivity of all origin countries—each corresponding to an EF value for a given technology and value chain stage. The ratio of the averaged labor productivity of the origin countries to that of the target country was calculated and labeled as the "country multiplier." In short, country multipliers indicate the difference in labor productivity between the target country and the origin countries from which EFs were derived. This adjustment factor is used to adjust EFs to better reflect the different levels of labor productivity in the target countries (figure 1.)

Figure 1. Adjustment of EFs for energy technologies



vi Since different studies that estimate EFs conduct research on power plants with varying installed capacity, it would be ideal to calculate the weighted average when deriving the EF for the target countries to weigh more significance to values derived from power plants with large capacities. However, not all studies indicated such details on plant capacities, thus a normal average was used instead.

Figure 2. EF approach for renewable energy technologies

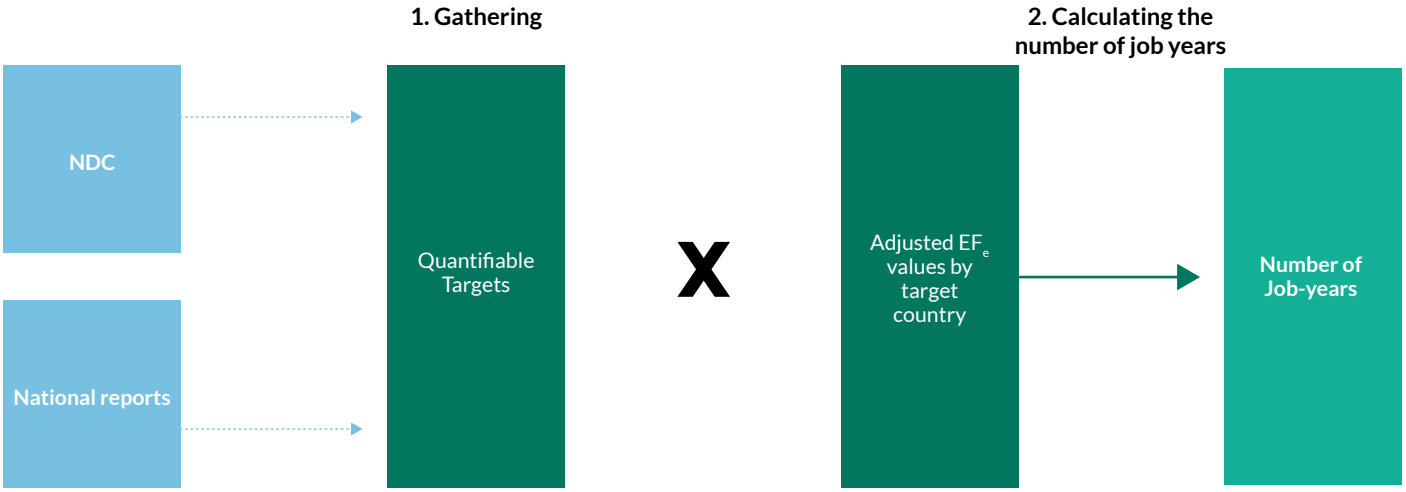
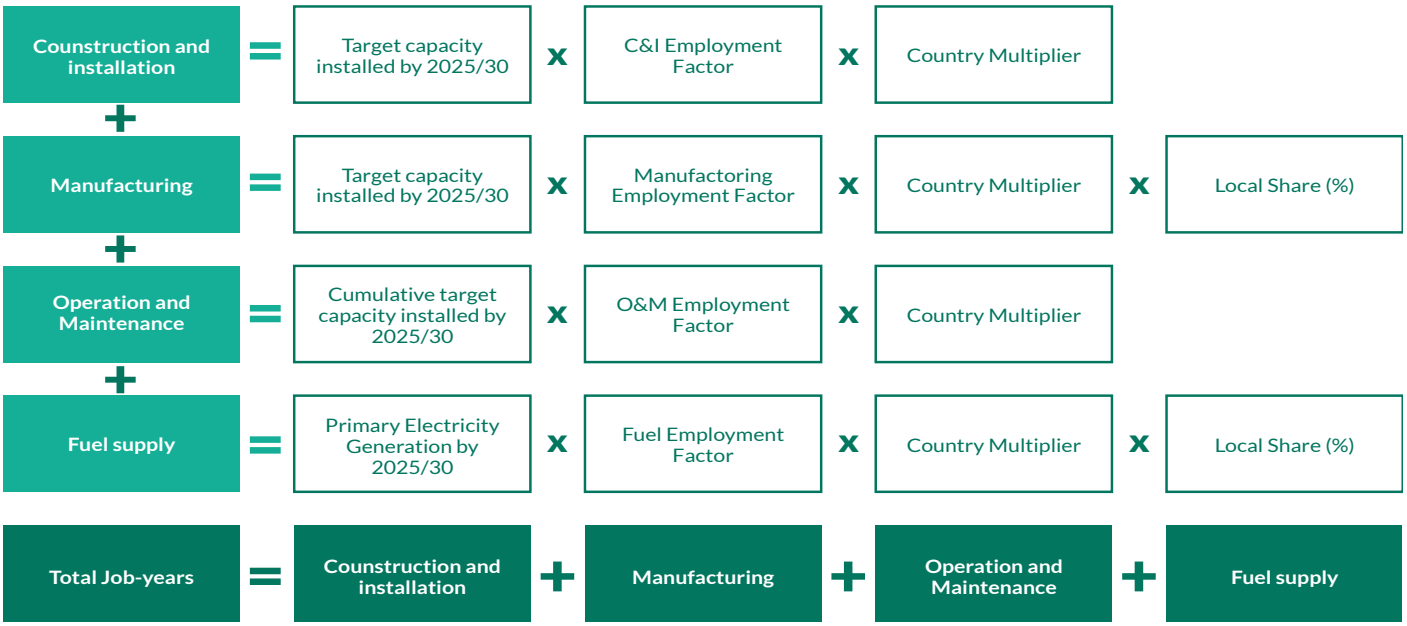


Figure 3. Job creation assessment calculations.



Note 1: The cumulative job creation numbers between 2020 and the target year (2025/30) have been calculated.
Note 2: Local share for all value chain stages except manufacturing and fuel supply has been assumed to be 100%.

Learning Rates

As RE technology matures, job creation potential is expected to decline as a result of enhanced efficiency of production or working practices. This increase in learning rates and the corresponding decrease in employment is captured by taking the decline in technology costs as a proxy. Cost decline for each technology per value chain stage was calculated, starting from the year in which an EF was generated to reflect changes in learning rates.

For EFs associated with C&I and manufacturing, the decline rate of capital expenditure was considered to generate decline factors, while reduction in operational expenditure was used to adjust operation and maintenance EFs.

Job Calculations

Based on the two adjustments (i.e., labor productivity and learning rates), EFs were adjusted and multiplied by the pledged energy target to derive the number of jobs that could be generated. After 2019, all targets taken from the NDCs are considered as net capacity additions. Datasets from IRENA[17] have been retrieved and used to fill the gaps in targets, investment requirements, and conditionality. For jobs in C&I and manufacturing, additional capacity installed

was annualized and multiplied by the EFs to calculate the number of job-years over the target implementation period. The annual job creation was then added to calculate the total number of jobs generated over the period of 6 or 11 years (depending on the target year). Meanwhile, the *cumulative* capacity for each year was used to calculate the employment in O&M and fuel supply[vii] per year, also expressed in job-years, assuming that the additional capacity is installed gradually in a linear fashion until the target year. The job-years created per year were then added up to calculate the total number of job-years generated over the target implementation period. Details on the calculation of the total number of jobs created up to the target year can be found in annex B.

Local share

Local share indicates the percentage of manufacturing that takes place within the country. Local share values presented in table 1 are adopted from Rutovitz et al.[15], with modifications for Latin America and additions for the Oceania and Caribbean regions to better reflect the reality in GGGI Member countries in these regions. The local share in the C&I and O&M stages of the value chain have been assumed to be 100%, given that the activities of these stages are generally taking place in the country. There might be cases where the country lacks the necessary skills and know-how during the C&I stage of certain RE technologies and therefore may need either to import high-skilled workers or to enhance the capacity and skills of the local labor force through training and skilling vocational programs. For the local share of fuel supply, the data on production and consumption from EIA[18] was utilized to derive the local share of coal, oil, and gas, which was used to adjust the EFs to better reflect the reality.

Table 1. Local share of RE manufacturing within a region

Region	2020 (%)	2025 (%)	2030 (%)
Africa	30	40	50
Asia	50	60	70
Caribbean (SIDS)	0	0	0
Latin America	35	42.5	50
Oceania (SIDS)	0	0	0

Note 1: These values apply to solar PV, solar thermal power, geothermal power, and wind.

Note 2: All manufacturing for fossil fuels, biomass[viii], and hydropower is assumed to occur within the region (100%).

Note 3: Table adjusted from Rutovitz et al., 2015.

Decline factors

Decline factors reflect the rate of cost decline of a technology, which indicates an increase in technology maturity and the corresponding reduction in employment potential. Data on technology costs were collected from Lazard[19] (which includes data for 2009 and 2014) and Ram et al.[13], (which comprises historical and projected costs from 2015 to 2030).[ix]

Assumptions, boundaries and limitations

The studies that generated EFs were conducted in different countries and regions and adopted various methodologies and assumptions. However, there was a limited number of EFs for certain technologies (particularly for biomass and fossil fuels) and value chain stages (namely manufacturing), which should be noted when reading the results of the analysis.

The study focuses on the jobs that can be created by countries' implementation and achievement of the energy targets as reported in their NDCs. The estimation of jobs that could be created because of global demand for certain fuels or RE technology components, reflected in exports, is beyond the scope of this study.

GDP per capita growth rate is derived from projection data up to 2030. Projected data per country were available only up to 2025 and were derived from IMF[20] To account for the GDP per capita growth rate between 2025 and 2030, the regional GDP per capita growth rate from the IEA World Energy Outlook2220 was used and applied to individual countries.

Despite the voluminous collection of EF values used in this study, the origin countries are mostly OECD or developed countries. Therefore, the assumptions and conditions under which the studies were conducted may not be fully applicable to the target countries. Adjustment by labor productivity, time horizon, and local share was an approach aimed at balancing such differences. However, having more EF studies conducted in developing countries could eliminate disparities between countries of varying development stages.

vii For fuel jobs, the study adopted data and calculation from Ram et al., which require two variables: a) electricity generation, which for each RE target was calculated using the load factors (further details on load factors follow below), and b) power plant efficiency.

viii Load factors were used to estimate the electricity generation and calculate fuel jobs for biomass. Regional load factors are taken from Ram et al. except for Oceania, which adopts load factors from Fiji under the assumption that all SIDS have similar load factors.

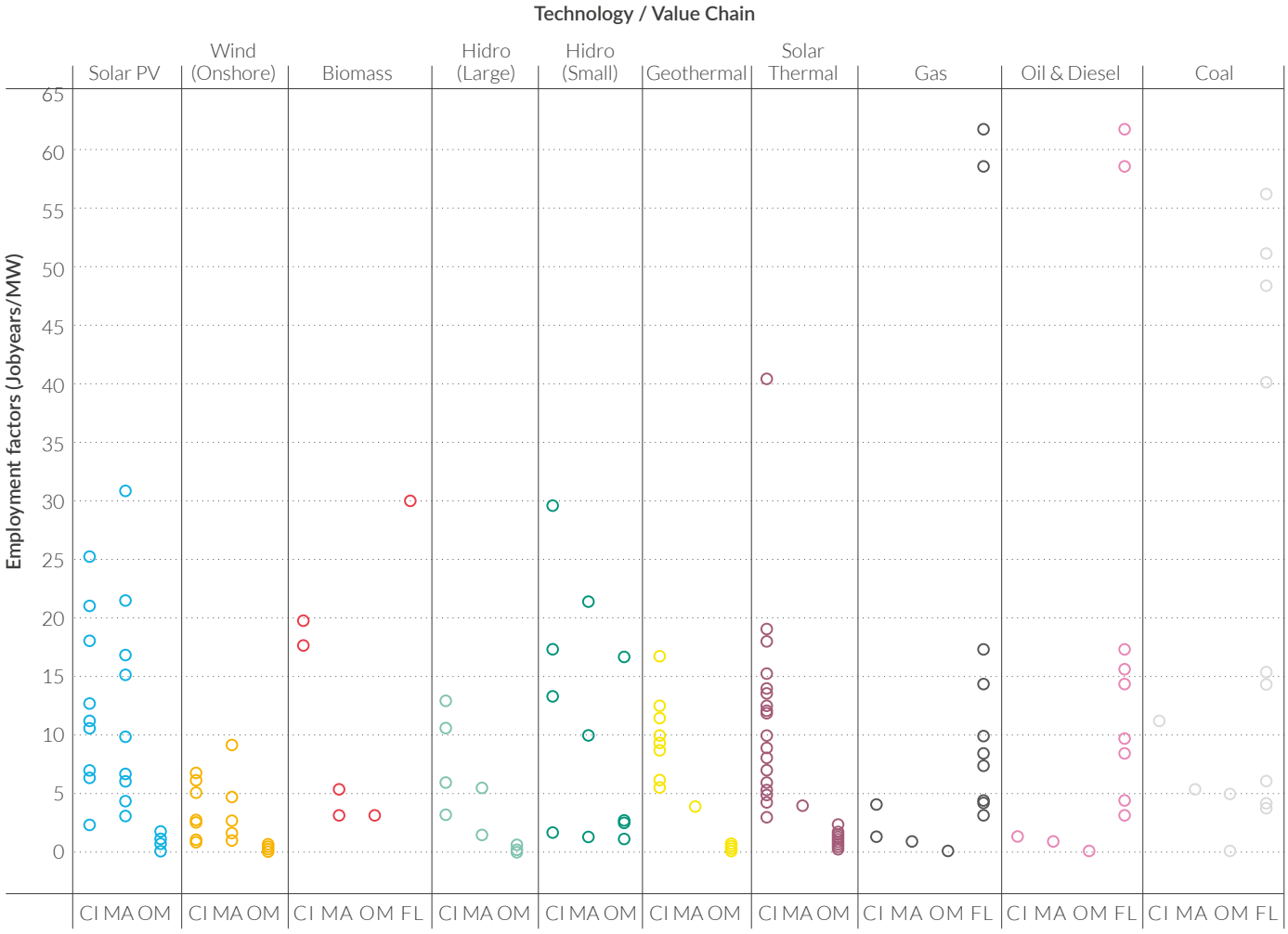
ix Consistent cost data for solar thermal was scarce, so the learning rate for solar thermal was set as zero from 2015 onwards.

Results

Adjusted EF values

It is notable that most regions show significantly higher employment potential for RE jobs in C&I when compared to conventional fossil fuel–based energy technologies, which applies to manufacturing jobs in some regions.

Figure 4. Range of original EF values disaggregated by technology and value chain stage



Abbreviations: CI – Construction & Installation, MA – Manufacturing, OM – Operation and Maintenance, FL – Fuel Supply
Note: The above EF values have not been adjusted by labor productivity or the decline rates. The median values of the adjusted EF values classified by region follow in the next section.

Currently, all target countries in the African region generate a considerable amount of electricity from hydropower. The results present significant employment impacts not just in hydropower but also in other RE deployment, namely solar PV and biomass. In fact, when compared to oil, solar PV deployment can create 4.7 times more C&I job-years, biofuel 10 times more job-years, and small hydropower 9.5 times more job-years. Similarly, job-years in the manufacturing sector are more abundant in RE technologies than in oil. Therefore, in countries where a large proportion of the electricity is generated from oil (e.g., Senegal), implementing their NDC targets by deploying solar PV and biomass (among many others) could be a priority to consider in their pathway toward a green recovery.

To demonstrate, if the government of Burkina Faso implements its NDC targets, this could result in approximately 96,000 job-years in the energy sector, and in the case of Ethiopia, around 400,000 job-years may be anticipated. Job creation for Ethiopia comes solely from large hydropower—the only RE technology that was associated with the NDC target. However, significant job creation could occur in other RE technologies. For instance, if Ethiopia were to achieve its Sustainable Development Goal 7 (Affordable and clean energy), wind power, geothermal, and biomass should be incorporated in the energy mix—which has been reflected in the 2030 targets proposed in the Sustainable Energy for All report.[21] If these targets are to be implemented, about 1 million job-years could potentially be generated from these three RE sources alone, underscoring the role that RE technologies other than hydropower could play in alleviating the impacts of COVID-19 on the job market in Ethiopia.

Figure 5. Median EFs for Member/target countries in **AFRICA** in 2020

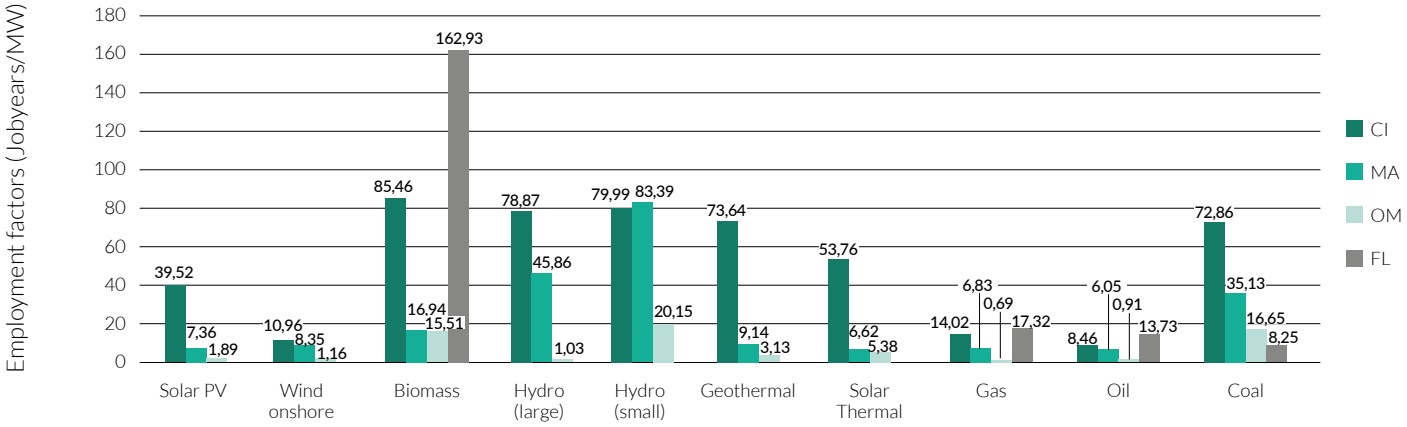
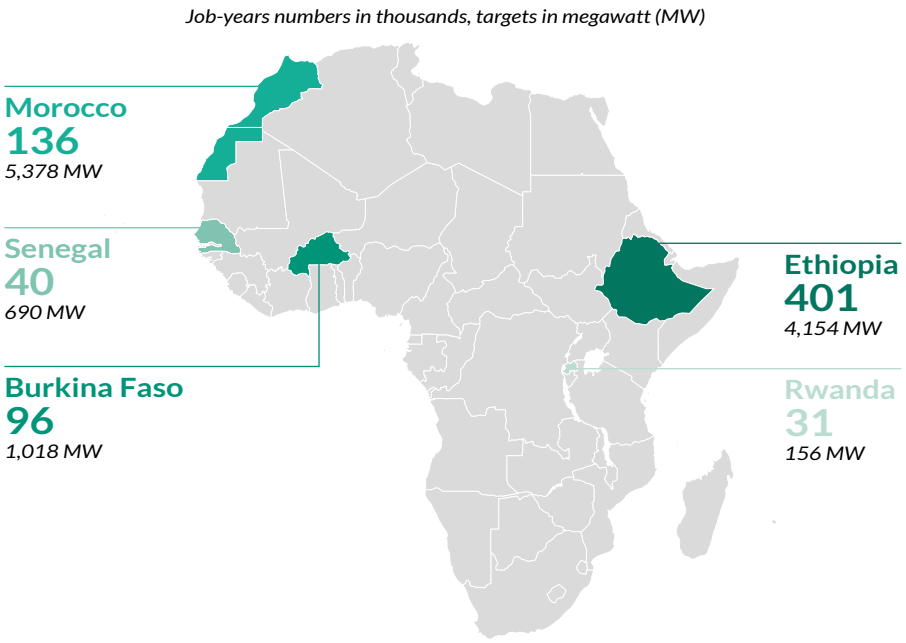


Figure 6. Job creation in the renewable energy sector in Member/ target countries in **AFRICA** cumulatively up to the target year



Target countries in Asia share similarities with the job creation potential of RE. The job creation potential is considerably higher for RE technologies when compared to gas, which holds a large share of the current electricity mix, notably in Jordan and Vietnam. For instance, when compared to the employment potential of gas, solar PV could create about 2.5 times more job-years in all three stages of the value chain. Similar patterns are found in cases for biomass and wind onshore as portrayed in figure 7.

