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Status Analysis of Green Recovery Spending in Response to COVID-19 Crises
- With the Focus on Green Climate Technology (GCT) in Developing Countries -

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ABSTRACT

Purpose: The global society has faced the COVID-19 crises which might slow down the speed of global net-zero race, as the governments have tended to invest in recovery policies that might have negative climate change impacts. In order to diagnose the current investment trends, this research analyzes the status of green recovery spending in the context of developing countries that are more vulnerable to climate risks. In addition, the analysis focuses on green measures with regard to technologies that take up the majority of overall spending. Therefore, this study raises the question of whether developing countries are building back better after the pandemic. **Method:** To answer this question, the research conducts a status analysis of green recovery spending in 2020, using the database of Global Recovery Observatory that provides the amount of green spending by each policy, and also the classification of Green Climate Technology (GCT) as a reference. **Result:** The results conclude that the developing countries are *not* building back better, as the green recovery spending only accounts for one tenths of total recovery spending while more than half of them is by few countries with higher income level. In addition, the spending on green technologies skews towards certain type of technologies. Drawing on the findings, this study provides four policy implications: to prioritize green investments in the government budget, to expand green ODA especially to low income countries, to diversify green policy types and include non-infrastructure aspect, and to integrate socio-economic perspectives for inclusive green transformation.

KEYWORD

코로나 위기
녹색회복
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1. Introduction

Since 2021, the global society has entered into a new era that is engaged with the emissions goal set in the Paris Agreement to limit global warming to well below 2, preferably to 1.5 degrees Celsius, compared to pre-industrial levels[1)][1]. A special report on global warming of 1.5℃ by the IPCC (Intergovernmental Panel on Climate Change) finds that global net human-caused emissions of CO_2 would need to fall by about 45 percent from 2010 levels by 2030, reaching 'net zero' around 2050[2]. In a way to achieve such ambitious goal, countries have legislated the carbon neutrality pledge that mandates to reach net zero emissions with a certain time-line (mostly by 2050)[3].

Unexpectedly, the world has faced the COVID-19 crises which might slow down the speed of global net-zero race. The pandemic has taken away the global attention from the urgency of climate crises, as the governments have prioritized recovery policies, many of which are challenging the environmental endeavors. Responding to this, many countries have committed to a 'green recovery' that has a likely positive environmental impact within the stimulus packages[4]. However, as of April 2021, around 17% of recovery spending is marked as green measures, where as the rest are are indicated as negative or mixed measures[4]. In order to meet the global 1.5℃ goal and sustainability in the long term, post COVID-19 response should entail strong green stimulus which combines 1.2% increase in green investment and 0.4% decrease in fossil fuel investments[5].

Against this background, this research aims to analyze the status of green recovery spending especially in developing countries, which has not been explored comparing to the one in advanced economies[6-7]. In addition, the analysis focuses on green measures with regard to technologies that take up the majority of overall recovery spending. The green recovery database of Global Recovery Observatory is used, which is matched to the classification of Green Climate Technology (GCT). By doing so, this study intends to diagnose whether developing countries are building back better after the pandemic.

The remaining of this paper is structured as follows. Section 2 describes the concept of green recovery in the context of historical crises including COVID-19 pandemic, and then the significant role of technology in accelerating green recovery, especially in developing countries. Section 3 explains database and methods

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used for the analysis of green recovery spending, and the results on the status of green recovery spending is presented in Section 4. Lastly, key findings and policy implications are identified.

2. Conceptual backgrounds

2.1. Why green recovery

Green recovery refers to economic recovery measures that are aligned with, and can support the transition towards sustainability and climate change objectives[8]. The rise of such concept is exclusively induced by the COVID-19 pandemic which has caused the economic contraction since the Great Depression[9 cited in 8]. During the initial stage of the pandemic, many countries have committed to the national and sub-national stimulus packages that are mostly responding to emergency rescue such as health system and job losses[4].