The high job creation potential of RE technologies is reflected in the job creation impact that RE deployment could have, provided that national RE targets are met. For instance, Vietnam could create up to about 1.5 million job-years, which is reflective of its ambitious RE targets[x] by 2030. Similarly, implementation of the NDC targets of Indonesia implies the generation of about 1.8 million job-years, which would multiply during the energy transition phase when fossil fuels are superseded by RE. Given that job creation per unit of electricity produced is often higher in RE technologies than in conventional energy, fossil fuel-intensive countries like Indonesia could curb pandemic-induced unemployment rates through RE deployment—an added co-benefit to the reduced environmental and health hazards that RE technologies offer.

Figure 7. Median EF for Member/target countries in **ASIA** in 2020

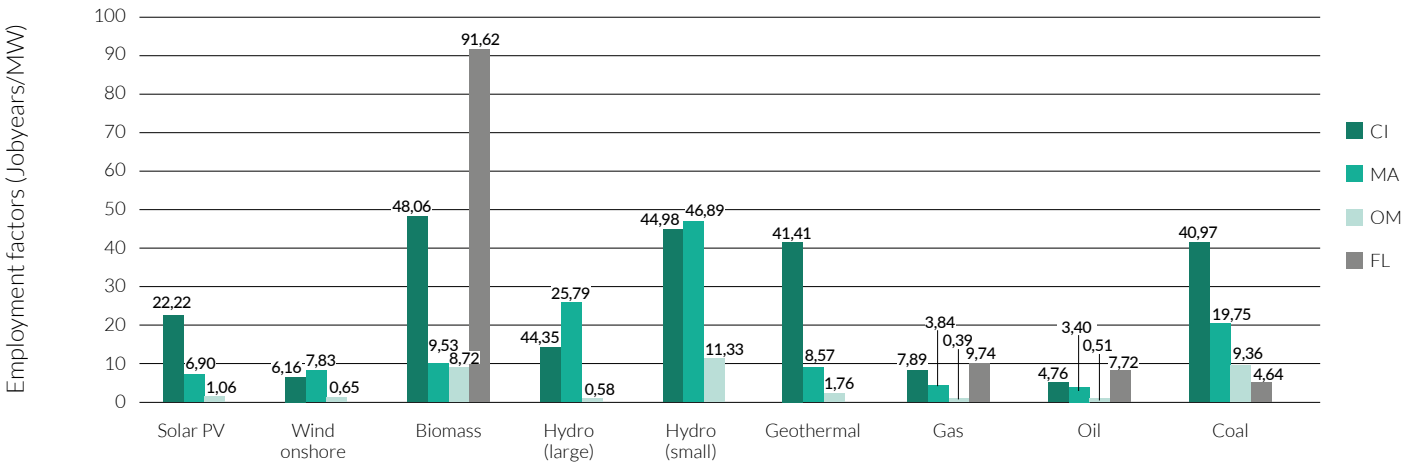
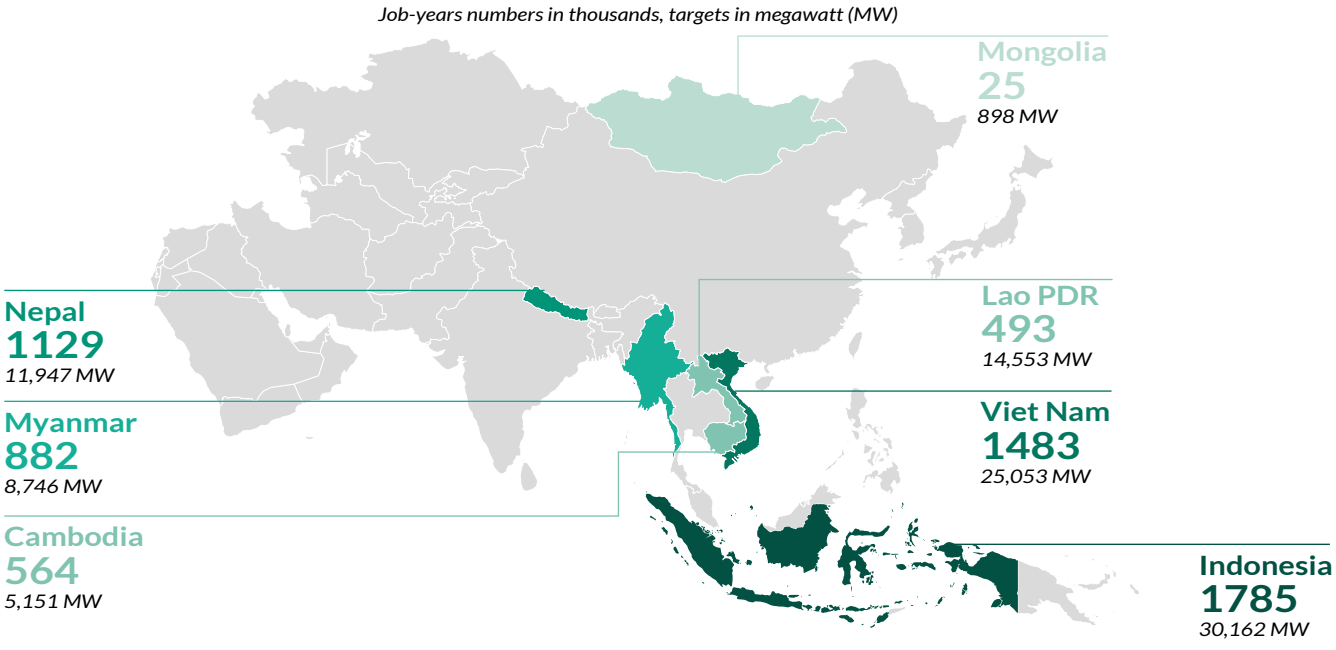


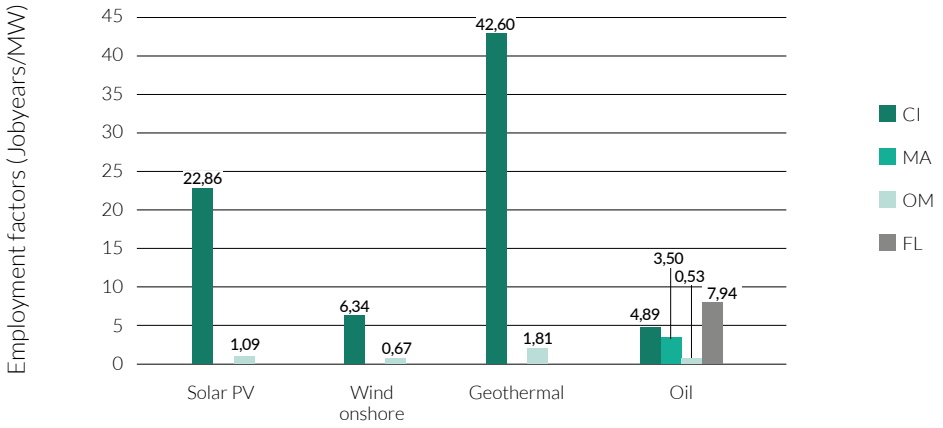
Figure 8. Job creation in the renewable energy sector in target countries in **ASIA** cumulatively up to the target year



x These targets are taken from The Revised National Power Development Plan (PDP) for 2011-2020 with a vision to 2030 (revised PDP VII) (2016).

Regarding the three target countries in the Caribbean,[ix] where oil constitutes more than 95% of the electricity mix in 2019, results suggest significant job creation potential in the C&I stage for RE technology. This is most prominent in solar PV—a technology that was included in all energy targets in these countries—where over four times more job-years in C&I could be created when compared to oil. This is reflected in the estimated 6,000 job-years that would be created in Antigua and Barbuda by implementing the pledged target, which would create annual job-years that can employ about 7.6% of the local labor force in the energy sector.[22]

Figure 9. Median EFs for Member/target countries in the **CARIBBEAN** in 2020



For target countries in Latin America, the current electricity mix is dominated by hydropower, as the main source of RE, closely followed by gas.[xii] Despite the relatively low share of solar PV in the electricity mix, it is commonly associated with the countries' targets. This sets an optimistic outlook for countries in Latin America in terms of employment impacts since the potential job-years that could be created by deployment of solar PV are significantly higher than for gas, and this applies to *all* stages of the value chain. Solar PV can create 2.8 times more job-years in C&I, approximately 1.4 times more job-years in the manufacturing stage, and 2.7 times more O&M job-years—all in comparison to gas.

For countries, like Peru, that already have a sizeable proportion of electricity generated from hydropower, green recovery could be pursued by exploring the job potential offered by other RE technologies, like solar PV and wind onshore, which could generate more jobs in almost all stages of the value chain relative to fossil fuel–based technologies. Similarly, for countries like Mexico, where electricity generation relies on gas as its main energy source, a large number of jobs per capacity installed could be created by incorporating solar PV, or even wind power, to meet the increasing energy demand in future while simultaneously addressing the unemployment rate that has risen due to the impact of the pandemic.[xiii]

To illustrate, results reveal job opportunities that amount to over 1 million job-years cumulatively for a period of 11 years up to 2030 in Mexico if the country implements the targets set under the Climate Law documented in a previous GGGI analysis.[23] This can employ almost 26% of the current labor market in the electricity industry annually.[24] Consequently, implementation of RE targets could be the key to expediting green recovery processes, which is particularly relevant for regions such as Latin America and the Caribbean, where the impacts of the COVID-19 pandemic on labor markets were severely felt (ILO, 2021).

xi The three Caribbean countries are Antigua and Barbuda, Grenada, and Saint Lucia.

xii Based on the electricity mix of the three Latin American countries in 2019. See https://ourworldindata.org/electricity-mix.

xiii International Labour Organization, ILOSTAT database. Data retrieved on June 15, 2021.

Figure 10. Median EFs for Member/target countries in the **LATIN AMERICA** in 2020

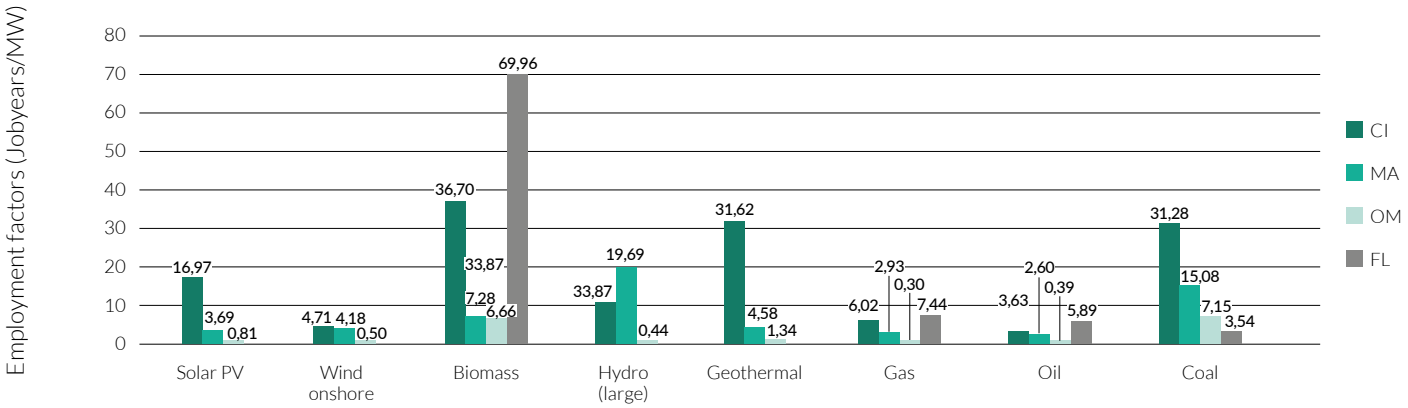
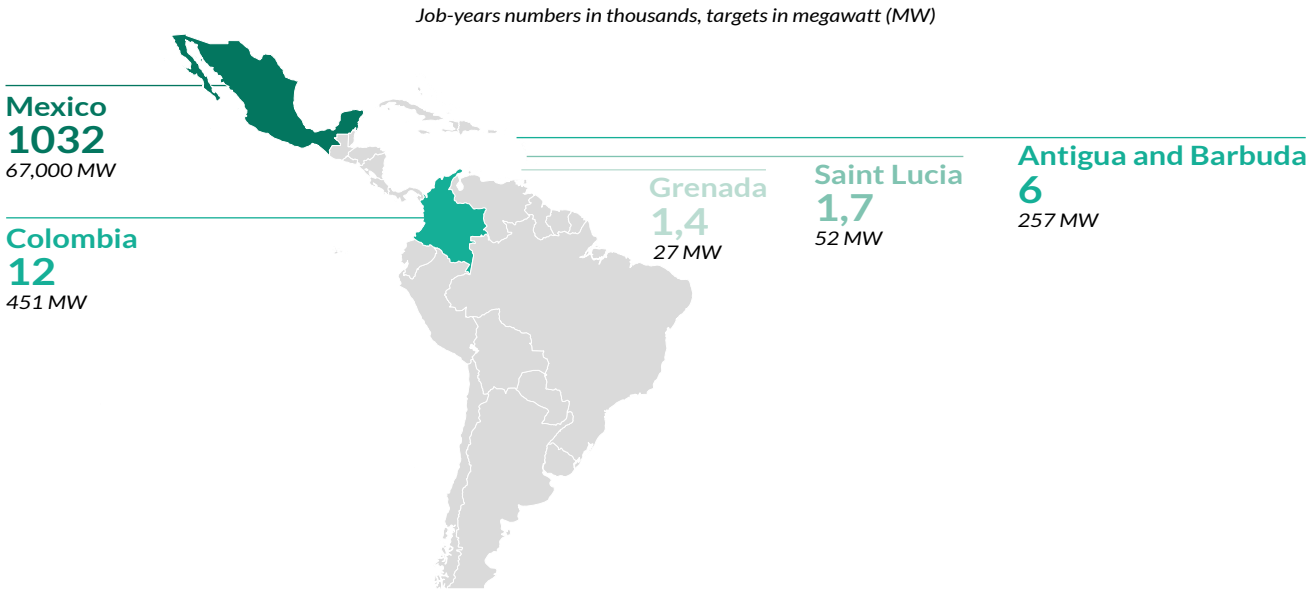


Figure 11. Job creation in the renewable energy sector in target countries in **LATIN AMERICA** and the **CARIBBEAN** cumulatively up to the target year



The results demonstrate positive employment impacts of RE deployment in target countries in Oceania. This is particularly relevant for C&I job-years, which are considerably more numerous for RE technology than for fossil fuel–based technologies, namely oil in Tonga, Solomon Islands, and Kiribati, which accounts for over 85% of the current electricity mix, and gas in Papua New Guinea, which generates about 27% of the national electricity.[xiv] For instance, solar PV and wind onshore—the two most frequently quoted technologies in the NDCs of the Member countries—suggest job creation potential in the C&I stage that was higher than oil by 4.7 times and 1.4 times, respectively. Moreover, similar patterns can be seen in biomass—not only in the C&I stage but also in the manufacturing stage, where it could create four times more job-years per capacity installed than oil.

These are important findings, considering that many of the Oceanian target countries' energy targets address solar PV and biomass. These targets translate to a total of almost 6,000 full-time equivalents (FTEs) and about 9,000 FTEs for Fiji and Solomon Islands, respectively, by 2030. When factoring in the current labor market and energy demand of SIDS, jobs created by implementing the NDC targets would contribute significantly to the local job market. Tonga, for instance, would add about 2,000 job-years by 2030, which, once annualized, is double the total labor force in the local electricity[xv] supply sector[25].

Overall, investments in implementing RE targets offer substantial job creation potential, particularly in Africa and the Caribbean. Results underscore the role of RE deployment in creating jobs that would expedite the green recovery process, with clear opportunities in the C&I sectors as well as manufacturing in target countries (i.e., those in Latin America and Africa).

xiv Data on the electricity mix per country was retrieved from Our World Data. Figures from 2019 were considered when calculating the proportion of a technology in the total electricity mix.

xv This sector is more specifically labeled as electricity, gas, steam and air conditioning supply on the Tonga Statistics Department database.

Figure 12. Median EFs for Member/target countries in **OCEANIA** in 2020

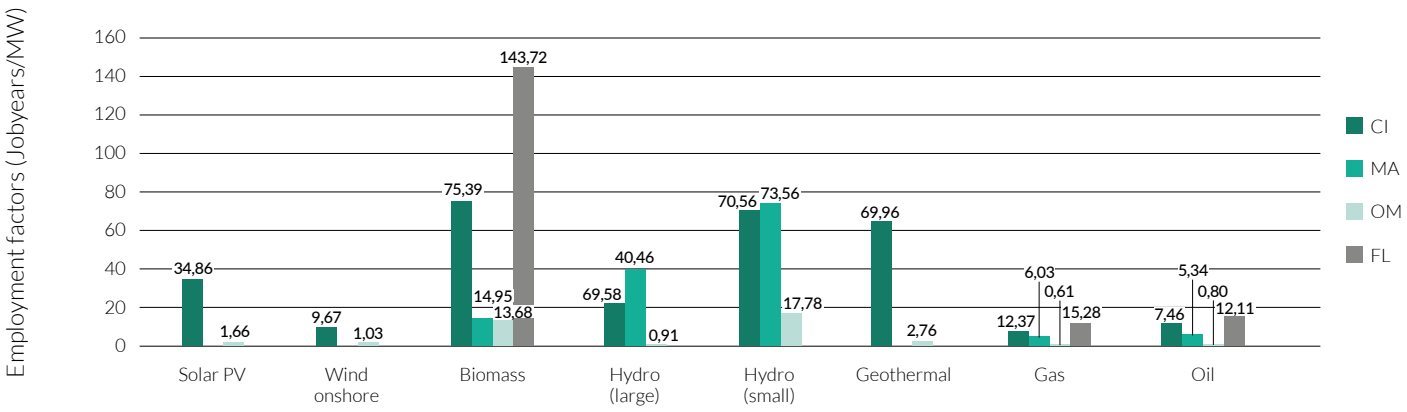


Figure 13. Job creation in the renewable energy sector in target countries in **OCEANIA** cumulatively up to the target year

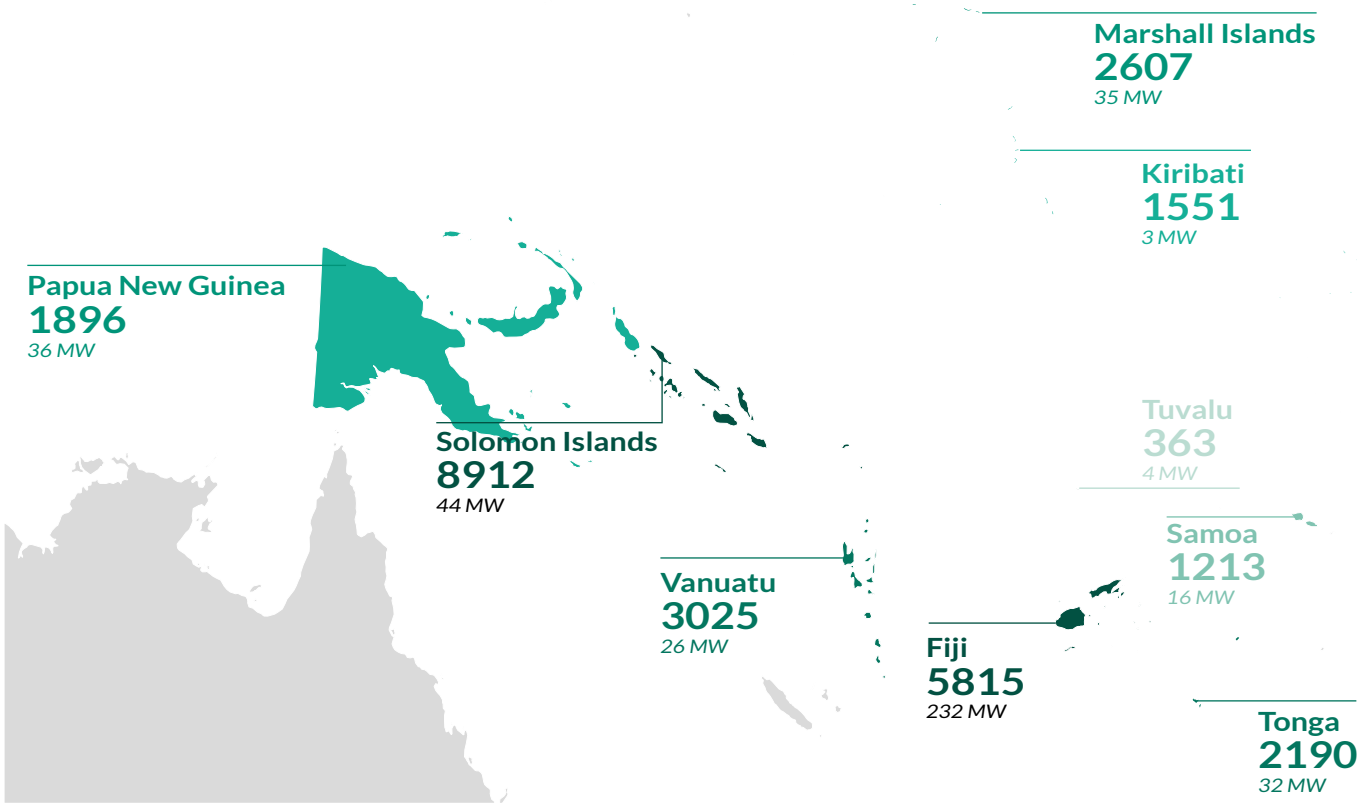


Table 2. RE targets and investment requirements

	Country	Target Year	Update Status	SPV		WON		BIO		HYL		GEO		Aggregated	
				Targets (MW)	Investments (US million $)	Targets (MW)	Investments (US million $)	Targets (MW)	Investments (US million $)	Targets (MW)	Investments (US million $)	Targets (MW)	Investments (US million $)	Targets (MW)	Investments (US million $)
Africa	Burkina Faso	2030	First NDC Updated	649.62	155.6	-	-	10	22.1	358.2	653				5.3
	Ethiopia	2030	INDC	-						4154.4	2769.6				
	Morocco	2030	First NDC Updated	2000	6026	2188	2925			1198	1124.5				
	Rwanda	2030	First NDC updated							156.3	472.6				
	Senegal	2030	First NDC	201	276.4	200	390.4	50	260.4	239	475			2658.1	
Asia	Cambodia	2030	National Report	1725	1975.1			29	82.2	3397	13234.3				
	Indonesia	2030	First NDC	883.4	1268.7	99.8	236.2	9447	26782.2	15842.7	44439.4	3888.9	16219.5		
	Jordan	2025	First NDC	586	671			24.7	70.1						
	Lao PDR	2030	First NDC Updated	993	1137	300	2.5	260	737.1	13000	27372.4				
	Mongolia	2030	Updated NDC (NDC Action Plan)	56	573	198	584			644	1350				
	Myanmar	2030	Unpublished updated NDC	3076.9		2.1				5676					1209
	Nepal	2030	National Report	750.3	859.1	10	23.7			11187	43576			1032.3	28400
	Viet Nam	2030	National Report	7304	8363.1	5623	13315.3	2394.5	6788.4	9731	37910.8				79.9
Caribbean	Antigua and Barbuda	2030	IRENA roadmap	199	386.1	58	90.2								
	Grenada	2025	Second NDC	10	14.6	2	4.4					15	81.1		
	Saint Lucia	2025	NDC partnership Plan	10	50	12	18.7					30	162.3		
Latin America	Colombia	2030	First NDC updated	451.3	647.6										
	Mexico	2030	GGGI publication	33000	47355	34000	58412								

Abbreviations: SPV – Solar PV, BIO – Biomass, HYL – Hydro (Large), HYS – Hydro (Small), GEO – Geothermal, WON – Wind onshore

Note 1: "Hydro (Large)" includes targets and investments for both large and small hydropower.

Note 2: Countries that are yellow have explicitly reported the investment needs in their NDCs or national plans.

Note 3: Unconditional targets are light green, whereas conditional targets are orange. When targets were reported with an unconditional and conditional component, the numbers were aggregated and uncolored. More detailed information on the unconditional and conditional components of targets can be found in Annex C.

Table 2. RE targets and investment requirements (cont.)

	Country	Target Year	Update Status	SPV		WON		BIO		HYL		GEO		Aggregated	
				Targets (MW)	Investments (US million $)	Targets (MW)	Investments (US million $)	Targets (MW)	Investments (US million $)	Targets (MW)	Investments (US million $)	Targets (MW)	Investments (US million $)	Targets (MW)	Investments (US million $)
Oceania	Fiji	2030	LT-LEDS	162.8	315.8	46.7	72.6	23	131.7						
	Kiribati	2025	First NDC	0.7	1.9			2.1	12						
	Marshall Islands	2030	National Electricity roadmap	19.6	44	15	70								
	Papua New Guinea	2030	Second NDC	16.1	86.7					20	168.7				
	Samoa	2025	First NDC			0.6	1.2	12	68.7	3.5	7.1				
	Solomon Islands	2030	First NDC	1.6	5.4					12.3	41.1	30	150		
	Tonga	2030	Second NDC (+INDC)	13.7	26.6	17.7	27.5	0.8	4.6						
	Tuvalu	2025	National Report	3.1	6.1	0.8	1.2							4	16.2
	Vanuatu	2030	First NDC	17.5	34							8	43.3		

Abbreviations: SPV – Solar PV, BIO – Biomass, HYL – Hydro (Large), HYS – Hydro (Small), GEO – Geothermal, WON – Wind onshore

Note 1: "Hydro (Large)" includes targets and investments for both large and small hydropower.

Note 2: Countries that are yellow have explicitly reported the investment needs in their NDCs or national plans.

Note 3: Unconditional targets are light green, whereas conditional targets are orange. When targets were reported with an unconditional and conditional component, the numbers were aggregated and uncolored. More detailed information on the unconditional and conditional components of targets can be found in Annex C.

Table 3. Direct job creation of RE investments cumulatively up to the target year

	Country	Economic Status	Target Year	SPV	WON	BIO	HYL	GEO	Total
				Job Years					
Africa	Burkina Faso	LDC	2030	91,461		5,138			96,599
	Ethiopia	LDC	2030				401,542		401,542
	Morocco	MIC	2030	56,412	39,301		40,519		136,231
	Rwanda	LDC	2030				31,650		31,650
	Senegal	LDC	2030	9,883	6,262	8,942	15,375		40,462
Asia	Cambodia	LDC	2030	165,836		9,138	389,733		564,706
	Indonesia	MIC	2030	30,986	1,937	940,251	573,602	238,204	1,784,980
	Jordan	MIC	2025	12,779		1,567			14,346
	Lao PDR	LDC	2030	27,692	5,359	27,547	432,696		439,294
	Mongolia	MIC	2030	1,474	3,339		20,230		25,042
	Myanmar	LDC	2030	195,008	79		687,464		882,552
	Nepal	LDC	2030	61,695	355		1,066,912		1,128,962
	Viet Nam	MIC	2030	466,342	51,193	435,671	529,931		1,483,137
Caribbean	Antigua and Barbuda	SIDS	2030	4,835	1,142				5,978
	Grenada	SIDS	2025	426	41			973	1,440
	Saint Lucia	SIDS	2025	224	166			1,310	1,700

Abbreviations: LDC – Least Developed Countries, SIDS – Small Island Developing States, MIC – Middle Income Countries

Table 3. Direct job creation of RE investments cumulatively up to the target year (cont.)

	Country	Economic Status	Target Year	SPV	WON	BIO	HYL	GEO	Total
				Job Years					
Latin America	Colombia	MIC	2030	12,393					12,393
	Mexico	MIC	2030	625,326	407,212				1,032,539
Oceania	Fiji	SIDS	2030	3,126	594	2,095			5,815
	Kiribati	SIDS	2025	122		1,429			1,551
	Marshall Islands	SIDS	2030	1,765	842				2,607
	Papua New Guinea	SIDS	2030	454			1,442		1,896
	Samoa	SIDS	2025		5	1,072	135		1,213
	Solomon Islands	SIDS	2030				1,906	7,006	8,912
	Tonga	SIDS	2030	1718	356	116			2190
	Tuvalu	SIDS	2030	327	36				363
	Vanuatu	SIDS	2030	2,095	80			850	3,025

Abbreviations: LDC – Least Developed Countries, SIDS – Small Island Developing States, MIC – Middle Income Countries

Regarding technology addressed in the NDCs, solar PV is most often associated with an ambitious target, followed by wind onshore and large hydropower. All 13 target countries in Latin America, the Caribbean, and Asia include solar PV targets, with eight out of nine countries for Oceania. Moreover, despite the high employment potential of small hydro, targets associated with the technology were few. This can be explained by countries' tendencies to report large and small hydro collectively as "hydro power," which has been interpreted as large hydro unless indicated otherwise. Only six countries reported targets that include geothermal power as most countries in this study do not have the natural endowments and conditions for geothermal power generation.

Information on the investment needs for NDC implementation is crucial in the process of identifying funding sources and financing instruments for achieving RE targets. However, a total of merely 13 countries have explicitly stated the investment requirements for a target (either for all or, more commonly, for selected technologies), in either the NDCs or the national reports. Some of the investment needs were aggregated numbers for all RE activities, namely for Senegal, Nepal, Myanmar, Burkina Faso, and Vietnam. Other NDCs and national reports either exclude details on financial requirements entirely or indicate the combined cost of all mitigation activities, which includes targets outside the scope of the study. This highlights the need for countries to place more importance on making the investment needs explicit to enhance the quality and feasibility of their NDC targets.

Occupations and Skill Requirements of Selected RE Technologies

Varying levels of expertise, skillsets, and occupations are required across the different value chain stages of RE technologies Solar PV has a large proportion of construction workers and technicians relative to professionals—particularly evident in the manufacturing and C&I stages. This entails employment opportunities for blue-collar workers, most of whom will be available domestically with relatively less reskilling and training needed for them to take on RE jobs. A small portion of the workforce includes nontechnical occupations, such as administrative personnel, logistic experts, and market and sales personnel, most of whom can be recruited from other industries including the brown sector. This has important socioeconomic implications since the income of workers in LDCs, including SIDS, often cannot cover the cost of vocational training needed to perform the specialized tasks in high-skilled occupations. Similar job opportunities for blue-collar workers exist in the onshore wind sector, mostly in the C&I stage, where activities like site preparation and transportation of equipment are highly labor-intensive, requiring a low to medium level of skills.[26] Moreover, C&I work is common for many construction projects, so resources and capacities can be domestically available with relatively limited training and skilling requirements, which entails reduced obstacles in implementing this stage of wind projects.

However, the proportion of professionals and managers with specialized skills is higher in wind technology than that in solar PV.[27] This reflects the complexity of the technologies involved in wind power deployment, particularly in the manufacturing and O&M phases. Occupations in need include high-skilled operators and industrial and telecommunication engineers who must have a high level of expertise in wind operations to attend to any breakdowns or technical disruptions that occur over the course of operation.

Such high-skilled labor positions are often more difficult to recruit, which demonstrates a misalignment[28] that could potentially stem from energy transition: *educational misalignment*, which refers to the mismatch between the skills associated with the jobs being phased out (i.e., brown jobs) and the newly generated RE jobs. This is most relevant to LDCs where access to technology and industries of similar kinds are limited. Therefore, the importance of vocational training and reskilling should be reemphasized, particularly in the context of the green economic recovery, to ensure that sufficient human resources are available in such specialized occupations.

Part of this can be done by incorporating science, technology, engineering and mathematics education in university degrees; specialized training courses for existing workers; and collaborative workshops with universities or research labs to offer employees expert training opportunities. This also opens the door to providing training opportunities to women, who are often underrepresented in the field of RE technologies,[29] with particular emphasis on enhancing the accessibility of training courses. This can be achieved by considering women's child care responsibilities and social restraints that may hinder women participation when constructing relevant policies and training programmes. RE deployment and the preceding vocational trainings offer new opportunities to the younger population which is particularly relevant to countries with a young population, like Indonesia, where together with its resources and untapped RE capacities, green growth and, ultimately, energy transition can be achieved with relative ease, provided that effective training systems are in place, supported by policies that stabilize and expedite the energy transition.

4. Assessing Forestry Employment in Developing and Emerging Economies

Compiling Forestry Targets of NDCs

A total of 31 countries were reviewed upon submitting their NDCs, 16 of which reported forestry targets that matched one of the EF categories. Of the 16 countries, 14 presented quantified forestry targets that could be used to estimate the number of job-years created with the achieved targets.

To assess the employment opportunities in the forestry sector, NDC targets that were reported under or in relation to the Agriculture Forestry and other Land Use (AFOLU) and Land Use and Land Use Change and Forestry (LULUCF) sectors were reviewed. In some cases, forestry targets were included under other areas, such as agricultural, infrastructure, and land-use planning. Only forestry-related targets were included in the assessment, whereas targets not related to forestry were excluded.

The most common ways of reporting quantified forestry targets were in hectares, USD of investment, and CO2e emissions reductions. Forestry targets that were not provided with specific units or were vague in wording were not included in the assessment. The **primary volume spatial indicator for the forestry targets** used here is the **surface area measured in hectares**. Where NDC forestry targets were given in other units, the number of equivalent hectares was derived using different sources of information. For example, in some cases, the number of hectares or the amount of investment requirements required had to be calculated separately. This was possible either because of additional information provided by National experts or because further information was collected through the review of other official documents, including NDC roadmaps, REDD+ strategies, and national forestry strategies.

In addition, some targets presented with associated sub-targets were carefully reviewed to ensure avoidance of double counting. Whenever different targets appeared to relate to the same

objective, such as focusing on the same area of land or on the general deforestation and degradation of forests, the overall target with reported values was chosen. Similarly, when the same targets were related to both mitigation and adaptation, as well as to avoid double-counting, the target was included and counted only once, either under either the mitigation or an adaptation objective.

NDCs presented different types of targets regarding their conditionality. In most cases, NDCs reported targets to be either unconditional or conditional. To accomplish these reported targets, the implementation is straightforward, either with or without international support. In a few cases, countries presented both unconditional and conditional targets for the same forestry activities or targets. Conditional targets are considered to be additional to the unconditional targets. Therefore, with the provision of international support, such conditional targets could be achieved, and a greater number of job-years can be created compared to the unconditional scenario. Detailed information on all targets and their conditionality can be found in Annex E.

Matching NDC Forestry Targets with EF Categories

For this assessment, EFs composed by Nair and Rutt[30] and WWF-ILO[31] were used to estimate the number of job-years that certain forestry activity categories create. Even though the original study by Nair and Rutt was published in 2009, ILO and WWF used the EFs of this study in a recent report in 2020. Given that there is no other study providing EFs of forestry activities, these two studies were considered the most relevant in the field of job assessments in the forestry sector[xvi]. Since these are global studies and include developed as well as developing countries, it should be highlighted that the derived EFs are generic estimates.

Nair and Rutt identified nine different types of employment categories in the forestry sector that provide EFs expressed in **FTE per hectare and FTE per USD million**. The WWF-ILO report, other than the job creation activities mentioned by Nair and Rutt, introduces additional forestry employment categories that are integral to the implementation of nature-based solutions. Among these additional categories, one category was added to the assessment as it was relevant to NDC forestry targets.

In summary, the following EF categories from the two aforementioned studies were used: 1) afforestation, reforestation and desertification control; 2) improvement of productivity of existing planted forests; 3) watershed improvement; 4) indigenous forest management; 5) forest conservation; 6) agroforestry; 7) fire management; 8) urban and peri-urban forestry; 9) skill improvement of forestry and wood industry workers; and 10) management and conservation of protected areas and buffer zones. More detailed explanation of the 10 forestry categories is given in Annex D.

After obtaining all forestry targets from the NDCs, the targets were matched to the different EF categories. The matching process was not always straightforward. Sometimes targets were not clear in their objectives or contained objectives that are not included in any of the 10 EF categories. Whenever targets were not clear or could not be matched, they were excluded from further steps.

Nair and Rutt provide estimates for jobs (FTE), annual target area (hectares), and approximate annual outlay (USD). Based on the provided estimates, the number of FTEs created per hectare or per USD million invested was calculated and applied to the reported NDC targets. Ultimately, the number of job-years that would be created if the NDC targets were implemented was obtained. The estimations of the job creation potential of the forestry targets do not take into account the jobs that might be displaced through their implementation, particularly with regard to reduced deforestation and degradation rates.

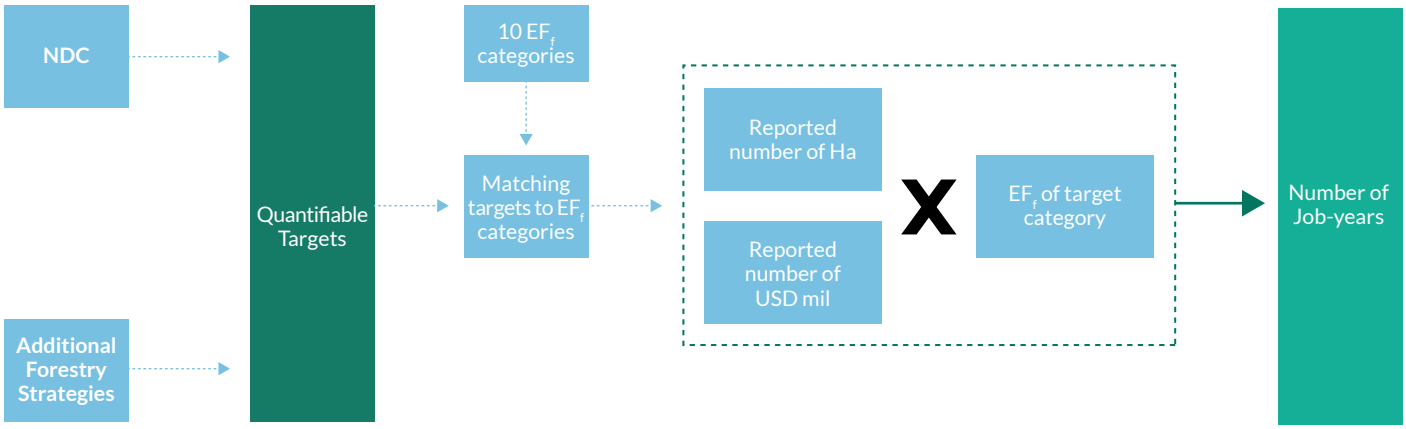
Both studies by Nair and Rutt and WWF-ILO provide a range of the minimum and maximum numbers of jobs that can be created by 10 forestry employment categories involving different types of employment activities. The use of ranges on EF values attempts to consider country and regional differences. Since most of the countries of our sample are low-income countries with relatively low labor productivity, the job creation potential is assumed to be in the high range. Similarly, the lower the level of income and labor productivity, the closer the job creation potential would be to the high range.

However, certain sub-targets that are directed at different types of employment activities were included in the first step of matching the NDC targets to the EF categories. This procedure was performed to identify what kind of employment activities are generally identified through NDCs. The decision of including and excluding certain targets for estimating their job potential was made based on the presumption that jobs will be created if a certain target is achieved. In some cases, this refers to a few main targets that contain smaller sub-targets. It is important to note though, that this relationship actually works also the other way around: the target will be achieved if the work force is well equipped and prepared to undertake these jobs and fill them in.

Forestry Targets that different NDCs reported and projected for their forestry sectors showed a wide variety of objectives. Targets were not always all communicated clearly, and in some instances, further explanations and interpretations were required. These were either obtained through a review of additional documents that the NDC referred to, such as REDD+ or National Forestry Sector Strategies, or through additional information provided by GGGI country offices. Where available, targets not explicitly mentioned in the NDC but that were mentioned as being in additional documents were included in this assessment.

xvi It is important to note that although the EFs for forestry have been used recently by ILO/WWF, still the initial forestry factors developed in 2009 might be considered outdated. Therefore a new in depth bottom-up study or series of studies, based on surveys or Input-Output modelling, could be conducted and provide more updated EF values for forestry activities.