As the pandemic advanced, however, it has been incrementally assured that green fiscal spending can produce stronger economic returns, based on a growing body of evidence[11 cited in 10]. In this context, the Lancet COVID-19 Commission suggests that the long-term green spending during the pandemic can be a springboard to accelerate the transition to a sustainable and inclusive economy [8]. Such understanding is supported by the research that stimulus packages may increase the CO_2 emissions and therefore induce unpredictable dangers by climate crises, as the world has already witnessed during the 2009 global economic crisis: the stimulus fiscal spending that has few environmental considerations ended up with generating the highest amount of emissions in 2010[12]. In contrast, green recovery could stimulate economy in terms of increased gross value added (GVA) and job opportunities[13].

According to the report of UNEP and Oxford Univ., the recovery spending policy of 50 largest economies announced in 2020 is USD 1.9tn, and 18% of recovery spending is marked as green spending[10]. By economy level, developing countries have announced only about one sixths of green spending comparing to advanced economies[10]. Especially, analysed by policy sector, green spending of developing countries are largely limited to clean energy and/or clean transport. This narrowness can be related to high technological barriers, low distribution rate of enabling technologies and lack of capital in developing countries. Considering the significant role of technologies in sustainability transition[14], more spending on clean and low-carbon technologies should be expanded to build back better.

2.2. Technology for green recovery

As mentioned above, technology is key to achieving transformations to sustainable future, by meeting the United Nation's SDGs (Sustainable Development Goals) and net-zero target. In this sense, many researches have emphasized on the necessity to develop and implement green and/or climate technologies across various sectors, including energy, water, waste management, transport, etc.[15][16]. Especially, sustainability transition scholars have introduced the concept of technological innovation which describes how existing technological systems (regime) are replaced by emerging ones (niche). Here, technological niches refer to environmentally benign technologies whose usage are aimed at reducing emissions and increasing adaptation capacity to climate change crises[17][18]. Such transitions to green technology niche can offer an opportunity to the success of green recovery from the COVID-19 pandemic.

Then, there arises the question of which technologies are green and have positive environmental impacts. The IPCC divided the notion of climate change into two categories, i.e.

Table 1. Classification of Green Climate Technology (GCT) [20]

Category	Section	Technology (45)
Mitigation	1) Non-renewable Energy	Nuclear power, Nuclear fusion power, Clean thermal power & efficiency, Hydropower, Photovoltaic power, Solar heat, Geothermal power, Wind power, Ocean energy, Bio energy, Waste, Hydrogen manufacturing, Fuel cell, Power storage, Transmission & distribution system, Intelligent electric device, Transport efficiency, Industrial efficiency, Building efficiency, CCUS, Non-CO2 mitigation
	2) Renewable Energy	
	3) New Energy	
	4) Energy Storage	
	5) Transmission, Distribution, Power IT	
	6) Energy Demand	
	7) Greenhouse Gas Sequestration	
Adaptation	8) Agriculture & Livestock	Genetic resources & genetic improvement, Crop cultivation & production, Livestock disease control, processing, storage & distribution, Water system & aquatic ecosystem, Water resource security & supply, Water treatment, Water disaster control, Climate change forecast & modeling, Climate information & warning system, Ocean ecosystem, Marine resources, Offshore disaster control, Contagious disease control, Food safety & prevention, Productive forest improvement, Forest damage mitigation, Ecosystem monitoring & recovery
	9) Water Management	
	10) Climate Change Forecast & Monitoring	
	11) Ocean, Marine & Offshore Management	
	12) Health Care	
	13) Forest & Land Management	
Mitigation/ Adaptation Convergence	14) Mixture of Multiple Areas	New and renewable energy hybrid, Low power consumption equipment, Energy harvesting, Artificial photosynthesis, Other technologies related to climate change

mitigation and adaptation[19]. Following this, the Green Technology Center developed the classification of green climate technology (GCT) that is divided into three fields[20]. First, a mitigation field includes technologies that reduce GHG sources and emissions and enhance GHG sinks. Second, adaptation technologies deal with environmental, social and economic risks and effects induced by climate change in human and nature system. Third is the convergence of combined use of multiple mitigation and adaptation technologies. Table 1. explains the GCT classification with 14 divisions and 45 sections, which will be applied to the analysis of green recovery spending on the technologies.