Figure 14. EF approach for forestry



Assumptions, boundaries and limitations

The **primary volume spatial indicator for the forestry targets** used here is the surface area of forest cover measured in hectares. Where NDC forestry targets were given in other units, the number of equivalent hectares was derived using different sources of information.

Necessary **information that was required to calculate the values of such targets** included the number of hectares for a country's specific forest area or, in some cases, the current baselines of the targets. Some targets involved planting a specific number of trees. Even though the number of tree seedlings planted per hectare varies according to many factors—such as forest type, climate, and site conditions—for this assessment, these targets were calculated by following the assumption that 1,000 seedlings would be planted per hectare.[32]

Occasionally, forestry targets indicated **annual rates**, like decreasing an annual deforestation or degradation rate or increasing an annual reforestation and restoration rate. These targets, implying an annual number of hectares of a specific forestry activity, were calculated according to the NDCs' time frame, by multiplying the reported annual hectares by the number of years from the baseline year up to 2030.

The assessment provides all updated or **most recent baselines** for all reviewed NDCs. In most cases, NDCs were updated and submitted to the UNFCCC in the year 2020 and aimed for completion by 2030. The time frame for these NDCs is therefore 11 years, assuming the baseline is 2019, one year before the publication of the NDC, and considering the year 2020. Whenever targets or NDCs did no report baselines, the baseline was assumed as the year before the publication, considering the time to compose the NDC before submission. The most common baselines were 2015, 2019, and 2020, representing time frames between 10 and 15 years in which additional targets are planned to be implemented.

Quite often, NDC targets aimed for a reduction of deforestation and degradation. This study does not account for jobs that might be lost due to the implementation of these targets and limitation of activities that cause deforestation and degradation.[xvii]

In some cases, targets were reported with corresponding CO2e emission reductions, which they would contribute if achieved. We include CO2e emissions targets as they were reported in the NDCs. However, CO2e emission figures were not regarded or discussed further in the employment assessment.

The submission dates of NDCs varied, and the updated version was not always available. Countries that have not submitted an updated NDC present a high likelihood of NDCs containing outdated targets that might be already partially or fully achieved. Whenever possible, the most recent status of target achievement was acquired to ensure that all presented targets expressed in number of hectares, required investments, and the potential creation of jobs are as up to date as possible.

xvii Based on experts' judgments the main causes of current deforestation and land degradation are, among others, illegal clearing of forests for firewood, overgrazing, fires, water erosion, illicit crops, conversion to grassland, unplanned infrastructure development, and logging and global warming. According to FAO (2020) the drivers of deforestation in primary forests are context specific but include unsustainable industrial timber extraction, agricultural expansion and fires which are often associated with infrastructure and logging-site development.

In addition, information on whether **forestry targets are unconditional or conditional** was often lacking. As a result, unclear targets are subject to uncertainties and assumptions. Assumptions about targets' conditionality were made based on the previously mentioned NDC review approach.

Further limitations were encountered for targets that were not informative enough regarding their measurements. If no additional information could be gathered, targets could not be calculated, and eventually the new jobs created could not be estimated. Consequently, these targets have been disregarded in this assessment.

Applying the EF approach based on the study by Nair and Rutt in 2009 and the report from ILO and WWF in 2020, a major challenge was to match the NDC forestry targets to the defined EF categories and the according employment activities. Since targets might depend on the country's forestry context, and different kinds of activities might be behind setting these targets, the decision of which target to match with which category was highly constrained. Limited options to align the targets with specified employment categories led to the result of leaving targets out of the estimation for new jobs, because of the absence of any suitable categories. This demonstrates a major constraint and shows the existing discrepancy between the current situation of what NDC forestry targets report and what is captured so far in studies to approach the estimation of employment in this sector. Further country-level employment studies, with a more fine-grained approach, are needed to assess the employment creation potential and reflect the exact activities and targets of NDCs, National Forestry strategies and green recovery plans more accurately.

Results

Forestry targets

Upon collecting all forestry quantified targets from reviewed NDCs, the majority of targets relate to mitigation, aiming to reduce CO2e emissions. Only a few targets are reported as adaptation targets.

By matching the NDC forestry targets to the 10 EF forestry categories, it can be observed that the most common forestry targets refer to afforestation, reforestation activities, and desertification control. Other common targets include activities such as forest conservation and indigenous forest management. There were no NDC forestry targets identified matching EF forestry categories related to urban and peri-urban forestry and the improvement of productivity of existing planted forests.

Table 4 presents the results of the matching process of NDC forestry targets to the EF categories. Targets were divided into mitigation and adaptation targets, and the same targets were grouped together. In addition, the table indicates the FTE per hectare for each category.

According to Nair and Rutt, in afforestation and reforestation—the most common forestry targets reported in the NDCs—important sources of employment contain activities such as land preparation, production of planting material, and planting maintenance, which would be adapted to local conditions, knowledge, and skills. Regarding forest conservation, employment activities such as demarcating boundaries of protected areas, maintaining paths and trails, developing recreation sites, and establishing nature education and information centers are included.

Looking at the EFs, compiled by Nair and Rutt, the highest job creation potential appears in urban and peri-urban forestry (1-5 FTE/ ha) and watershed improvement (1-3 FTE/ ha) and the lowest in management conservation of protected areas and buffer zones (0.0002 – 0.004 FTE/ ha) and improvement of existing planted forests (0.05-0.1 FTE/ ha).[33]

Despite the highest employment creation potential, urban and peri-urban forestry activities were not reported in any of the reviewed NDCs. This is somehow expected, considering that forestry under the NDCs is a national matter that aims to enhance national carbon sinks at a large scale, while urban and peri-urban forestry projects' mitigation potential is relatively limited. However, considering the multiple benefits that urban and peri-urban forestry and nature-based solutions provide to urban dwellers, including the high potential of jobs creation (for unemployed urban residents), then national and sub-national governments need to align their forestry strategies, particularly in the context of COVID-19 recovery. This means that in a few cases the jobs creation potential of reforestation/ afforestation and reduced deforestation targets might have been underestimated. More detailed description and understanding of the exact sub-activities of the targets could shed some light on this issue.

Looking at the **required investments to carry out those targets**, it becomes clear that in most cases additional finance is needed. The majority of the targets are declared to be achieved under conditional circumstances with required international support.

Often, only one version of the NDC draft had been submitted to the UNFCCC. After reviewing and comparing older and newer NDCs, few concrete conclusions could be made. A few countries seem to have enhanced their NDCs in terms of reporting more ambitious forestry targets. In some cases, targets were the same, and no differences in the updated NDC draft were identified. Lastly, in many cases, making a comparison was difficult due to different wording of targets or different units of measure presented.

Table 4. Matching NDC forestry targets to EF categories

EF Category	Afforestation, reforestation and desertification control		Forest conservation		Watershed improvement		Skill improvement of forestry and wood industry workers		Indigenous forest management		Fire management		Management and conservation of protected areas & buffer zones		Agroforestry		Urban and peri-urban forestry		Improvement of productivity of existing planted forests	
FTE / Ha	1	0.8	0.15	0.1	3	1	-	-	0.5	0.25	0.125	0.1	0.004	0.0002	0.0375	0,25	5	1	0.1	0.05
Mitigation	Increase area of specific land/forests (3)		Reducing deforestation (2)		Improving peat water management		Promoting downstream processing of logs		Sustainable forest management		Reduce area burned due to late fires/ controlled fires				Development/ Encouraging agro-forestry initiatives					
	Restorative activities of ecosystems (2)		Reducing deforestation of specific areas / forests (2)				Enhanced application of timber legality standards and permitting processes		Forests under community-based management		Reduce area burned by bushfires									
	Increase reforested / restored areas (2)		Reducing degradation (2)																	
	Forest cover to reach a certain % (2)		Protection of forests (2)																	
	Rate of Rehabilitation (2)		Peatland deforestation / degradation (2)																	
	Forestation / reforestation (2)		Defence forests																	
	Forest plantations for commercial purposes		Trend of expected deforestation																	
	Development of Industrial Plantation Forest		Maintain a % of land under forest cover																	
	Protection / Afforestation of special-use forest		Avoided degradation																	
	Afforestation																			
	Planting trees																			
	Peatland restoration																			
Adapatation	Promote afforestation / reforestation of designated areas		Protection of an area		Protect stream banks				Assisted natural regeneration (ANR)				Diveristy conservation space		Agroforestry / Sustainable Agriculture Development					
	Planting trees								Improve Forest Management											

Note: The numbers in parentheses indicate the number of times that the respective forestry activity has been reported in the reviewed NDCs.

Number of jobs

After reviewing 31 countries, 14 NDCs presented quantified targets with sufficiently available information to estimate the number of FTE job-years after matching the forestry targets to the EF categories. The following table shows all estimated results in number of job-years created and the required investment for reported NDC forestry targets. Every country is stated with their economic status (i.e. MIC, LDC, or SIDS), the NDC that reports the targets, the intended target year, whether targets are mitigation of adaptation targets, the reported NDC forestry targets, which EF category the targets were matched with, the reported units of hectares, and investment with the estimated job-years per target as well as the total number of job-years per country.

Table 5. Direct job creation potential of Forestry investments to achieve the NDC targets in job years for the 11-year period of analysis

	Country	Economic Situation	NDC Status	Target Year	M/A	NDC Target	EF Category	Reported Units & Estimated Job-years				Total	
								Ha	USD million	Job-years		Job-years	
										Min	Max	Min	Max
Africa	Burkina Faso	LDC	First NDC	2030	M	Forestation / Reforestation project	Afforestation, reforestation and desertification control	-	65	32,469	40,586	262,649	534,186
					A	Protect stream banks	Watershed improvement	30,000	13	30,000	90,000		
						Assisted natural regeneration (ANR)	Indigenous forest management	800,000	134	200,000	400,000		
						Diveristy conservation space	Management and conservation of protected areas & buffer zones	900,000	504	180	3,600		
	Morocco	MIC	First NDC Updated	2030	M	Restorative activities of ecosystems	Afforestation, reforestation and desertification control	700,000	825	560,000	700,000	680,000	880,000
						Avoided degradation	Forest conservation	1,200,000	612	120,000	180,000		
	Rwanda	LDC	First NDC Updated	2030	A	Promote afforestation / reforestation of designated areas	Afforestation, reforestation and desertification control		16.84	8,418	10,522	56,078	82,826
						Improve Forest Management	Indigenous forest management		8.13	1,627	3,254		
						Development of Agroforestry and Sustainable Agriculture	Agroforestry		92.07	46,033	69,050		
	Senegal	LDC	First NDC	2030	M	Increase reforested / restored areas of mangroves	Afforestation, reforestation and desertification control	58,267	455	46,614	58,267	681,414	864,267
						Increase reforested / restored areas of various plantations		731,000		584,800	731,000		
						Defence forests	Forest conservation	500,000		50,000	75,000		

Abbreviations: LDC – Least Developed Countries, SIDS – Small Island Developing States, MIC – Middle Income Countries.

Note 1: The investment described for Senegal implies additional targets, which are not shown in this table here. More information on all the reported forestry targets can be found in Annex E.

Note 2: Orange and light green have been used in the table to classify the reported conditionality of targets. In the case where targets were reported to be achieved unconditionally, the according units are light green. Where targets are to be achieved under conditional conditions, the units are orange. When targets were reported with an unconditional and conditional component, the numbers were aggregated and left uncolored. More detailed information on the unconditional and conditional components of targets can be found in Annex E.

Table 5. Direct job creation potential of Forestry investments to achieve the NDC targets in job years for the 11-year period of analysis

	Country	Economic Situation	NDC Status	Target Year	M/A	NDC Target	EF Category	Reported Units & Estimated Job-years				Total	
								Ha	USD million	Job-years		Job-years	
										Min	Max	Min	Max
Asia	Cambodia	LDC	First NDC Updated	2030	M	60% forest cover	Afforestation, reforestation and desertification control	3,268,866	5,230	2,615,093	3,268,866	2,615,093	3,268,866
	Indonesia	MIC	First NDC	2030	M	Rate of HTI development	Afforestation, reforestation and desertification control	7,040,000	11,264	5,632,000	7,040,000	16,680,250	26,799,550
						Rate of rehabilitation without rotation		3,047,000	4,875	2,437,600	3,047,000		
						Rate of rehabilitation with rotation		3,619,000	5,790	2,895,200	3,619,000		
						Peatland restoration		345,000	552	276,000	345,000		
						Improving peat water management	Watershed improvement	2,483,000	15,498	2,483,000	7,449,000		
						Sustainable forest management	Indigenous forest management	6,919,000	8,649	1,729,750	3,459,500		
						Peatland deforestation rate	Forest conservation	57,000	20	5,700	8,550		
						Peatland degradation rate		57,000	20	5,700	8,550		
						Mineral land deforestation rate		6,046,000	2,116	604,600	906,900		
						Mineral land degradation rate		6,107,000	2,137	610,700	916,050		
	Lao PDR	LDC	First NDC Updated	2030	M	Increase forest cover to 70% of land area	Afforestation, reforestation and desertification control	2,842,286	1,700	2,273,829	2,842,286	2,273,829	2,842,286
	Myanmar	LDC	First NDC Updated	2030	M	Increase land under Reserved Forest and Protected Public Forest to 30%	Afforestation, reforestation and desertification control	3,078,429	4,925	2,462,744	3,078,429	4,708,982	5,886,228
						Increase Protected Areas Systems (PAS) to cover 10% of national area		2,807,798	4,492	2,246,239	2,807,798		
	Nepal	LDC	Second NDC	2025	A	At least 200,000 ha areas are protected	Forest conservation	200,000	70	20,000	30,000	336,825	658,923
				2030	M	Maintain 45% of total area under forest cover		94,542	33.09	9,454	14,181		
						Forests under community-based management comprise 60%	Indigenous forest management	1,229,484	1,536.86	307,371	614,742		
	Vietnam	MIC	First NDC Updated	2030	M	Protection and afforestation of special-use forest	Afforestation, reforestation and desertification control	50,000	80	40,000	50,000	390,000	575,000
						Protection of natural forests	Forest conservation	3,500,000	1,225.00	350,000	525,000		

Table 5. Direct job creation potential of Forestry investments to achieve the NDC targets in job years for the 11-year period of analysis

	Country	Economic Situation	NDC Status	Target Year	M/A	NDC Target	EF Category	Reported Units & Estimated Job-years				Total	
								Ha	USD million	Job-years		Job-years	
										Min	Max	Min	Max
LAC	Colombia	MIC	First NDC Updated	2025	M	Expected deforestation trend	Forest conservation	176,682	366	17,668	26,502	308,475	396,260
				2030		Reduce rate of deforestation		250,000	149	25,000	37,500		
						Ecological restoration	Afforestation, reforestation and desertification control	332,258	532	265,806	332,258		
Oceania	Fiji	SIDS	First NDC Updated	2035	A	Planting trees	Afforestation, reforestation and desertification control	30,000	48	24,000	30,000	24,000	30,000
	Papua New Guinea	SIDS	Second NDC	2030	M	Increase area of planted forest and forest restoration	Afforestation, reforestation and desertification control	10,000	16	8,000	10,000	64,760	95,140
						Area of annual deforestation is reduced by 25%	Forest conservation	91,300	29.05	9,130	13,695		
						Area of forest degradation is reduced by 25%		476,300	151.55	47,630	71,445		
	Tonga	SIDS	Second NDC	2030	M	Planting trees	Afforestation, reforestation and desertification control	1,000	1.6	800	1,000	800	1,000

Abbreviations: LDC – Least Developed Countries, SIDS – Small Island Developing States, MIC – Middle Income Countries.

Note 1: The investment described for Senegal implies additional targets, which are not shown in this table here. More information on all the reported forestry targets can be found in Annex E.

Note 2: Orange and light green have been used in the table to classify the reported conditionality of targets. In the case where targets were reported to be achieved unconditionally, the according units are light green. Where targets are to be achieved under conditional conditions, the units are orange. When targets were reported with an unconditional and conditional component, the numbers were aggregated and left uncolored. More detailed information on the unconditional and conditional components of targets can be found in Annex E.

Implementing the NDC targets will generate many jobs, especially in Lao PDR, Senegal, Cambodia and Indonesia.[xviii] Achieving the forestry targets in Senegal, for example, could add up to 860,000 job-years, while Indonesia could generate up to 26,800,000 job-years. The number of jobs that can be created per year (until 2030) compared to the labor force currently working in the sector of "agriculture, forestry and fishery," equals to 40% in Lao PDR, 30% in Senegal, 9% in Cambodia and 6% in Indonesia.

Out of the 14 countries where job creation potential was estimated, 6 countries are in Asia. The following figure shows the job creation in the target countries in Asia, as well as the NDC forestry target in hectares.

xviii Target information for Indonesia originates from the First NDC Roadmap (2016). In July 2021, Indonesia submitted its Updated NDC with more ambitious targets. Unfortunately, these have not been included in this study.

Figure 15. Job creation in the forestry sector in target countries in **ASIA** cumulatively up to the target year

Occupations and Skill Requirements per Type of Forestry Activity

Various types of skills for different areas of forestry activities are required. Areas of activities in the forestry sector overlap and therefore require knowledge about what occurs in the other areas of activities.[34]

In general, forestry actions require the following occupations and activities:

Occupations and activities related to forest management and conservation

To ensure sustainable and long-term forest management, forest planning- and governance-related occupations and skills are crucial. Sustainable management requires reliable knowledge and information on forest resilience and a deep understanding of how current species pools are likely to be affected by climate change.[35] Due to the required technical background of these jobs, it is highly likely that most of the estimated job-years will be related to managing work required in the forest. The area of forest conservation, in addition to the mentioned employment activities by Nair and Rutt, also includes restoration, promotion, and management of forest biodiversity and addressing biodiversity loss. Jobs in this field require knowledge of sustainable forest and wildlife management, species, habitat, ecosystem functionality, biodiversity conservation, protection of soils, management of genetic resources, and the development and implementation of suitable policies and practices. Furthermore, forest management that is community-based, is an effective way for guaranteeing land rights for local communities and ensure sustainable income.[36]

Occupations and activities related to agroforestry

There is a strong demand for workers who are experienced in coordination of farm and nonfarm natural resource management. A critical role includes self-learning, knowledge-sharing, and research and development. Forest professionals play a leading role in developing value chains for produced tree products and assist in project design, implementation, and optimization. Required skills include a broad understanding of trees, agricultural systems, food production, and land management. For promoting agroforestry to various related sectors, good communication, teaching, and moderation skills will be required as well as marketing and research skills.[38] Agroforestry enables income diversification, supports livelihoods and contributes to food security. Often it considers ancestral traditional and indigenous knowledge.[37]

Occupations and activities related to fire management

Globally, there is a shortage of professionally qualified forest pathologists, entomologists, and laboratory staff to implement and supervise necessary forest protection contingency plans and strategies. Jobs are required to ensure that vital forest resources are appropriately monitored and protected. This involves training of forest staff to learn and practice the latest techniques for preventing and controlling forest fires.[38] Increasing natural disasters make risk management essential, which requires interdisciplinary tasks, ongoing risk and management strategies, and contingency planning.[38]

Occupations and activities related to urban and peri-urban forestry

Tasks include selecting suitable tree species for best adaptation to urban settings and choosing proper planting, watering, fertilization, and mulching regimes as well as techniques for the protection of trees and branches. Urban forestry practitioners will be required to design and manage healthy, stable, attractive, and accessible urban forests. Workers need to deal with variable natural environments, like harsh and extreme growing conditions, as well as deal with urban societies and urban landscape managers and planners. Further, a deep understanding of tree architecture, tree vitality, and diagnostic methods is required, as well as the identification, control, and management of pests, tree diseases, and tree care practices.[38]

Occupations and activities related to water and forests

To maintain forests and their water-related ecosystem services, there is a need for new forms of adaptive management. Opportunities for green employment will ensure that forest water ecosystems are protected and managed. Job creation will include activities in the development of forest and water policies as well as in the adaptation of forest management practices. [38,38]

Occupations and activities related to wood production

Workers require a high level of expertise about local conditions, such as climate, soil, wind, hydrology, and mechanization. Nowadays, a broader range of skills is needed than before; previously, technical and practical skills dominated. In addition to those skills, understanding and practicing appropriate social, public relations, and communication skills will be demanded in the future. Further, due to machines replacing hard physical work, an increasing number of safety specialists will be required, which might imply retraining. Required knowledge includes timber grading, storage and conservation techniques, timber transportation, timber marketing, and all related logistical and organizational skills.[38]

In general, skill requirements to undertake the majority of forest activities seem to be relatively low (compared to the energy sector) and accessible, if combined with training programmes to assure the quick acquisition of the skills required. Furthermore, employment opportunities in the forestry sector are well-suited to absorb many workers that are employed in at-risk sectors during the pandemic.[39] This presents a significant opportunity to include and implement these types of activities in countries' green recovery plans. Moreover, through the employment of workers in the forestry sector, immediate benefits, can be created, such as creating a social safety net, thus accelerating economic well-being.

Even though some types of employment might be temporary, the benefits will not only be favorable to the individual worker by having access to an immediate social safety net in times of a pandemic but also support the country's way forward to enhance carbon sinks and maximize the provision of ecosystem services. It is important to note that investments in forestry activities will need rural workforce since, in many of the target countries of the study, the actual implementation of forestry activities will be undertaken by rural workers. That could be of great interest for governments designing their green recovery strategies and aim to improve the livelihoods of rural areas and reduce income gaps.

Nevertheless, continued globalization and advancing technology present two major challenges to the forestry sector. First, a reduced number of workers needed for traditional forestry work may occur. Employment in traditional forestry, which is strongly focused on timber production, is highly likely to decline. It is therefore critical that the remaining workforce achieve effective and sustainable forest management. Difficulties are still presented by deficits in work decency, ageing workforces, and continued urbanization, making it urgent to attract needed talent for the future.

A skilled and enabled workforce is fundamental to tackle challenges and fulfil the opportunities that result from the transition to a green economy. Second, competent and adaptable workforces are lacking.[40] It is therefore essential to identify the currently needed human resources and provide them with the necessary skills. In the context of a green recovery, it is important to remain aware of the gaps and misalignments in competencies and introduce programs and policies to address them. Consequently, training, retraining, skilling, and reskilling the available workforce should be a priority for any green recovery package in low-income countries.

Job Years per Investment (USD million) for Energy and Forestry

Table 6. Average job years per one million USD for RE technologies and forestry activities

Energy		Forestry	
Solar PV	53	Afforestation, reforestation and desertification control	630
Biomass	55	Forest conservation	355
Hidro /Large	19	Watershed improvement	320
Geothermal	14	Indigenous forest management	300
Wind Onshore	11		

For a comparison of the direct job-years generated between the two sectors, the created job-years per unit of investment (USD million) have been estimated. Only the estimated investment requirements have been used to maintain consistency in the process of investment estimation.

Generally, the job-years created per USD million invested are higher in the forestry sector than in the energy sector. In particular, the area of afforestation holds a high potential for direct employment creation. It is worth noting, though, that this comparison is based only on direct employment assessment in the two sectors based on the EFs from different studies. Based on earlier studies, it is known that renewable energy could create significant number of indirect and induced jobs around two to three times the direct jobs. In addition, renewable energy investments, particularly in the context of "energy access for all" could create and support more economic activities and therefore more jobs. It is also worth looking in more detail into the qualitative aspects (e.g. wages, social security, decency) of jobs creation both in the energy and forestry sectors to get a complete picture.

Furthermore, the numbers of EFs in the energy sector are generally higher than those presented in existing literature, which reflect the economic development status of the target countries.

Further information on which countries have been included in the estimations and the ranges of job-years created can be found in Annex G.

5. The Role of Renewable Energy and Forestry for Green Recovery

Although there was continuous progress on the achievement of SDG7 – Affordable and Clean Energy, the global efforts and investment needed to reach the 2030 target were falling short.[41] In addition, the crisis caused by the COVID-19 pandemic has eroded several years of progress in affordable and reliable energy access. The crisis has affected populations that are already connected to energy services, preventing them from being able to afford modern energy services. For example, according to the International Energy Agency (IEA), in sub-Saharan Africa, 30 million people who had access to electricity in 2019 may no longer be able to afford basic electricity services by the end of 2021, representing around 6% of the connected population.[42]

Likewise, the COVID-19 crisis will have negative repercussions on the achievement of SDG 15 – Life on land, which directly aims to "protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss" (UNFCCC, 2020). According to the Food and Agriculture Organization of the United Nations (FAO), the "COVID-19 pandemic may lead to an increase in deforestation and associated biodiversity loss. As household incomes decrease and food is less available, people in some rural areas will turn to forests and forest products for subsistence, including plants and wildlife for food, which can result in overharvesting of natural resources." (FAO, 2020). Therefore, inclusive and green recovery plans should prioritize measures that can benefit the forestry sector.

Increasing RE capacity, in combination with implementing energy efficiency actions, as well as maintaining and expanding sustainable forestry activities have proven to be an effective set of recovery measures to restart countries' economic development while supporting sustainable development trajectories that can tackle the accentuated social inequalities.

Developing countries concentrate their green recovery spending mainly on clean energy and natural capital projects and programs. For example, Colombia's social and economic reactivation plan,

Nuevo Compromiso por el Futuro de Colombia, seeks a clean and sustainable growth via an energy transition and the reduction of illicit activities within the agricultural and forestry sectors, among other actions.[43] Similarly, Costa Rica launched its *National Bioeconomy Strategy*, which in light of the COVID-19 crisis, allows the country to developed new productive activities based primarily on the sustainable exploitation of natural resources.[44] Though developed countries distribute their green recovery spending among multiple other sectors, such as telecommunications, RE and natural capital actions are also a primary part of their recovery strategies. For example, the Canadian government will increase and accelerate investments in energy-efficient buildings, clean and next-generation energy solutions, as well as in natural infrastructure and nature- based services as part of its five bold moves for a resilient recovery.[45]

Although still inadequate to drive a long-term transformation and address the current climate crisis—particularly in Africa, Latin America, and Asia-Pacific—approximately 25% (more than USD 85 billion)[xix],[46] of green recovery spending has been allocated to initiatives on low-carbon energy and energy efficiency in developing as well as developed nations. In contrast, green recovery spending on forestry has been scarcer, accounting for less than 1% (less than USD 5 billion) despite being a sector with a high impact on the most vulnerable population. However, countries recognized the value of sustainable manage their natural capital to increase future economic, social, and health resilience; and aim to increase their recovery efforts in the forestry sector.

The Size of the Opportunity and the Challenges to Pursuing It

According to the recent IPCC special report on 1.5 degrees, only ten years remain for governments to act on reducing the carbon emissions to zero by 2050 to avoid the catastrophic consequences of climate change.[1] Greening the economic stimulus by investing in RE and forestry sectors is a historic opportunity to boost countries' economies while simultaneously addressing the climate crisis.

The recovery packages offer a unique opportunity to close the investment gap between an ambitious energy transformation scenario, which requires a USD 110 trillion investment, and the current plans that call for investing at least USD 95 trillion.[47] Grasping this opportunity will result in addressing economic slowdown by generating ripple effects throughout the economy, creating new green jobs, curbing climate change, and reducing health risks and their related costs. It will also increase energy access and affordability, energy system resilience, and the welfare of the most vulnerable populations.

The IEA estimated that investing in a more ambitious energy transformation scenario—compared to the current course set by current and planned policies—would deliver USD 9 trillion on additional global GDP gains by 2050, equivalent to USD 3–7 on every dollar invested. Additionally, it would create 7 million jobs, ensure 100% energy access, reduce carbon emissions by 70%, ensure full price competitiveness of renewables, increase access to affordable energy, and improve energy security through the reduction of fossil fuel demand by 64% by 2050.[44,50]

Recovery packages could also help close the global financing gap to achieve nature-related SDGs by 2030, which is estimated at USD 750 billion per year[48]. Recovery measures could help increase private sector participation in financing natural capital projects as well as combat illegal forestry activities. Moreover, seizing this opportunity would help safeguard circa half of the global GDP (US$ 44 trillion) - which is estimated to be highly or moderately dependent on nature.[49]

However, seizing this opportunity and increasing RE and forestry targets come with exacerbated challenges due to the COVID-19 crisis, particularly for developing nations.

First, the cost of borrowing has increased since the pandemic outbreak as private sector investors and financial institutions charge a higher sovereign risk premium[50]. To regain investors' confidence, it is crucial to prioritize clean energy measures in stimulus packages and corresponding policy strategies that can reflect a long-term commitment toward the energy transition. For example, at the end of 2020, the Philippines had eliminated the constitutional barriers limiting foreign investments in renewables.[51] In the forestry sector, green recovery measures should help develop the conditions to make forestry sector investments profitable. For example, by establishing tax breaks on forestry investments reducing harmful forestry subsidies, providing de-risking guarantees, and promoting the adequate valuation of ecosystem services.

Second, the quarantine measures have halted residential installations of renewables and delayed construction and commission of RE parks in most countries. Simultaneously, the stranded projects affect the entire production value chain as small provider companies are unemployed, and there is a shortage of installation components that increases the market prices. To overcome this challenge, countries like India have listed RE installations as essential services, allowing the workforce to continue operations as needed.

Like the effects of the COVID-19 crisis on the RE energy sector's value chains, the production and trade of forestry products have been disrupted. These disruptions affected the most vulnerable population such as informal workers, rural communities with no safety nets, and many micro, small and medium-sized enterprises (MSMEs) in developing countries. Moreover, confinement policies have caused an increase in illegal forestry activities as forest monitors in situ are limited, restricting law enforcement. As a consequence, "despite the potential of the forest sector to promote growth and employment, the persistent decent work deficits have been worsened by the pandemic" (ILO, 2020)[52]

xix Estimated based on a total of USD 336 billion of environmentally positive investments on recovery packages.

Third, the initial decrease in energy prices, in combination with the market failures that inhibit green innovation, disincentivized the speed-up of an energy transition in certain countries. However, policy reforms are being used to overcome this challenge, including eliminating fossil fuel subsidies and starting carbon taxes to further reduce the social costs of fossil fuel use and utilize the savings for other COVID-19 crisis priorities. For example, Tunisia, although dependent on fuel imports, removed its fuel subsidy in face of the low fuel prices and has maintained its position despite the expected price increase.[53]

Reasons for Driving Green Recovery through Renewable Energy Projects and Forestry Activities

Prioritizing RE and forestry measures on green recovery strategies represents an economically effective opportunity to quickly respond to the economic crisis.

Clean energy measures have a higher employment multiplier than interventions in other sectors. Every million dollars invested in renewables would create at least 25 jobs, while each million invested in energy efficiency would create about 10 jobs.[54] Equally, RE measures profit from a fast development and implementation period as countries usually have an available pipeline of bankable projects at cost-competitive prices. Moreover, the sector is highly attractive for private sector investors—under adequate policy frameworks that diminish risks—thus, it has the potential to alleviate pressure from the limited public sector resources. Finally, it generates long-term positive economic spillovers and social and environmental co-benefits.

Similarly, forestry is a high labor-intensive economic sector which requires relatively low capital investments. According to Nature 4 Climate, "large-scale ecosystem restoration efforts, usually supported by government programs, have enormous potential to create jobs, perhaps as many as 40 jobs for every $1 million invested. Moreover, evidence from the 2009-2010 stimulus showed that every million dollars invested in ecosystem restoration created 10 times as many jobs as investments in the coal sector".[55] Jobs in the forestry sector require limited worker training and medium to low skill people; thus, they can be relatively fast- created. Moreover, forests provide safety nets (i.e. food and income) for the rural poor contributing to the generation of social, environmental and economic co-benefits.

High Investment and Employment Multiplier Effects

According to a recent IMF study, the RE spending multiplier is systematically higher than the fossil fuel–based energy multiplier. The impact multiplier for RE is 1.19.[56] "For fossil fuel–based energy, the impact multiplier is 0.65, suggesting that these kinds of expenditures tend to crowd out private investment or consumer spending that would have otherwise taken place to a larger extent" (IMF, 2021)[57]. For each dollar invested in fossil fuel–based energy, 35 cents are crowding out, whereas for each dollar invested in RE, 19 cents of investments are crowding in.

RE investments could deliver benefits both in the short and the long term. The former creates more direct jobs during manufacturing and distribution and the C&I stages, compared to fossil fuel–based energy. Jobs in these sectors are particularly relevant when the economy reaches high levels of unemployment in the middle of an economic recession. RE investments consequently boost spending and increase short-term GDP multipliers derived from expanding demand. Investment in RE sectors also increases the demand for goods and services from industries in the supply chain that support the creation of indirect jobs. In addition, employees in these industries buy different goods and services, thereby boosting aggregate demand and creating induced jobs. In the long run, it is important to consider whether the recovery packages will lock the economy into carbon-intensive or low- or zero-carbon development pathways, which could be detrimental to the global climate crisis.

Green land-use activities (including forestry) in developing countries also have high investment multipliers. This is because they typically capture spending programs financed by donors. "Given that green land-use programs do not crowd out nor absorb, but rather supplement, domestic resources, they are naturally characterized by high multipliers" (IMF, 2020)

Significant Environmental and Socioeconomic Co-Benefits

The main sources of air pollution are similar to those of GHG emissions, namely the burning of fossil fuels, particularly in the transport, electricity, residential, and industrial sectors. According to the WHO, household air pollution globally causes 3.8 million premature deaths per year[58] whilst ambient air pollution accounts for 4.2 million deaths per year[59]. The impacts of air pollution are much worse in low- and middle-income countries, such as in South Asia and sub-Saharan Africa, where 1.22% and 1.19% of GDP are lost, respectively, due to poor air quality.[60] Investing in energy efficiency and RE while electrifying the main emitting sectors will deliver significant climate and health co-benefits in addition to economic and employment benefits.

Under the pandemic framework, in addition to the carbon sequestration and economic co-benefits of forest restoration and preservation activities, their potential health co-benefits are of particular interest. There is growing evidence that changes in land use increase the spread of zoonotic infectious diseases such as COVID-19. Consequently, increasing and improving sustainable forest interventions could prevent future pandemics.

Opportunity to achieve gender equity in the energy and forestry sector increase social inclusion

Pursuing a more inclusive recovery will lead to a more sustainable economy. Thus, developing recovery measures that are gender conscious, represents an opportunity to tackle the systemic gender discrimination within the energy and forestry sectors.

GGGI's study "*Tracking Increase In Women's Employment In The Renewable Energy Sector Under NDC Targets*", states that the energy transition and more ambitious NDCs targets develop will lead to an increase in the demand for high-skill workers in the energy sector. As governments implement COVID-19 recovery stimulus able to remove the existing barriers on equal employment opportunities for women in the energy sector, the talent pool available could increase and countries could respond to the future increasing demand of new high-skilled workers.[61]

The World Economic Forum (WEF), estimated in its 2015 gender report that women make up only 19% of the energy labor force, representing 32% of board memberships, 11% of senior roles, 19% of mid-level positions, 24% of junior roles, and 19% of line positions.[62] Pre-pandemic studies, expected an increase in women's participation in the energy sector is expected. For example, WEF's Future of Work Survey estimated that by 2020 women would make up 20% of senior positions, 27% of mid and junior level roles, and 25% of line positions.[63] However, the 2020 survey, recognizes the long-term impact of the coronavirus pandemic on equality across all economic sectors.

Equally, women's participation in forestry management activities – particularly in community forest- could be emphasized through recovery measures. Certain studies suggest that increasing women's involvement in the sector could lead to a reduction in forestry-related corruption and could further promote the development of forest conservation activities.[64] Moreover, implementing sustainable management forestry measures is critical for a green recovery because they rely on a just and equitable production and aim to address indigenous and local communities rights.

Case Example: Mexico's Green Recovery Efforts

GGGI Mexico has worked together with national and subnational governments, as well as with other international organizations, to develop technical assessments, policy briefs, and investment projects that inform economic recovery practitioners and decision-makers about the potential generation of co-benefits—particularly new green jobs creation—of greening certain economic sectors and promoting a transition toward a sustainable economy.

During 2019–2020, GGGI Mexico collaborated with the Danish Energy Agency to estimate the employment generation of the revised energy targets established in the updated NDCs. The technical assessment aimed to inform the National Institute of Ecology and Climate Change about the co-benefits of the latest NDC. The assessment compares the job creation potential and investment requirements of the Trend Based Scenario of the Mexican energy system against the Updated NDC Scenario. The results prove that complying with the Updated NDC Scenario could generate approximately 8% more jobs. Under a green recovery context, this assessment demonstrates Mexico should drive to accomplish its international climate commitments to ameliorate the unemployment effects of the COVID-19 economic crisis.

Similarly, job creation–oriented assessments under a green recovery context have been developed across other GGGI Members. For example, Peru, Mongolia, and Colombia are assessing the job creation opportunities of their respective energy and forestry sectors.

Best Practices to Boost Renewable Energy through Green Recovery Programs

The Global Recovery Observatory stresses that both developed and developing countries have extensive opportunity areas for improvement on their green recovery plans to Build Back Better, particularly when promoting RE measures. For example, certain regions are considering fossil fuel energy as a key leverage for their country's productive development and/or have a misalignment between green recovery plans and national development plans. This is the case for certain Southeast Asian countries, who despite having agreed to achieve a 23% share of RE in the total primary energy supply in the region and 35% in ASEAN installed power capacity by 2025, under the ASEAN Plan of Action for Energy Cooperation 2021–2025[65], certain national energy plans propose to expand their share of fossil energy to support the countries' industrial development.

To help countries profit from the green recovery opportunity areas in the energy sector, some **best practices** derived from international and GGGI case studies are listed below.

1. Linking medium- to long-term green recovery measures to NDCs and national SDG targets to reiterate the government's commitments toward clean energy and accelerating the energy transition.

Investments in clean energy must be backed by policy frameworks to allow the development of the sector by increasing investors' confidence and proving an implementable long-term policy commitment. For example, the Indonesian government has reconfirmed its plan to enact a new regulation on RE that had been announced before the pandemic.

Similarly, developing countries are currently undergoing efforts to align and revise their long-term development plans in light of the impacts of the COVID-19 crisis and their response. For example, GGGI is supporting the government of Senegal to assess the country's current green recovery measures and ultimately provide recommendations on how to further "green" their recovery and support the conceptualization, operationalization, and financing of

the Green Emerging Senegal Plan, allowing the country to progress toward its environmental targets.

2. Simultaneously investing in training or retraining programs to address the skills gaps in the RE and energy efficiency sectors.

(Re)training recovery programs, including vocational training promoting green energy and innovation, are essential as an immediate response to the economic crisis and surging unemployment rates. Investing in human resources through training programs can employ people in the short term while supporting a just transition to green energy in the medium to long term. GGGI's previous employment study on RE for Mexico, Indonesia and Rwanda found that investments in solar and wind technology to meet countries' RE targets specified in their NDCs and national energy plans will require 48–76% low- to medium-skilled workers and 24–52% high-skilled occupations[66]. The requirements for low- to medium-skilled labor in the RE sectors must be immediately met in the short term by investing in vocational training programs and responding to high unemployment rates and severely affected energy sectors such as the coal mining industry.

The lack of skills represents a barrier to RE deployment, mostly in developing countries. The low availability of a local highly skilled population leads to high design, construction, and maintenance costs of RE and energy efficiency projects. Therefore, to counteract this barrier, countries are utilizing their unemployment rescue and recovery programs to reskill and/or close the skills gap of the population for new green jobs, particularly in energy efficiency. For example, the Republic of Korea created two new skills councils: one for the RE sector and the second for green industry trends, risk analysis, and green finance.

Careful anticipation of employment shifts is necessary to implement the green energy transition. A well-managed approach is essential to avoid or minimize adverse impacts or risks to workers, communities, and businesses. A robust and fair transition requires the right policies to be in place, promoting participation, social protection, and reskilling. Consequently, certain developing countries are assessing the missing skills needed to increase their RE share and design their vocation and on-the-job (re) training programs for occupations in need. For example, the Mongolian government, with the support of GGGI, is measuring the employment co-benefits of their NDC energy targets as well as assessing the required skills to achieve those targets. Moreover, governments are partnering with multilateral organizations to transfer international experiences and best practices for enhanced learning courses.

3. Decarbonizing end-use fossil fuel–consuming sectors by scaling up renewables or low-carbon energy options.

The decarbonization and energy efficiency increase of certain strategic sectors—industrial processes, electricity distribution systems, construction, transportation—are critical for a global green economic development.[67] Consequently, developed countries are increasing investments and R&D resources to address hard-to-abate sectors as well as scaling up transition-related technologies. For example, the French government has linked airline bailouts to environmental conditions. Equally, it will support the development of low-carbon and renewable hydrogen, along with other European countries.