3. Methodology

This study uses a data set of Global Recovery Observatory (GRO) developed by the Oxford University as a part of Economic Recovery Project. The GRO presents global government spending during the COVID-19 pandemic, with an aim to guide governments towards more sustainable investment in dealing with the pandemic[21]. The database tracks and assesses COVID-19 related fiscal spending policy announced by 50 leading economies, both advanced and developing countries[21].

The spending is divided into rescue spending (short-term measures designed for emergency support) and recovery spending (long-term measures to boost economic growth)[22]. Each recovery spending of the database is marked as either green or not green, based on the assessment of policy impact versus a scenario in which no intervention is made, and also supported by a survey of leading economists[22]. Therefore, this study focuses on the green spending, and the temporal scope of the analysis is the year of 2020, considering the data availability.

Given that this study focuses on the emerging economies of which COVID-19 fiscal spending has been rarely analysed, the selection criteria for the analysis country includes the OECD/DAC countries, of which green spending data is available in the GRO database. As a result, 18 countries are selected, and these countries are divided by income level and region for the analysis, as shown in Table 2.

In order to analyze the green spending on technologies, GCT taxonomy is used. The 45 technologies of GCT (see Table 1.) are matched to archetypes of GRO, which are marked as infrastructure/technology incentive and investment. For this, a keyword is extracted from each GCT technology, and then matched to GRO archetype based on each policy description. A matching matrix is developed as Table 3., and which will be used for the analysis of GCT spending for green recovery.

Table 2. Analysis countries divided by income level and region

	LDC (Least Developed Countries)	LMIC (Lower Middle Income Countries)	UMIC (Upper Middle Income Countries)
East Asia & Pacific	-	Philippines	China
Europe & Central Asia	-	-	Turkey
Latin America & Caribbean	-	Honduras	Argentina, Brazil, Colombia, Jamaica, Panama, Peru
Middle East & North Africa	-	-	Iraq
South Asia	Bangladesh	India, Pakistan	-
Sub-saharan Africa	Burkina Faso, Senegal	Kenya	Mauritius

Note: Classification of income level by OECD[23] and region by World Bank[24]

Table 3. A matching matrix of GCT technology and GRO green policy of 18 selected countries

Approach	GCT Technology	GRO Green Policy
Mitigation	1) Non-renewable Energy	Nuclear power
	2) Renewable Energy	Solar technology, wind farm, biomass power, hydro power
	3) New Energy	-
	4) Energy Storage	-
	5) Transmission, Distribution, Power IT	-
	6) Energy Demand	Energy efficiency, e-mobility, green transport, green building
	7) GHG Sequestration	-
Adaptation	8) Agriculture & Livestock	Climate-smart agriculture, irrigation, vulnerability reduction
	9) Water Management	Water supply, pollution prevention, water conservation, dam cleaning, canalization
	10) Climate Change Forecast & Monitoring	-
	11) Ocean, Marine & Offshore Management	-
	12) Health Care	-
	13) Forest & Land Management	Afforestation, reforestation, wetlands, wildlife conservation
Mitigation/ Adaptation Convergence	14) Mixture of Multiple Areas	-

Note: Green policies in this table are limited to the ones of 18 selected countries in Table 2.

4. Results

The overall analysis of this study uses the GRO database (excel) which provides the amount of recovery/green spending by

each policy announced in 2020[25]. This section first covers the analysis of green recovery spending of 18 selected countries as an overview, then moves to the analysis of GCT spending on mitigation and adaptation by income level and region, which is based on the matching matrix (see Table 3.).

4.1. Green recovery spending

The green recovery spending of selected 18 countries account for around 57 USD (billions). This is 11.6% of total recovery spending, and 0.3% of total GDP of selected countries. As described in Fig. 1. below, three countries – Turkey, Jamaica and Mauritius – have 100% green spending out of recovery spending, while the ratio of recovery spending out of GDP is less than 0.5%. In contrast, Peru has the highest recovery spending as %GDP, but the lowest green spending ratio. By income level, lower middle income countries (LMICs) have the lowest green recovery spending and recovery spending (%GDP). Some of upper middle income countries (UMICs), including China and Iraq have low green spending ratio to recovery spending, while others in the same income level group, such as Brazil, Colombia and Panama have higher ratio.

4.2. GCT spending

The GCT spending accounts for 99.6% of green recovery spending, while the rest (0.4%) is for non-infrastructure. Referring to GCT classification (see Table 3.), mitigation technologies account for 54%, and adaptation technologies for 46%. Fig. 2. shows the result by income level and region. Firstly, by income level, countries with low income (LMICs and LDCs) have higher spending on mitigation, whereas UMICs have balanced spending between mitigation and adaptation. Secondly, by region, Asian countries have higher spending on adaptation technologies, whereas Latin American countries have exclusive investment on mitigation (only 6% for mitigation).

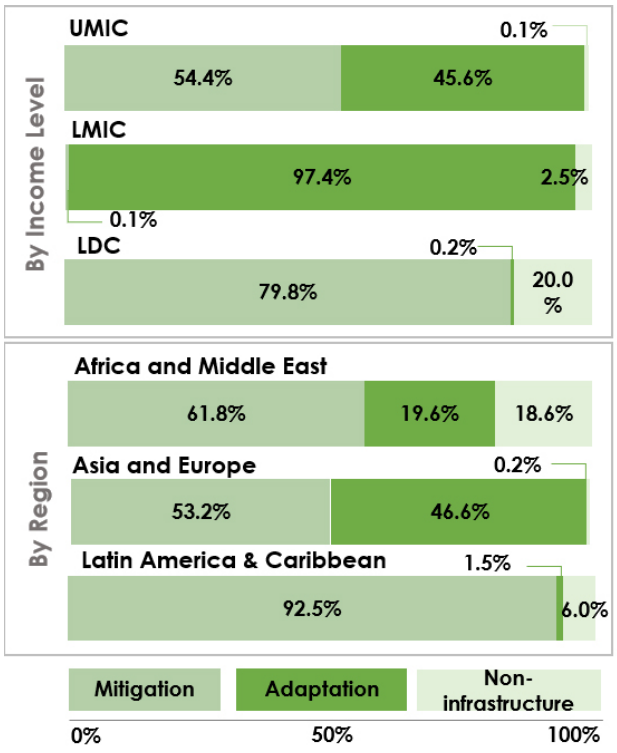

Fig. 2. Green recovery spending by income level and region
Note: Based on Global Recovery Observatory database[25] and GCT classification[20]