For developing countries, spending on clean transport measures for recovery is the second largest after RE and nature-based solutions. For example, GGGI is supporting Lao PDR's green recovery by strengthening the electrification of the road transport sector. Supporting the e-mobility transition in Lao PDR can reduce economic exposure to exogenous shocks. As there is no domestic petroleum source, the country fully relies on fuel imports, and more than 80% of imported fuel is used in the transport sectors. Therefore, the development of an e-mobility infrastructure can propel the demand for RE while boosting economic diversification and generating social co-benefits.

4. Estimating the affordability and the economic, social, and environmental co-benefits of green recovery projects in the energy sector to support policy decision-making.

The development of co-benefits and financial integrated assessments allows politically effective decision-making. These assessments serve to understand how RE and energy efficiency projects can improve livelihoods and influence positive economic development. Additionally, co-benefit assessments contribute to increasing the scope of actions and measures that are feasible in the sector and form the basis for providing policy recommendations that can maximize social, environmental, and economic benefits.[68] Therefore, certain countries are undergoing efforts to estimate the co-benefits of their NDC-related actions and their green recovery measures. For example, GGGI is developing a high-level assessment of employment co-benefits in five economic sectors—including RE and energy efficiency—to support the Peruvian government in identifying sectoral green recovery interventions that could potentiate employment creation.

5. Deploying decentralized RE solutions to address the most vulnerable populations.

In the face of challenges presented by the pandemic, RE-based decentralized energy systems, especially for the health sector (primary health centers and hospitals) and productive use (agriculture, food processing, cold chains, and SMEs), will be critical to achieving SDG goals. Energy access must remain a priority for governments, multilateral finance institutions, and donor countries for green recovery. GGGI's Africa regional program on solar irrigation pumping systems, covering Burkina Faso, Ethiopia, Senegal, Mozambique, and Uganda, is creating climate-resilient decentralized energy systems that would be critical for the green recovery of agriculture supply chains in pandemic-type circumstances. GGGI has launched another initiative in partnership with International Solar Alliance to achieve 1 million solar pumps to create impact at scale.[69]

6. Strengthening the overall energy system to ensure the stability and flexibility of the grid when increasing RE penetration and reduce distribution losses.

Even before the COVID-19 crisis, the increase of RE capacity in certain countries was already restrained by the saturation of their energy network. Countries face a mismatch between the rapid increase in wind and solar generation investments and the slow development of transmission and distribution infrastructure as well as energy storage solutions. Therefore, forward-looking green recovery efforts are simultaneously focusing on preparing the grids for net zero by ensuring stability and flexibility to supply the predicted rise in electricity demand and allow the inclusion of a high number of electric vehicles. Strengthening the overall energy system, by itself, has the potential to generate new long-term highly-skill jobs.

7. Phasing out fossil fuel subsidies and reallocating revenues toward investments in RE and energy efficiency.

Currently, the oil prices internationally are at very low levels, presenting an opportunity to start gradually removing the fossil fuel subsidies in many developing and developed countries. Fossil fuel subsidies utilize central government resources that could be used for other sectors (e.g., health, education) or other purposes, such as reduction of debt, compensation of the affected households, and investments in energy efficiency and RE. Reallocating subsidy savings to compensation, energy efficiency, and RE will contribute to offsetting the energy cost increase resulting from subsidy removal. Adequate social dialogue is needed to ensure the views and concerns of key stakeholders are taken into account and incorporated in the design of the fossil fuel subsidy reform and that adequate compensation schemes target those most in need. GGGI's study on fossil fuel subsidy removal in Saint Lucia concluded that the scenario of gradual fossil fuel subsidy reform and reallocation to debt reduction (40%), investments in RE (15%) and energy efficiency (15%), and compensation to low-income households (30%) could, 10 years after adoption, reduce the energy bill by 3.5%, increase the annual GDP by 1.9% and reduce CO2 emissions by 16.4% compared to the BAU scenario. In addition, GGGI has been requested by the government of Fiji to conduct a similar study on fossil fuel subsidy reform.

8. Linking the provision of recovery support to environmental measures, particularly for SMEs and their value chains.

Governments have started to establish obligatory environmental conditions for companies to access recovery support. For example, Canada included annual environmental planning and reporting requirements among the conditions that large firms will need to meet to qualify for its emergency loan program.[70] Equally, governments are promoting a change through monetary support. For example, the European Bank for Reconstruction and Development provided EUR 70 million to a green recovery program in Egypt that provides loans to SMEs to invest in environmentally friendly and more energy-efficient technologies that can increase their competitiveness and green their value chains.[71]

9. Increasing private sector investments through restructuring financing approaches aligned with appropriate public-sector incentives.

Boosting green finance as part of green recovery is crucial; according to IRENA, immediate investment increases could put renewable power generation on track to grow five times faster[72]. However, the unprecedented decrease in private sector investments has led to restructuring financing approaches. An example of this is how countries are examining public-private partnerships (PPPs), in coordination with their private sector counterparts, to reduce costs. In addition, governments could also explore through PPPs how to increase the local content of manufacturing specific energy technology components and forestry practices. Equally, countries are reexploring the use of debt-for-climate swap options. While there is still a significant amount of work and negotiations to be done regarding the relationship between debt-for-climate swaps and international climate finance commitments, there already some examples of debt-for-nature swaps under the Tropical Forest Conservation Act, in which approximately USD 200 million in debt (face value) has been reduced, restructured, or swapped using this mechanism, generating approximately USD 167 million in local currency for conservation purposes.[73] The World Bank and the International Monetary Fund are planning to launch a platform to advise poor countries on funding climate and conservation activities, amid a broader push that could link such spending to debt relief as COVID-19 crisis response to resilient recovery. These multilateral institutions are developing an "organizing framework" for connecting debt relief to countries' plans for investing in "green, resilient and inclusive development," or GRID.[74] There is an explicit focus on an energy system transition toward low-carbon development and increased access to clean and affordable energy while improving efficiency.

Best Practices to Contribute to the Forestry Sector through Green Recovery Programs

1. Mobilize investments to achieve NDC forestry targets.

Since a large number of FTEs can be generated through the realization of NDC forestry targets, investment here will accelerate green employment. Especially with the ambition of green recovery from the pandemic, investing the required funds into these targets will be beneficial not only for the newly hired workers but also for the country's economy itself. Spending money in this direction will increase the recovery in a sustainable way and lead to achieving NDCs, thus combatting global warming while delivering multiple ecosystem services.

2. Integrating forest landscape restoration agenda in green recovery financial stimulus packages through the use of existing and innovative financing frameworks, such as REDD+, carbon markets, domestic budgets (green budgeting) and tax policy tools.

According to UNEP, the use of REDD+ is crucial to reaching a green economy as it can increase long-term forestry outputs. The use of REDD+ can improve investment conditions and when integrated into larger landscape-scale planning frameworks -which involve multiple other economic- it can ultimately increase long-term returns on investments at the national and sub-national level.

3. Highlighting the importance of protecting, sustainably managed and restored natural ecosystems as a way of increasing and maintaining human health and economic resilience for the most vulnerable.

There is an information gap on the impact of natural capital depletion on human well-being and health. "Evaluating impacts requires the monitoring of relevant biophysical and socioeconomic measures. Most current monitoring data are inadequate."[75] However, the COVID-19 pandemic has emphasized the importance of closing this information gap.

4. Implementing fiscal and economic stimuli that encourage legal practices across the forest related value chains.

The high level of informality in the forest sector in many developing countries leads to a lack of transparency in monitoring operations, hinders the proper value estimation of the natural capital, and limits the creation of green jobs. However, forest sector fiscal policies dependent on country-specific context can trigger a reduction in informal and illegal activities.[76] For example, "it is possible to improve the environmental incentives of most forestry-related taxes by letting the rates vary according to whether the good is certified "deforestation-free" or (even just) "legal"" (World Bank, 2021). E.g. In Peru FSC certification leads to a reduction in harvesting fees paid by forest concessionaires in the Amazon.

5. Strengthening value chain integration by supporting local entrepreneurship connection to final market.

Green recovery measures should ease the access of local forestry value chain actors to credit, market information, business contacts, financial capability and technical knowledge/skills with the aim of scaling, speeding the recovery and strengthening local employment creation. Moreover, recovery measures should facilitate an integrated, inclusive and collaborative approach between SMEs and large firms as well as between different economic sectors. Jobs-creating investments should also support development of self-sustaining sectors in the longer run.

6. Promote an adequate accounting of natural capital and valuation of its ecosystem services.

Public officials who aim to pursue a green recovery should utilize science-based valuation and accounting to properly inform policy interventions. The monetary valuation of ecosystem services and the accounting of natural capital can support decision-making in both, the public and private sectors. Robust valuations and accounting systems can increase investments in the forestry sector and ease the proper implementation of preservation incentives. However, despite the existence of multiple tools and accounting frameworks that increase the credibility and legitimacy of the valuation and accounting exercises, experts have failed to engage leaders and translate information into action.

7. Increasing financial disclosure of biodiversity impacts from private sector investments.

Increasing transparency on the impact of investments over natural capital is critical to increasing private finance mobilization. As climate change and its effects become more visible, institutional investors increase their utilization of frameworks to report on biodiversity and natural capital preservation. Current green recovery investments could help mainstream disclosure practices to help close the forest sector financing gap.

8. Investments in forestry (and RE) should target and lead to women and youth employment generation.

In addition, employment in linked informal sectors, would create greater revenues for state budgets, and spur development of the sector. This is particularly relevant in the context of the green recovery where currently many informal workers are unemployed.

6. Concluding remarks and Recommendations

This section outlines the key conclusions drawn from this study of employment co-benefits of RE and forestry NDC targets in 30 GGGI Member developing and emerging economies. The study is part of an ongoing effort by GGGI to assess the green job creation potential of the green transformation and, more specifically, a green recovery from the COVID-19 pandemic that also accelerates climate action.

1. **This study reports a first set of EFs for RE and forestry in developing and emerging economies.** This study assessed the employment co-benefits of RE and forestry investments to achieve the NDC targets submitted under the Paris Agreement. It uses a detailed analysis of EFs that have been adjusted to fit the conditions of labor productivity at the national level. To our knowledge, **the resulting database of national-level EFs for RE and forestry** for 27 and 14 countries, respectively, **is the first such analysis specifically for developing and emerging economies.**

2. **The study analyzed quantitative RE and forest targets in the NDCs of 30 GGGI Member developing and emerging economies.** Part of the study reported here consisted of a detailed analysis of the NDCs of 30 GGGI Member developed and emerging countries to establish RE and forest targets, along with associated assumptions and technologies. Some of the data from the NDCs were supplemented by information from related government documents, and in some cases, interpolations, interpretations, and assumptions were made by the authors. As a result, RE targets were compiled for 27 countries, and forest targets were compiled for 14 countries. The NDC target data used for the employment assessment are detailed in Annex C for RE targets and in Annex E for forestry targets.

3. **Five RE technologies were assessed to generate country-specific EFs.** The RE employment assessment distinguished between five basic proven RE technologies—solar PV, onshore wind, biomass energy, geothermal energy, and hydropower (large and small)—and four stages of the value chain—C&I, manufacturing, operation and maintenance, and fuel production. A total of 174 EFs were compiled, which were adjusted for country of origin and changes over time by accounting for differences in national labor productivity and learning rates by adopting the methodology developed by

Rutovitz et al. (2015).

4. **EFs were also assessed for 10 forest management approaches.** The forest-related employment assessment considers 10 employment categories: 1) afforestation, reforestation and desertification control; 2) improvement of productivity of existing planted forests; 3) watershed improvement; 4) indigenous forest management; 5) forest conservation; 6) agroforestry; 7) fire management; 8) urban and peri-urban forestry; 9) skill improvement or forestry and wood industry workers; and 10) management and conservation of protected areas and buffer zones. EFs are based on two key publications, Rutt and Nair and ILO-WWF, and are based on the number of jobs for each employment category per unit of surface forest area (hectares) or unit of investment (USD million).

5. **This study concludes that for the 27 GGGI Member emerging and developing economies that had quantifiable RE targets in their NDCs, implementation of these commitments would lead cumulatively to more than 8 million job-years for the 11-year period until the target year.** The majority of the employment co-benefits, well over 4 million job-years, are situated in just three emerging economies with large energy sectors: Indonesia, Mexico, and Vietnam. Some LDCs have significant numbers of employment co-benefits as well—particularly Cambodia, Ethiopia, Lao PDR, Myanmar, and Nepal—but these are dominated by hydropower-linked targets dominate job creation. While the job-year numbers are small for SIDS, due to the small size of their economy, employment benefits can still be significant as a share of the local labor market.

6. **RE investments in LDCs are more determined by their SDG7 (affordable and clean energy) target, than by their NDCs.** LDCs have very low RE targets in their NDCs that are linked to solar PV or onshore wind energy, thus leading to low employment co-benefits. Given that many of these countries, particularly in Africa, currently have very low access to energy rates, investments in RE, solar, and wind, while not driven by their current NDCs, can (or should) still be significant to achieve sustainable energy access for all. Therefore, investing in RE, solar, and wind as part of a green recovery strategy should still be prioritized and will provide major significant employment co-benefits.

7. **This study concludes that for the 14 GGGI Member emerging and developing economies that had quantifiable forest-related targets in their NDCs, implementing these commitments would lead cumulatively to some approximately 30–40 million job-years over an 11-year period until 2030.** About half of these forest-related employment co-benefits accrue to one very large emerging economy, Indonesia. A significant number of LDCs also have a high potential for forest-related employment (e.g., Burkina Faso, Cambodia, Lao PDR, Myanmar, Nepal, and Senegal), where potential job-years are on the order of 0.5–1 million per country.

8. **Forest investments are critical for climate adaptation, and both have very large substantial employment co-benefits.** The forestry sector provides employment opportunities for a climate-vulnerable rural population and is relevant both for climate mitigation and adaptation while at the same time enhances biodiversity and the provision of critical ecosystems services. As can be seen in Annex E, many targets are reported to be conditional targets. In order to realize this conditional part of forestry targets and tap into their potential to create jobs, international support and finance are required. Another key rural sector is agriculture, and for many developing countries where a large share of the population is (self-) employed in agriculture, climate-smart agriculture is a critical sector of the green recovery to stimulate employment co-benefits from climate action. While we were unable to include agriculture in this study due to a lack of available EF data for agriculture activities, as was the case for forestry and energy, we plan to conduct country-based follow-up studies using I-O modelling to address the climate-employment nexus as related to agriculture.

9. **RE investments have major employment co-benefits for a green recovery.** While the total number of NDC RE-related jobs in LDCs is not high—for example, only 100,000 job years in Ethiopia, all from hydropower—achieving the SDG7 (affordable and clean energy) would yield a million job-years for Ethiopia, from solar PV, wind, and biomass energy. For SIDS, while the job year numbers are not high, as labor markets are small, the share of RE jobs can still be high. For example, for instance, in Tonga, the estimated 2100 job-years represent double the local labor force in the electricity generation sector. In summary, this study concludes that there are significant opportunities for employment co-benefits for green recovery from investments in RE and forestry for developing and emerging economies, through implementation of the NDC commitments or, in the case of LDCs, achievement of SDG-7.

10. **In the context of emerging and developing economies, investments in forestry activities are more labor intensive compared to investments in RE sectors. In addition, jobs in forestry sector can be created at a lower cost than those in the RE sector.** This study estimates gross direct employment, in job-years, created through RE investments per million USD range from 10 to 50. Direct job-year estimates for forestry-related investments per million USD range from 300 to 600. Consequently, forest-related investments are 15 times more labor-intensive than RE-related investments, which are themselves estimated to be at least two to three times more labor-intensive than their fossil fuel–based alternatives.

Concluding Remarks and Recommendations

1. **Prioritize green recovery for developing and emerging economies.** Green recovery spending is still insufficient to match the severity of the economic and climate crisis, estimated as only 21% of all recovery spending by the summer of 2021, and the overwhelming majority of this

green spending is in OECD countries. Therefore, increasing efforts and resources on a green recovery—particularly in Africa, Latin America, and Asia-Pacific, where the COVID-19 crisis has exacerbated social inequalities the most—should be prioritized. Given the limited fiscal space and high levels of current indebtedness, priority should be given to financial resources that do not increase the governments' indebtedness further, such as green bonds, debt-for-nature or debt-for-climate swaps, private sector investment, and blended public-private investments that take maximum advantage of green ODA and climate finance.

2. **Developing and emerging economies should prioritize RE investments for several reasons.** RE investments contribute to meeting NDC targets under the Paris Agreement, achieving SDG7, and, as shown in this study, generating significant green job co-benefits to support recovery from the COVID-19 pandemic, at a much higher level than fossil fuel-based alternatives.

3. **Many developing and emerging economies should consider forest-related investments as opportunities to create large numbers of green jobs at a relatively low cost and with fast implementation.** Given that blue collar and informal sector workers have been hit the most by the COVID-19 economic crisis, unemployed or under-employed people with relatively low skills are readily available to take up new jobs. Further, the high numbers of low-cost green jobs associated with forest projects and the relatively low skill requirements make them particularly attractive as green recovery measures. Regarding revising NDCs and implementing recovery measures it is important to be more explicit about actions and investments, and what support is needed, especially as countries will be recovering from the pandemic. However, policy makers should take into account potential spatial misalignments and constraints of the labor-market regarding the flexibility of workers, especially in remote and sparsely populated forest regions. Lastly, reforestation and forest conservation investments have many critical benefits, including climate mitigation and adaptation as well as biodiversity-related benefits and vital ecosystem and biodiversity benefits.

4. **Focus on shovel-ready projects** within Investments in the RE and forestry sectors to attract private sector investments and realize climate goals. In many cases NDCs are followed or combined with NDC roadmaps that entail implementation and investment planning and project development in all NDC sectors including RE and forestry.

5. **Plan ahead and develop skills enhancement and Vocational Education and Training Programs (VETP).** Government sponsored VETP should to address any knowledge and skills misalignments and assure that the necessary human resources are available and well equipped for private and public investments in the RE and forestry sectors. VETP should be important elements of green recovery plans and packages and should be well combined and aligned with sectoral (e.g. energy and forestry) policies.

6. **Support data collection, monitoring and reporting methods in developing countries in these two sectors.** This would lead not only to effective NDC implementation monitoring but also contribute to evidence-based planning for deploying scarce development and public funding for maximum environmental and employment impact.