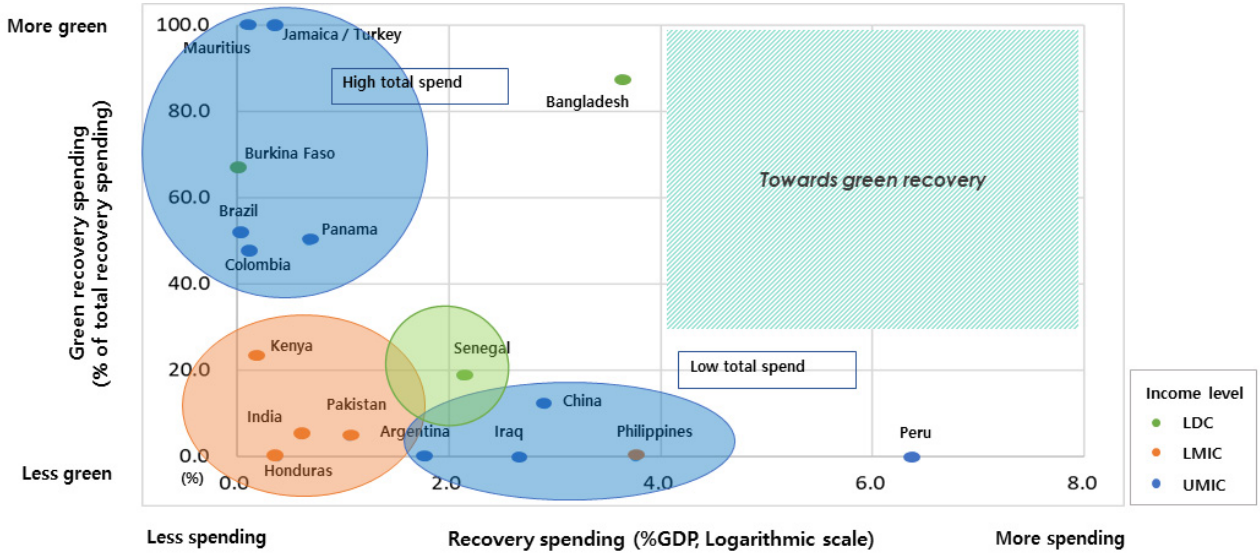

Fig. 1. Green recovery spending as a percentage of total recovery spending vs. recovery spending as %GDP
Note: Based on Global Recovery Observatory database[25], GDP data from World Bank [24] and Income level classification by OECD[23]; Both Burkina Faso and Brazil have 0.3% of recovery spending (%GDP).

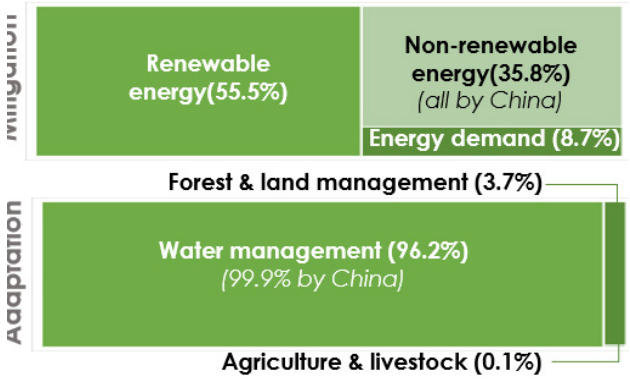

Fig. 3. Green recovery spending by green climate technology
Note: Based on Global Recovery Observatory database[25] and GCT classification[20]

As shown in Fig. 3, green spending of 18 selected countries is on six GCT technologies. Mitigation spending is divided into three GCT technologies (renewable energy, non-renewable energy, energy demand), and adaptation spending is also into three (water management, forest and land management, agriculture and livestock).

Firstly in mitigation, spending on renewable energy takes up around 56%, which includes 16 policies by 8 countries. Argentina started the project to deliver 5,400 solar panels to rural producers in 19 provinces[26]. The National Bank for Economic and Social Development (BNDES) of Brazil approved long-term financing for the implementation of the Ventos de Santa Martina wind farm. It is estimated that 1,500 jobs will be created[27]. Non-renewable energy accounts for about 36% of mitigation spending, and all is by China. In September, China approved nuclear power projects (USD 10 billion) to construct four nuclear reactors, tow in coastal Zhejiang Province and tow on the southeastern island of Hainan[28]. For energy demand, a variety of policies have been announced, including the investment in electric vehicles and charging stations (India, China), energy efficiency funding (Brazil) and GHG emissions reduction incentives to SMEs (Colombia)[25].

Secondly in adaptation, both agriculture and forest/land management have higher number of polices than water management. However, the amount of spending is exclusively on water management (96.2%), while 99.9% of this spending is by China on reinforcements of dilapidated reservoirs (USD 100 billion) and water pollution prevention (USD 61 billion)[25]. For agriculture and livestock, Jamaica has planned the programme that provides support for production incentive to include seeds and other planting material, input material and technical assistance. It also covers drought mitigation and climate management support to include water and irrigation systems [29]. Mauritius has announced the EU funded projects to promote agroecological farming, reduce the use of pesticides, and increase resilience of agriculture to climate change[30]. In forest and land management, the Compensatory Afforestation Management & Planning Authority (CAMPA) of India will initiate the funds for afforestation and plantation works, including artificial regeneration, assisted natural regeneration, soil and moisture conservation works, and forest and wildlife related infrastructure development[31].