Annexes

Annex A: Employment factors – literature and EF adjustment factors used

(Primary) Source	Original Source	Year of Publication	Country of Origin	Type of Technology	Value Chain Stage	Notes/Links
Briggs, C., Rutovitz, J., Dominish, E., Nagrath, K. 2020.	IRENA	2017	China	Solar PV	MA	https://www.irena.org/publications/2017/Jun/Renewable-Energy-Benefits-Leveraging-Local-Capacity-for-Solar-PV
		2017	Canada, Chile, China, the European Union and the United States.	Wind-onshore	MA	
	-	2020	Australia	Solar PV	OM	
	-	2020	Australia	Hydro-large	OM	
	-	2020	Australia	Wind-onshore	CI	
	-	2020	Australia	Solar PV	CI	https://www.uts.edu.au/sites/default/files/2020-06/Renewable-Jobs-Australia-ISF%20F.pdf
Cameron and van der Zwaan (2015)	-	2011	Japan	Solar PV	CI, MA, OM	Input output model
	-	2011	South Africa	Solar PV	CI, MA	IO LCA approach
Carla O. et al. (2015)	-	2015	Portugal	Solar PV	CI	
	-	2015	Portugal	Biomass	CI	
	-	2015	Portugal	Hydro-large	CI, OM	
	-	2015	Portugal	Hydro-small	CI	
	-	2015	Portugal	Wind-onshore	CI, OM	
	-	2015	Portugal	Gas	CI, OM	
	-	2021	Portugal	Coal	OM	
Greenpeace	-	2018	Thailand	Solar PV	OM	
	-	2018	Thailand	Biomass	MA	
	-	2018	Thailand	Wind-onshore	OM	

(Primary) Source	Original Source	Year of Publication	Country of Origin	Type of Technology	Value Chain Stage	Notes/Links
Rutovitz (2012)	ACIL Tasman	2009	Australia	Geothermal	CI, OM, MA	
	Geothermal Energy Association	2009, 2010, 2011, 2012	United States of America (the)	Geothermal	CI, OM, MA	
	Good Company Associates, n.d	2009	United States of America (the)	Geothermal	CI, OM	
	Nevada Geothermal Power Inc	2006	United States of America (the)	Geothermal	OM	
	Renewable Energy World	2012	United States of America (the)	Geothermal	OM	www.renewableenergyworld.com/rea/news/article/2012/01/geothermal-heating-up-in-nevada-despite-frigid-industry-climate
	US Department of Energy	2009	United States of America (the)	Geothermal	CI	
Rutovtiz (2015)	Korea Energy Management Corporation (KEMCO), New and Renewable Energy Center (NREC)	2010, 2012	Korea (the Republic of)	Solar PV	MA	
	National Renewable Energy Laboratory	2014	United States of America (the)	Hydro-small	CI, OM, MA	
	US Energy Information Administration, BP Statistical Review of World Energy 2015	2013	United States of America (the)	Coal	FL	2013 data for US derived from coal mining jobs from Annual Coal Report 2013 (US Energy Information Administration 2013a) and coal production from BP Statistical Review of World Energy 2015 (BP 2015).
	Vuik et al.	2012	Netherlands (the)	Hydro-small	OM	
	Comings et al.	2014	United States of America (the)	Solar PV	CI, OM	From IO model based on JEDI and other data
		2014	United States of America (the)	Wind-onshore	CI, OM	
	Abengoa Mojave Solar Project, Harper Dry Lake, California	2011	United States of America (the)	Solar Thermal	CI, OM	www.nrel.gov/csp/solarpaces/project_detail.cfm/projectID=57
	Alba Nova 1, Ghisonaccia (Corsica Island)	2015	France	Solar Thermal	CI, OM	http://www.nrel.gov/csp/solarpaces/project_detail.cfm/projectID=221
	Aste 1A, Alcázar de San Juan (Ciudad Real)	2012	Spain	Solar Thermal	CI, OM	http://www.nrel.gov/csp/solarpaces/project_detail.cfm/projectID=215
	Astexol II, Olivenza (Badajoz)	2012	Spain	Solar Thermal	CI, OM	http://www.nrel.gov/csp/solarpaces/project_detail.cfm/projectID=229

(Primary) Source	Original Source	Year of Publication	Country of Origin	Type of Technology	Value Chain Stage	Notes/Links
Rutovtiz (2015)	Australian Bureau of Statistics 2015, BP Statistical Review of World Energy 2015	2015	Australia	Gas	FL	
		2015	Australia	Coal	FL	
	Based on country total annual increase and Kunz (2010)	2009	Germany	Solar PV	CI	
	Borges Termosolar, Les Borges Blanques (Lleida)	2012	United States of America (the)	Solar PV	MA	http://www.nrel.gov/csp/solarpaces/project_detail.cfm/projectID=242
	EIA Solar	2013	Colombia	Coal	FL	2013 data for Colombia derived from employment and production data from company information corresponding to 39% of Colombian production (Cerrejon 2015), converted to PJ using production from BP Statistical Review of World Energy 2015 (BP 2015)
	Chamber of Mines of South Africa	2013	South Africa	Coal	FL	2013 data for South Africa derived from coal mining jobs from national data (Chamber of Mines of South Africa 2014), converted to PJ using coal production from BP Statistical Review of World Energy 2015 (BP 2015).
	Crescent Dunes Solar Energy Project, Tonopah, Nevada.	2011	United States of America (the)	Solar Thermal	CI, OM	www.nrel.gov/csp/solarpaces/project_detail.cfm/projectID=60
	Department of Labour - New Zealand Government, Ministry of Business Innovation and Employment	2012	New Zealand	Gas	FL	2012 factor derived from employment data (Department of Labour - New Zealand Government 2010) and production statistics (Ministry of Business Innovation and Employment 2012)
	Derived from Mulenhoff	2011	Greece	Solar PV	OM	
	Tourkolias & Mirasgedis	2011	Greece	Hydro-small	CI, MA, OM	
		2011	Greece	Wind-onshore	CI, OM	
		2011	Greece	Solar PV	MA	
		2011	Greece	Wind-onshore	MA	
		2011	Greece	Biomass	MA, OM	IO study

(Primary) Source	Original Source	Year of Publication	Country of Origin	Type of Technology	Value Chain Stage	Notes/Links
Rutovtiz (2015)	O'Sullivan et al, German Federal Ministry of Economic Affairs and Energy	2011	Germany	Solar PV	OM	
				Wind-onshore	OM	
	Euracoal	2012, 2013	Poland, Germany, Czech Republic, Turkey	Coal	FL	2013 data for Poland, Germany, Czech Republic, and Turkey from Eurocoal statistics using primary production of saleable coal. Data corresponds to 88% of OECD Europe production (Euracoal 2012; Euracoal 2013b; Euracoal 2013a; Euracoal 2013c).
	Euracoal, Emerging Markets Insight	2013	Ukraine, Russia	Coal	FL	2013 data for Ukraine from Eurocoal statistics (Euracoal 2013d) and Russia from report on Coal Mining Sector (Emerging Markets Insight 2013). Data corresponds to 68% of OECD Europe production.
	European Renewable Energy Council	2008	European Union	Solar Thermal	MA	Manufacturing employment uses the same factor as the 2012 report, 4 jobs in manufacturing per MW
	Trina Solar (2014), Yingli Green Energy (2014), Canadian Solar (2014), JinkoSolar (2013)		OECD	Solar PV	MA	Module production factor calculated from four largest global companies annual reports (does not include inverters or BOS) ; balance of system calculated from cost ratio of BOS to modules in the JEDI model (National Renewable Energy Laboratory 2014f)
	Genesis Solar Energy Project, Blythe, California	2011	United States of America (the)	Solar Thermal	CI, OM	www.nrel.gov/csp/solarpaces/project_detail.cfm/projectID=54
	Indian Ministry of Coal	2015	India	Coal	FL	2014 data from Indian Ministry of Coal annual report (Indian Ministry of Coal 2015a; Indian Ministry of Coal 2015b), converted to PJ using coal production from BP Statistical Review of World Energy 2015 (BP 2015).
	Ivanpah Solar Electric Generating Station (ISEGS)	2011	United States of America (the)	Solar Thermal	CI, OM	www.nrel.gov/csp/solarpaces/project_detail.cfm/projectID=62
	National Renewable Energy Laboratory	2009	United States of America (the)	Solar Thermal	OM	Kimberlina Solar Thermal Power Plant (Kimberlina)
		2010	United States of America (the)	Solar Thermal	CI, OM	

(Primary) Source	Original Source	Year of Publication	Country of Origin	Type of Technology	Value Chain Stage	Notes/Links
Rutovtiz (2015)	National Renewable Energy Laboratory	2010	United States of America (the)	Solar Thermal	CI, OM	
		2011	United States of America (the)	Solar Thermal	CI, OM	www.nrel.gov/csp/solarpaces/project_detail.cfm/projectID=61
		2012	Spain	Solar Thermal	CI, OM	La Africana, Posadas (Córdoba) http://www.nrel.gov/csp/solarpaces/project_detail.cfm/projectID=236
		2013	Spain	Solar Thermal	CI, OM	Solaben 1, Logrosán (Cáceres) http://www.nrel.gov/csp/solarpaces/project_detail.cfm/projectID=230
		2014	United States of America (the)	Solar PV	CI, MA	JEDI model
		2014	United States of America (the)	Wind-onshore	CI	Morón, Morón de la Frontera (Seville) http://www.nrel.gov/csp/solarpaces/project_detail.cfm/projectID=227
		2014	United States of America (the)	Hydro-large	CI, MA, OM	
		2014	OECD	Coal	CI, MA, OM	
	Leung-Wai, J. & Generosa, A.	2012	New Zealand	Wind-onshore	CI, OM	
	Llera, E., Scarpellini, S., Aranda, a., & Zabalza, I. (2013)	2013	Spain	Solar PV	CI, MA, OM	
	The World Bank	2009	United States of America (the)	Solar PV	OM	Local direct employment estimated to be generated by a 75 MW solar PV project in Kittitas County in the United States (The World Bank, 2011, page 29)
	National Bureau of Statistics of China 2013, BP Statistical Review of World Energy 2015		China	Gas	FL	2012 factor derived from national statistics (National Bureau of Statistics of China 2013) and production from BP Statistical Review of World Energy 2015 (BP 2015)
	National Bureau of Statistics of China 2013, BP Statistical Review of World Energy 2016		China	Coal	FL	2013 data for China derived from national statistics (National Bureau of Statistics of China 2013) and production from BP Statistical Review of World Energy 2015 (BP 2015).
	National Commission on Energy Policy	2009	United States of America (the)	Solar PV	CI	

(Primary) Source	Original Source	Year of Publication	Country of Origin	Type of Technology	Value Chain Stage	Notes/Links
Rutovtiz (2015)	National reporting of employment from Statistics Netherlands	2010	Netherlands	Solar PV	CI	
	Navigant Consulting	2009	United States of America (the)	Hydro-large	OM	
	Nevada Solar One (NSO), Boulder City, Nevada www.nrel.gov/csp/solarpaces/project_detail.cfm/projectID=20	2011	United States of America (the)	Solar Thermal	CI, OM	
	Sonatrach	2010	Algeria	Gas	FL	2010 Factor derived from employment and production data from the state-owned company Sonatrach (Sonatrach 2010)
	PETROM	2011	Romania	Gas	FL	Average of factors from 2009-2011 (PETROM 2011)
	PT Adaro Indonesia 2013; PT Kaltim Prima Coal 2013; PT Berau Coal Energy Tbk 2013; PT Kaltim Prima Coal 2012; PT Indo Tambangraya Megah (ITM) 2014; PT Bukit Asam (Persero) Tbk 2014; PT Indo Tambangraya Megah (ITM) 2013,		Indonesia	Coal	FL	2012-13 data for Indonesia derived from employment and production data from 5 companies corresponding to 38% of Indonesian production
	Renewable UK,	2011	United Kingdom of Great Britain and Northern Ireland (the)	Wind-onshore	CI, OM	
	Rutovitz & Harris 2012b	2012	Korea (the Republic of)	Hydro-large	OM	
	Rutovitz & Ison 2011	2011	Japan	Hydro-large	OM	
	Rutovitz & Mikhailovich	2013	Switzerland	Hydro-large	OM	
		2013	Netherlands (the)	Gas	FL	Netherlands factor for 2009 from Rutovitz & Mikhailovich 2013b
	Rutovitz & Razain	2013	France	Hydro-large	OM	
	Rutovitz, J., Ison, N., Langham, E. and Paddon, M.	2011	Australia	Wind-onshore	CI, OM	

(Primary) Source	Original Source	Year of Publication	Country of Origin	Type of Technology	Value Chain Stage	Notes/Links
Rutovtiz (2015)	Thoen & Johannessen 2011, BP Statistical Review of World Energy 2015		Norway	Gas	FL	Average of factors for 2011- 2013, derived from employment figures from (Thoen & Johannessen 2011) and production from BP Statistical Review of World Energy 2015 (BP 2015)
	EWEA, Vestas	2009, 2014	OECD	Wind-onshore	MA	
	Navigant Consulting	2009	United States of America (the)	Hydro-small	CI, MA, OM	Using mid-range of estimates for Micro hydro
	Zubov	2012	Russian Federation (the)	Gas	FL	Average of factors from 2009-2011 (Zubov 2012)
		2012	Italy	Gas	FL	Italy factor for 2012 from ENI Annual Report (Eni 2012)
		2014	OECD	Gas	MA, OM	JEDI model
		2014	United States of America (the)	Gas	FL	Average of factors from 2012-2014, derived from total employment for gas and oil extraction from US Bureau of Statistics (US Bureau of Statistics 2015) and production from BP Statistical Review of World Energy 2015 (BP 2015)
		2015	OECD	Gas	CI	
	Netherlands Domac et al. (2005); Hillring (2002); Thornley (2006); Upham & Speakman (2007); Valente et al. (2011)		Greece	Biomass	CI	I/O Study
	Moana Simas, Sergio Pacca	2013	Brazil	Wind-onshore	CI, MA, OM	Moana Simas, Sergio Pacca, "Assessing employment in renewable energy technologies: A case study for wind power in Brazil", Renewable and Sustainable Energy Reviews, Vol. 31, 2014, p.83-90

Access link: https://gggi365.sharepoint.com/:x:/s/caid/EfT26_bMJyVMsOX7Ho9Dlt4BFnQWDAfMDrSaUbgD0fWbZw?e=QrJbtm

Local share of fossil fuel jobs

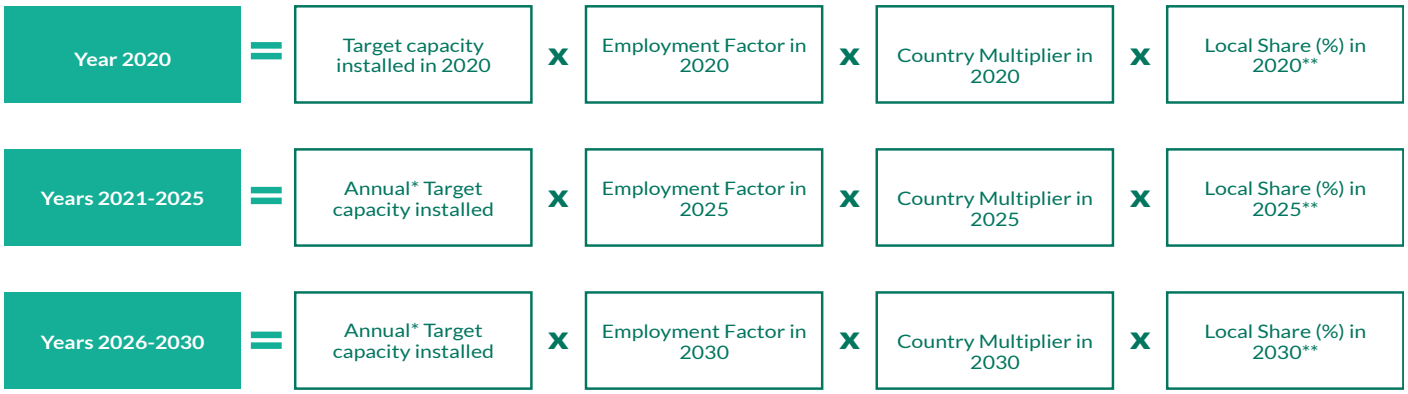
EF for fuel supply jobs in conventional energy technologies have been adjusted based on the local share of oil, gas and coal in each target country. The local proportions of fuel jobs have been estimated by using the ratio between the national fuel production and consumption data derived from the U.S. Energy Information Administration database[xx]. The following local shares (%) have been used to derive the regional local share to adjust the EF values for gas, oil and coal. When the production is larger than the consumption of fossil fuel energy, the local share has been assumed to be 100%. Moreover, the local share in 2018 has been assumed to remain constant up to 2020.

Local Share (%) - 2018			
Countries	Oil	Gas	Coal
Antigua and Barbuda	0%	0%	0%
Burkina Faso	0%	0%	0%
Cambodia	0%	0%	0%
Colombia	100%	94%	100%
Ethiopia	0%	0%	0%
Fiji	0%	0%	0%
Grenada	0%	0%	0%
Indonesia	49%	100%	100%
Jordan	0%	2%	0%
Kiribati	0%	0%	0%
Lao PDR	0%	0%	100%
Mexico	100%	35%	59%
Mongolia	73	0%	100%
Morocco	0%	8	0%
Nepal	0%	0%	6%
Papua New Guinea	81%	100%	0%
Peru	50%	100%	100%
Philippines (The)	0%	98%	43%
Rwanda	0%	0%	0%
Saint Lucia	0%	0%	0%
Samoa	0%	0%	0%
Senegal	0%	100%	0%
Solomon Islands	0%	0%	0%
Thailand	32%	70%	24%
Tonga	0%	0%	0%
Tuvalu	0%	0%	0%
Vanuatu	0%	0%	0%
Viet Nam	60%	100%	71%

xx U.S. Energy Information Administration. Accessed July 17, 2021. https://www.eia.gov/international/overview/world

Annex B: Energy – job creation calculations and assumptions

The following illustration presents the country multipliers, EFs, and local share used to calculate the total job creation for the 6 or 11-year period.



**The cumulative target is used for the operation and maintenance and fuel supply stages.*
*** Local share is only relevant to the manufacturing stage in this study.*

The assumptions and calculations made to estimate the job-years created for all value chain stages are as follows:

- In cases where *only* the 2025 targets are reported, the target is divided by 6 under the assumption that there is a linear increase in capacity added to reach the said target by 2025. Therefore, for countries with 2025 targets, cumulative job creation potential has been assessed for years between 2020 and 2025.
- In cases where *only* the 2030 targets are reported, the target is divided by 11 under the assumption that there is a linear increase in capacity added to reach the said target by 2030.
- In cases where *both* the 2025 and 2030 targets are reported, the 2025 target is divided by 6, assuming a linear increase in capacity added between 2020 and 2025, and the 2030 target by 5, assuming a linear increase in capacity installed between 2026 and 2030.
- In the case where 2020, 2025, and 2030 targets are reported (i.e., Vietnam), the 2020 target has been used to calculate the job-years generated in 2020, while both 2025 and 2030 targets are divided 5, making the same assumption as stated above.

Annex C: NDC review of RE targets

		Africa					Asia									
Country		Burkina Faso	Ethiopia	Morocco	Rwanda	Senegal	Cambodia	Indonesia	Jordan	Lao PDR		Mongolia	Myanmar		
Target Year		2030	2030	2030	2030	2030	2030	2030	2025	2025	2030	2030	2020	2025	2030
Update Status		First NDC Updated	INDC	First NDC Updated	First NDC updated	First NDC	National Report	First NDC	First NDC	First NDC Updated		Updated NDC (NDC Action Plan)	First NDC Updated		
SPV	Unconditional (MW)	247,6	-	-	-	101	-	627,2	-	-	-	-	40	1,998,6	1,998,6
	Conditional (MW)	402	-	2,000	-	100	1,724	256,2	586	-	993	56	-	239,8	1,069,3
	Old Targets (MW)	82	-	526,5	40,5	286	-		586	-	29	145	-	-	-
	Investments (US million $)			6,026						-	1,500	573	-	-	-
WON	Unconditional (MW)	-	-	-	-	100	-	78,4	-	-	-	-	-	-	1,4
	Conditional (MW)	-	-	2,180	-	100	-	21,4	-	-	300	198	-	-	0,7
	Old Targets (MW)	-	-	28,883.2	-	300	-	178,1	-	73	73	354	-	-	-
	Investments (US million $)			2,925								584			
BIO	Unconditional (MW)	-	-	-	-	-		7,179,7	-	-	-	-	-	-	-
	Conditional (MW)	10	-	-	-	50	29	2,267,3	24,7	115	260	-	-	-	-
	Old Targets (MW)	4,3	-	117,6	-	165	-		24,7	115	115	-	-	-	-
	Investments (US million $)									720					
HYL	Unconditional (MW)	-	4,154	1,098	132	239	-	11,497	-	-	13,000	-	-	3,388	5,756
	Conditional (MW)	-	-	-	-	-	3,397	4,436	-	-	-	644	-	-	520
	Old Targets (MW)	337	4,154	225	124	199	-		-		19,942	675	6,166	6,166	2,166
	Investments (US million $)		2,770	1,125	328							1,350			
HYS	Unconditional (MW)	-	-	-	24,5	-	-	-	-	-	-	-	-	-	-
	Conditional (MW)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Old Targets (MW)	20,9	-	-	-	-	-	-	-	-	-	-	-	-	-
	Investments (US million $)			-	-	-									
GEO	Unconditional (MW)	-	-	-	-	-	-	1,438,6	-	-	-	-	-	-	-
	Conditional (MW)	-	-	-	-	-	-	2,451	-	-	-	-	-	-	-
	Old Targets (MW)	-	-	-	-	-	-		-	-	-	-	-	-	-
	Investments (US million $)					-		-							
Aggregated	Unconditional (MW)	-	-	-	-	1928,6	-	-	-	-	-	-	-	-	-
	Conditional (MW)	-	-	-	-	2658,1	-	-	-	-	-	-	-	-	-
	Old Targets (MW)	5,3	-	-	-		-	-	-	-	-	-	-	-	-
	Investments (US million $)		-	-	-		-								1,209

		Asia					Caribbean			Latin America			Oceania			
Country		Nepal		Viet Nam			Antigua and Barbuda	Grenada	Saint Lucia	Colombia		Mexico	Fiji			Kiribati
Target Year		2025	2030	2020	2025	2030	2030	2025	2025	2025	2030	2030	2020	2025	2030	2025
Update Status		National Report		National Report			IRENA roadmap	Second NDC	NDC partnership Plan	First NDC Updated	First NDC updated	GGGI publication	LT-LEDS			First NDC
SPV	Unconditional (MW)	127	-	-	-	-	-	-	-	-	-	-	7,9	37,6	54,3	0,4
	Conditional (MW)	269,2	750,3	-	-	7,304	199	10	10	400	451,3	33,000	15,8	75,2	108,5	0,3
	Old Targets (MW)	-	-	-	-	-	-	7,5	-	-	-	-	-	-	-	0,7
	Investments (US million $)	-	-	-	-	-	-	14,6	50							
WON	Unconditional (MW)	10	-	-	-	-	-	-	-	-	-	-	-	-	13,3	-
	Conditional (MW)	-	-	423	1,623	5,623	58	2	12	-	-	34,000	-	-	33,3	-
	Old Targets (MW)	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-
	Investments (US million $)							4,4								
BIO	Unconditional (MW)	-	-	-	-	-	-	-	-	-	-	-	-	-	7,7	7,7
	Conditional (MW)	-	-	600	1,158	2,394,5	-	-	-	-	-	-	-	-	15,3	2,1
	Old Targets (MW)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Investments (US million $)															
HYL	Unconditional (MW)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Conditional (MW)	4,855	11,174	3,531	6,531	9,731	-	-	-	-	-	-	-	-	-	-
	Old Targets (MW)	25	25	-	-	-	-	-	-	-	-	-	-	-	-	-
	Investments (US million $)															
HYS	Unconditional (MW)	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Conditional (MW)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Old Targets (MW)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Investments (US million $)	-														
GEO	Unconditional (MW)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Conditional (MW)	-	-	-	-	-	-	15	30	-	-	-	-	-	-	-
	Old Targets (MW)	-	-	?	?	?	-	15	-	-	-	-	-	-	-	-
	Investments (US million $)							81,1	-	-	-	-	-			
Aggregated	Unconditional (MW)	282,3	-	-	-	-	-	-	-	-	-	-	161,6	-	-	-
	Conditional (MW)	750	-	-	-	-	-	-	-	-	-	-		-	-	-
	Old Targets (MW)		-	-	-	-	-	-	71,7	-	-	-	-	-	-	-
	Investments (US million $)	28,400				79, 9	-		-							

		Oceania											
Country		Marshall Islands	Papua New Guinea		Samoa	Solomon Islands	Tonga			Tuvalu		Vanuatu	
Target Year		2030	2025	2030	2025	2030	2020	2025	2030	2025	2030	2025	2030
Update Status		National Electricity roadmap	Second NDC		First NDC	First NDC	Second NDC (+INDC)			National Report		First NDC	
SPV	Unconditional (MW)	-	-	-	-	1,3	-	-	2,2	-	-	-	-
	Conditional (MW)	19,6	-	16,1	-	0,3	-	-	11,5	3,1	-	7,5	17,5
	Old Targets (MW)	45,1	-	-	-	-	13,7	13,7	-	-	-	-	17,5
	Investments (US million $)	44		86,7									
WON	Unconditional (MW)	-	-	-	-	-	-	-	-	-	-	-	-
	Conditional (MW)	15	-	-	0,6	-	2,1	-	17,7	0,8	-	3	-
	Old Targets (MW)	1,7	-	-	0,6	-	16,5	16,5	16,5	-	-	3	-
	Investments (US million $)	70											
BIO	Unconditional (MW)	-	-	-	-	-	-	-	-	-	-	-	-
	Conditional (MW)		-	-	12	-	-	-	0,8	-	-	-	-
	Old Targets (MW)	2,1	-	-	12	-	0,8	0,8	-	-	-	-	-
	Investments (US million $)								4,6				
HYL	Unconditional (MW)	-	-	-	-	9	-	-	-	-	-	-	-
	Conditional (MW)	-	8	20	4	4	-	-	-	-	-	-	-
	Old Targets (MW)	-	-	-	-	-	-	-	-	-	-	-	-
	Investments (US million $)		66	169									
HYS	Unconditional (MW)	-	-	-	-	-	-	-	-	-	-	-	-
	Conditional (MW)	-	-	-	-	-	-	-	-	-	-	-	-
	Old Targets (MW)	-	-	-	3,5	-	-	-	-	-	-	-	-
	Investments (US million $)												
GEO	Unconditional (MW)	-	-	-	-	30	-	-	-	-	-	-	-
	Conditional (MW)	-	-	-	-	-	-	-	-	-	-	4	8
	Old Targets (MW)	-	-	-	-	-	-	-	-	-	-	-	8
	Investments (US million $)					150						-	-
Aggregated	Unconditional (MW)	-	-	-	-	-	-	-	-	-	-	-	-
	Conditional (MW)	-	-	-	-	-	-	-	-	-	-	-	-
	Old Targets (MW)	-	-	-	-	-	-	-	-	-	4	-	-
	Investments (US million $)									16,2			

Note 1: NDCs of Grenada and Tonga build on the NDCs submitted in 2015. Investment needs for Grenada has been taken/confirmed by referring to the NDC Partnership Plan.
Note 2: Lao PDR states the aggregated energy target of solar and wind power to be 1 GW. The energy target for solar and wind derived from the old NDC was used instead.
Note 3: Myanmar states the aggregated energy target of solar and wind power. The ratio of the two technologies has been estimated by adopting the proportion of solar and wind power in the national electricity mix by 2030, projected by the Ministry of Electricity and Energy[xxi].
Note 4: Solar PV entails utility-scale solar photovoltaic projects, thus mini-grids and off-grid solar projects are not counted as part of the solar PV target.
Note 5: Ethiopia has an updated NDC, but due to its lack of specific energy targets, its INDC has been used in this assessment.
Note 6: For Morocco, the updated NDC presents the combined target for the installation of solar thermal power plants and solar PV. The solar thermal target indicated in the previous NDC (2000 MW) has been assumed to apply in the updated NDC when calculating the solar PV target.

xxi Eurocham Myanmar (2018). Energy Guide 2018, p.10. https://www.ccifrance-myanmar.org/sites/ccifrance-myanmar.org/files/resources-documents/energy_guide_2018.pdf

Annex D: Forestry employment factor categories and activities

EF Category	Explanation and detailed work activities	
Afforestation, reforestation and desertification control	Afforestation and reforestation, including reclamation of degraded or desertified lands, offer the greates scope for job creation. Sources of employment inlcude lLand preparation, production of planting material and planting maintenance.	Employment factors: Nair and R. Rutt (2009)
Improvement of productivity of existing planted forests	Routine maintenance operations include weeding, cleaning, thinning and pruning. Regular maintenance operations can improve productivity	
Watershed improvement	In addition to afforestation, watershed improvement may involve construction of water and soil conservation structures such as check dams, contour trenches and terraces, which is highly labour intensive.	
Indigenous forest management	In many countries the condition of these forests and their environmental services could be improved through assisted regeneration and "close-to-nature" forest management based on better understanding of ecosystem proccesses. There is scope for the use of traditional knowledge of local communities and the adoption of technologies appropriate to local conditions.	
Forest conservation	Conservation activities inlcude demarcating boundaries of protected areas, maintaining paths and trails, developing recreation sites and establishing nature education and information centres.	
Agroforestry	Tree growing has been an integral part of various famring systems providing a wide array of products, inlcuding non-wood forest products. With secure tenure and expanding local demand, agroforestry can be expanded and existing practices improved. Although this may not generate full-time employment, it will help reduce poverty of farm households.	
Fire management	Fuel management to reduce the incidence and severity of fires could also increase employment, including for local communities. Activities depend on local conditions, but many are labour intensive.	
Urban and peri-urban forestry	With growing urban populations, the demand for urban green spaces is increasing rapidly. Many city administrations are developing parks and other green spaces to improve the urban environment, yet these efforts could be expnaded in many places. Job creation includes planning, establishment and management of urban and peri-urban green spaces.	
Skill improvement of forestry and wood industry workers	In many countries forestry / forest industry workers have little or no formal training and insufficient skill levels. A systematic programme of skill development would require instructors, creating employment opportunities for qualified hands who would otherwise remain unemployed and be at risk of losing their skills. Employment opportunities also exist in research and development, such as in more energy- and material efficient "green technologies" and organizational management.	
Management and conservation of protected areas & buffer zones	Types of jobs include rangers, managers and educators, community liaison officers, environmental science jobs, and tourist guides. These inlcude further detailed work action such as management and education, monitoring & reporting, stakeholder involvement and inclusivity, indigenous & technical knoweldge transfer, ecotourism	WWF/ILO Report (2020)

Annex E: Direct job creation potential of forestry investments

The following comprehensive table of all reported NDC forestry targets includes all information provided by the submitted NDCs. In addition to table 5, this table contains targets that were reported without quantifiable measures, targets that could not be matched to any EF category, the baselines, and the distinguished conditionality of the targets.

	Country	Economic Situation	NDC Status	Year	M/A	NDC Target	EF Category	Base line	Unconditional				Conditional			
									Ha	USD million	Job-years		Ha	USD million	Job-years	
											Min	Max			Min	Max
Africa	Burkina Faso	LDC	First NDC	2030	M	Forestation / Reforestation project	Afforestation, reforestation and desertification control	2015						64,94	40,586	32,469
						Forest Investment Programme	Other							21,65		
					A	Audit of development plans							450,000	252		
						Protect stream banks	Watershed improvement						30,000	12,6	90,000	30,000
						Assisted natural regeneration (ANR)	Indigenous forest management						800,000	134,4	400,000	200,000
						Diveristy conservation space	Management and conservation of protected areas & buffer zones						900,000	504	3,600	180
	Morocco	MIC	First NDC Updated	2030	M	Restorative activities of ecosystems	Afforestation, reforestation and desertification control	2020	500,000	593	500,000	400,000	200,000	232	200,000	160,000
						Avoided degradation	Forest conservation		900,000	257	135,000	90,000	300,000	354	45,000	30,000
						Building resilience socioecosystem in vulnerable areas	Other		8,000	698			8,000	174		
	Rwanda	LDC	First NDC Updated	2025	A	Promote afforestation / reforestation of designated areas	Afforestation, reforestation and desertification control	2020		8,42	5,261	4,209				
						Improve Forest Management	Indigenous forest management							4,07	1,627	813
						Development of Agroforestry and Sustainable Agriculture	Agroforestry							46,03	34,525	23,017
						Develop integrated spatial data management system	Other							10		
						Inclusive land administration				2,5						
						Integrated approach to plan/monitor sustainable land management								30		
				2030		Promote afforestation / reforestation of designated areas	Afforestation, reforestation and desertification control			8,42	5,261	4,209				
						Improve Forest Management	Indigenous forest management							4,07	1,627	813
						Development of Agroforestry and Sustainable Agriculture	Agroforestry							46,03	34,525	23,017
						Develop integrated spatial data management system	Other							10		
						Inclusive land administration				2,5						
						Integrated approach to plan/monitor sustainable land management								30		

	Country	Economic Situation	NDC Status	Year	M/A	NDC Target	EF Category	Base line	Unconditional				Conditional			
									Ha	USD million	Job-years		Ha	USD million	Job-years	
											Min	Max			Min	Max
Africa	Senegal	LDC	First NDC	2030	M	Increase reforested / restored areas of mangroves	Afforestation, reforestation and desertification control	2019	14,267	4,68	14,267	11,414	44,000	450,12	44,000	35,200
						Increase reforested / restored areas of various plantations			231,000		231,000	184,800	500,000		500,000	400,000
						Defence forests	Forest conservation						500,000		75,000	50,000
						Reduce area burned by bushfires (90%)	Fire management									
						Reduce burned area by late fires (5%) and controlled fires (10%)										
Asia	Cambodia	LDC	First NDC Updated	2030	M	60% forest cover	Afforestation, reforestation and desertification control	2020					3,268,866	5,239,19	3,268,866	2,615,093
						Reduce 50% of historical emission from forest sector	Other									
				2030	A	Prepare planning guidelines at all levels for adaptationIntegrating climate change response measures to the commune land use planning		0		0,326				0,26		
						Prepare modality of standardized green spaces for urban planning								7,86		
						Promote land use planning tools for urban houses								2,56		
						Integrating response measures to social land concession policy								1,86		
						Vulnerability Assessment for development of strategic plans								2,56		
	Indonesia	MIC	First NDC	2030	M	Rate of HTI development	Afforestation, reforestation and desertification control	2015	3,520,000	5,632,00	3,520,000	2,816,000	3,520,000	5,632,00	3,520,000	2,816,000
						Rate of rehabilitation without rotation			1,144,000	1,830,40	1,144,000	915,200	1,903,000	3,044,80	1,903,000	1,522,400
						Rate of rehabilitation with rotation			1,903,000	3,044,80	1,903,000	1,522,400	1,716,000	2,745,60	1,716,000	1,372,800
						Peatland restoration			230,000	368,00	230,000	184,000	115,000	184,00	115,000	92,000
						Improving peat water management	Watershed improvement		767,000	5,202,00	2,301,000	767,000	1,716,000	10,296,00	5,148,000	1,716,000
						Sustainable forest management	Indigenous forest management		2,411,000	3,013,75	1,205,500	602,750	4,508,000	5,635,00	2,254,000	1,127,000
						Peatland deforestation rate	Forest conservation		43,000	15,05	6,450	4,300	14,000	4,90	2,100	1,400
						Peatland degradation rate			43,000	15,05	6 ,450	4,300	14,000	4,90	2,100	1,400
						Mineral land deforestation rate			4,010,000	1,403,50	601,500	401,000	2,036,000	712,60	305,400	203,600
						Mineral land degradation rate			4,014,000	1,404,90	602,100	401,400	2,093,000	732,55	313,950	209,300
	Jordan	MIC	First NDC	2025	M	"Afforesting 25% of barren forest areas"	Afforestation, reforestation and desertification control	2015								

	Country	Economic Situation	NDC Status	Year	M/A	NDC Target	EF Category	Base line	Unconditional				Conditional			
									Ha	USD million	Job-years		Ha	USD million	Job-years	
											Min	Max			Min	Max
Asia	Lao PDR	LDC	First NDC Updated Submission	2030	M	Increase forest cover to 70% of land area	Afforestation, reforestation and desertification control	2020					2,842,286	1,700	2,842,286	2,273,829
	Myanmar	LDC	First NDC Updated	2030	M	Increase land under Reserved Forest and Protected Public Forest to 30%	Afforestation, reforestation and desertification control	2019					3,078,429	4,925,49	3,078,429	2,462,744
						Increase land under Reserved Forest and Protected Public Forest to 30%							2,807,798	4,492,48	2,807,798	2,246,239
						Reduce net emissions by 25%	Other	2020								
						Reduce emissions by 50%										
	Nepal	LDC	Second NDC	2025	A	At least 200,000 ha areas are protected through implementation of adaptation plan	Forest conservation	2015					200,000	70,00	30,000	20,000
				2030	M	Maintain 45% of the total area of the country under forest cover (including other wooded land limited to less than 4%)		2020					94,542	33,09	14,181	9,454
						Forests under community-based management will comprise at least 60% of Nepal's forest area	Indigenous forest management	2015					1,229,484	1,536,86	614,742	307,371
	Philippines	MIC	First NDC	2030	A	Forest protection	Forest conservation	2020								
						Forest restoration and reforestation	Afforestation, reforestation and desertification control									
						Access to result-based finance in forest conservation	Other									
	Vietnam	MIC	First NDC Updated	2030	M	Protection and afforestation of special-use forest	Afforestation, reforestation and desertification control	2019					50,000	80,00	50,000	40,000
						Protection of natural forests	Forest conservation						3,500,000	1,225,00	525,000	350,000
LAC	Colombia	MIC	First NDC Updated	2025	M	Expected deforestation trend	Forest conservation	2019					176,682	366	26,502	17,668
				2030		Reduce rate of deforestation							250,000	149,34	37,500	25,000
						Ecological restoration	Afforestation, reforestation and desertification control	2018					332,258	531,61	332,258	265,806
						Development and consolidation of the productive chain of forest plantations for commercial purposes		-								

	Country	Economic Situation	NDC Status	Year	M/A	NDC Target	EF Category	Base line	Unconditional				Conditional			
									Ha	USD million	Job-years		Ha	USD million	Job-years	
											Min	Max			Min	Max
Oceania	Fiji	SIDS	First NDC Updated Submission	2035	A	Planting trees	Afforestation, reforestation and desertification control	2020					30,000	48,00	30,000	24,000
	Papua New Guinea	SIDS	Second NDC	2030	Mitigation	Increase area of planted forest and forest restoration	Afforestation, reforestation and desertification control	2019					10,000	16,00	10,000	8,000
						Area of annual deforestation is reduced by 25%	Forest conservation	2015					91,300	29,05	13,695	9,130
						Area of forest degradation is reduced by 25%							476,300	151,55	71,445	47,630
						Reduce emission from deforestation / forest degradation due to commercial agriculture expansion and commercial logging	Other	2015								
	Tonga	SIDS	Second NDC	2025	Mitigation	Planting trees	Afforestation, reforestation and desertification control	2020					1,000	1,60	1,000	800

Note 1: Orange and light green have been used in the table to classify the reported conditionality of targets. In the case where targets were reported to be achieved unconditionally, the according units are light green. Where targets are to be achieved under conditional conditions, the units are orange. When targets were reported with an unconditional and conditional component, the numbers were aggregated and left uncolored.

Note 2: Light blue and grey indicate numbers not reported by the NDCs but that have been estimated based on additional information. In the case of estimated investment requirements (USD million), the study from Nair and Rutt3736 provided annual outlays per hectare for each EF category, which were used to estimate the required investment for targets that reported hectares. These calculations only demonstrate a rough estimation and should be interpreted with caution.

Note 3: The investment requirements for Senegal relate to the total of reported targets. Light green indicates that the investment requirements are included in the shown amount of USD 4.68 million.

Note 4: The forestry targets presented by Colombia that aim for a deforestation rate were presented in two scenarios. The target that is included in this assessment is the so-called M3 scenario, which aims for a deforestation rate of 50,000 ha/year. Another scenario, which is not included in this assessment, is the Article 6 scenario, which aims for a deforestation rate of 0 ha/year. This scenario presents the overall goal for Colombia to reach zero deforestation. If this scenario were implemented, then the number of job-years created would be between 50,000 and 75,000. These job-years would be additional to the 2025 deforestation target.

Annex F: Indonesia, estimated job-years of NDC targets under BAU

Indonesia presented targets under the BAU scenario, in addition to unconditional and conditional targets. For the BAU targets, the estimated job-years are presented in the following table.

Indonesia - BAU					
NDC Target	EF Category	Ha	USD million	Job-years	
				Max	Min
Rate of HTI development	Afforestation, reforestation and desertification control	1,650,000	2,640	1,650,000	1,320,000
Rate of rehabilitation without rotation		1,067,000	1,707,2	1,067,000	853,600
Rate of rehabilitation with rotation		1,210,000	1,936	1,210,000	968,000
Sustainable forest management	Indigenous forest management	326,000	407,5	163,000	81,500
Peatland deforestation rate	Forest conservation	696,000	243,6	104,400	69,600
Peatland degradation rate		699,000	244,65	104,850	69,900
Mineral land deforestation rate		8,410,000	2,943,5	1,261,500	841,000
Mineral land degradation rate		8,607,000	3,012,45	1,291,050	860,700

Note: Light blue and grey indicate numbers not reported by the NDC but that have been estimated based on additional information.

Annex G: Job-years created per investment (USD million)

Job-years per investment (USD million)							
Energy				Forestry			
	Minimum	Maximum	Average		Minimum	Maximum	Average
Solar PV	10	188	**53**	Afforestation, reforestation and desertification control	560	700	**630**
Biomass	16	111	**55**	Forest conservation	284	426	**355**
Hydro (Large)	9	31	**19**	Watershed improvement	160	481	**320**
Geothermal	8	20	**14**	Indigenous forest management	200	400	**300**
Wind Onshore	4	25	**11**				

Note: Job-years created per investment are calculated based on the investments that have been estimated based on the targets and the corresponding number of job-years created.

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