5. Discussion and conclusion

The research analyzed the status of green recovery spending in the context of developing countries, with particular focus on policy measures with regard to green climate technologies. As a result, this study concludes that developing countries are *not* building back better after COVID-19 crises as clearly indicated in Fig. 2. above, and which calls for increased endeavors to attain green recovery.

5.1. Key findings

In addition to the main conclusion above, this study has drawn four key findings. First, green recovery spending of developing countries is not enough that it only takes up around one tenth of recovery spending. This can be interpreted that a number of recovery policy measures that have negative impacts on the environment have been announced, and some of them are already implemented. Second, more than half of green recovery spending is by UMICs. It may indicate that countries with higher income level appear to have more ambition and political will on green investments, and the income level has relations to the degree of policy efforts for green recovery.

Third, most of green recovery spending (99.6%) has been assigned on technologies, echoing the significance of technology in the recovery process. In other words, however, there have been lack of efforts on non-infrastructure investments. Fourth, GCT spending skews towards certain technologies, such as (non-)renewable energy, water management and agriculture. It can be an area of improvement to diversify investments on different types of technologies, but it also needs to explore whether such imbalance is due to lacking access to different technologies or just due to low demands of the countries.

5.2. Policy implications and future studies

The research can provide four policy implications. Firstly, *the governments should increase and prioritize green investments, in order to move towards green recovery from pandemic crises.* Countries should recognize that green recovery spending would not only generate economic and social benefits, but also reduce

environmental damage. One example that can be learned is 'green budgeting'. France is the first country to evaluate the environmental impact of its national budget, as they recognized environmental transition as a key element of its recovery plan. Considering the fact that budgets play an important role in determining how resources are allocated to achieve national goals, it is appropriate that priorities related to the environment should be considered in the budget process[32]. Green budgeting tagging, in particular, can be used as a useful tool to assess each individual budget measure and giving it a tag according to whether it contributes to or hinders green objectives.

Secondly, in the same manner, *donor countries should expand Green ODA (official development assistance), especially to low-income countries (here, LDCs, LMICs).* Furthermore, they should diversify policy investments in technologies for adaptation, such as climate change forecast and monitoring, disease control, and food safety (cf. Table 1.). For this, it can be necessary to develop and/or use technology demand-supply matching system – for example, recipient countries' climate goals (demand) and donor countries' competitive technologies, related funding and cooperation programmes/projects (supply).

Thirdly, *green stimulus should be accompanied by other types of policy such as non-infrastructural approach, including regulatory change, fiscal reforms, and skills training.* Such imbalanced investments are also found in the case of advanced economies that only few policy measures on employee retraining have been initiated, such as Spain's green transition employment plan and Sweden's green sectors matching program[10].

Lastly, in addition to green infrastructure investment (electric vehicle subsidies, renewable energy, building renovation, etc.), *efforts to integrate socio-economic perspectives are essential for inclusive and just green transformation,* e.g. inclusion of the socially disadvantaged, job creation through green transformation, and worker retraining[33]. In this sense, there should be considerations for an inclusive strategy to minimize the socio-economic impact of the process of transitioning to a green economy (e.g. fuel-based industry to renewable energy generation).

Based on the classification framework generated in this study, the potential research topics could include a sector analysis of green recovery spending, such as clean transport, green market, worker retraining and and job creation. This could be used as a diagnosis on specific sectors that are to be considered with more enhanced investments. In addition, considering the global trend of carbon neutrality and net-zero pledge by governments, it may be a worth to analyze the financial gap between the current green recovery investments (spending) and the policies that are announced and in implementation to redress pandemic crises.

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1) The Paris Agreement is a legally binding international treaty on climate change adopted by 196 Parties at COP 21 in 2015.

