Common Market for
Eastern and Southern Africa

Climate Action and Inclusive Growth

Special Report

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The objective of this paper is to provide an introductory note on how to make climate change more inclusive and sustainable.

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Introduction

Climate change is humanity's major challenge in the coming decades. Global greenhouse gas (GHG) emissions need to go to net-zero by mid-century. At the same time, countries need to adapt to the climate changes that are coming while making societies more inclusive and economic growth more sustainable. At present growth is not sustainable and hardly inclusive. This requires transformation and a major investment push in key economic sectors. Transformation requires comprehensive and coordinated government led climate action among others, using a broad package of tools and policies.

The objective of this paper is to provide an introductory note on how to make climate change more inclusive and sustainable. The first part of the paper presents science of climate change. The second section highlight causes of climate change. The third section discusses the economic consequences of climate change The fourth part highlights the macro-economic consequences of climate change. The fifth part briefly presents key findings of Climate Impact on Africa's Economic Growth. The sixth section briefly discusses, linkages between climate action and inclusive growth. The seventh part elaborates structural transformations needed to make climate change inclusive and sustainable. The eighth section presents some of the climate change mitigation measures which enable the transition to sustainable and inclusive growth. The last section presents the conclusions of the paper.

I. Science of Climate Change

Earth is at an appropriate distance to the sun as compared to other planets such as Venus and Mars and therefore the atmosphere regulates the temperature. This allows earth to maintain life. The sun's radiation travels towards the Earth. About half of that energy is reflected back by the atmosphere and the remainder reaches the earth. Heat from the earth is then released back to space. Some of this heat passes directly through the atmosphere, but a large portion is reflected to the Earth by the gases in the atmosphere. The composition of the gases in the atmosphere determines how much energy is retained. Some gases such as carbon dioxide act like a greenhouse and retain a higher share of the energy. Because of this, they are called greenhouse gases (GHG). Despite the partial absorption of greenhouse gases by land and ocean, the concentration in the atmosphere increases and so do global temperature.[1]

Concentrations of the key greenhouse gases have all increased since the Industrial Revolution due to human activities. Carbon dioxide, methane, and nitrous oxide concentrations are now more abundant in the earth's atmosphere than any time in the last 800,000 years. These greenhouse gas emissions have increased the greenhouse effect and caused the earth's surface temperature to rise. Burning fossil fuels changes the climate more than any other human activity.[2]

1 IMF Online Training on "Macro-economics of Climate Change" https://learning.edx.org/course/course-v1:IMFx+MC-Cx-SEP+1T2022/block-v1:IMFx+MCCx-SEP+1T2022+type@sequential+block@ee9de30e2b464c27a7327534f35a626f/block-v1:IMFx+MC-Cx-SEP+1T2022+type@vertical+block@1abf76b52a434bdeaa02ea2720ab1462

2 United States Environmental Protection Agency(EPA) "Causes of Climate Change" https://www.epa.gov/climatechange-science/causes-climate-change

Carbon dioxide: Human activities currently release over 30 billion tons of carbon dioxide into the atmosphere every year. Atmospheric carbon dioxide concentrations have increased by more than 40 percent since pre-industrial times, from approximately 280 parts per million (ppm) in the 18th century to 414 ppm in 2020.[3]

Methane: Human activities increased methane concentrations during most of the 20th century to more than 2.5 times the pre-industrial level, from approximately 722 parts per billion (ppb) in the 18th century to 1,867 ppb in 2019.[4]

Nitrous oxide: Nitrous oxide concentrations have risen approximately 20 percent since the start of the Industrial Revolution, with a relatively rapid increase toward the end of the 20th century. Nitrous oxide concentrations have increased from a pre-industrial level of 270 ppb to 332 ppb in 2019.[5]

If business continues as usual, the following are some of the consequences:[6]

(i) The world could heat up by about five degrees Celsius (nine degrees Fahrenheit) by 2100. This is roughly the temperature difference between an ice age and a planetary warm phase. Since Earth's climate is currently in a warm phase humanity would thereby create a "fire age".

(ii) Global warming leads to the thermal expansion of sea water and increases melt-water runoff from glaciers and ice sheets. Sea level has risen by about 15 to 20 centimeters during last century; another 50 to 150 centimeters are expected this century. Continued warming could destabilize the Greenland and Antarctic ice sheets. In Earth's history sea level rose by 10 to 15 meters with each degree of global warming. It is not yet clear though, how much time that process took.

(iii) The anthropogenic greenhouse effect could push the Earth's climate system past critical thresholds, so that important components may "tip" into qualitatively different modes of operation. This would affect climate on a sub-continental scale and could cause the complete disappearance of Arctic sea-ice and Himalayan glaciers or large-scale dieback of the Amazon rainforest.

(iv) According to current knowledge, the most dangerous impacts of climate change could be averted, if anthropogenic warming was limited to two degrees Celsius (3.6 degrees Fahrenheit). This requires confining the concentrations of all greenhouse gases and their effect to a level that does not exceed that of 450 ppm carbon dioxide. To reach the two degrees' target, global emissions of greenhouse gases have to be reduced by

3 Ibid
4 Ibid
5 Ibid
6 Climate Change Knowledge in a Nutshell; https://www.pik-potsdam.de/en/output/infodesk/climate-change-knowledge-in-a-nutshell

2050 to about half of the level of 1990.

(v) Adaptation to climate change and the confinement of global warming to two degrees Celsius therefore, require a "Great Transformation" of the global economy and of urban and rural life.

II. Causes of Climate Change

The following are the major causes of climate change:[7]

(i) **Generating power**: Generating electricity and heat by burning fossil fuels causes a large chunk of global emissions. Most electricity is still generated by burning coal, oil, or gas, which produces carbon dioxide and nitrous oxide – powerful greenhouse gases that blanket the Earth and trap the sun's heat. Globally, a bit more than a quarter of electricity comes from wind, solar and other renewable sources which, as opposed to fossil fuels, emit little to no greenhouse gases or pollutants into the air.

(ii) **Manufacturing goods:** Manufacturing and industry produce emissions, mostly from burning fossil fuels to produce energy for making things like cement, iron, steel, electronics, plastics, clothes, and other goods. Mining and other industrial processes also release gases, as does the construction industry. Machines used in the manufacturing process often run on coal, oil, or gas; and some materials, like plastics, are made from chemicals sourced from fossil fuels. The manufacturing industry is one of the largest contributors to greenhouse gas emissions worldwide

(iii) **Cutting down forests**: Cutting down forests to create farms or pastures, or for other reasons, causes emissions, since trees, when they are cut, release the carbon they have been storing. Each year approximately 12 million hectares of forest are destroyed. Since forests absorb carbon dioxide, destroying them also limits nature's ability to keep emissions out of the atmosphere. Deforestation, together with agriculture and other land use changes, is responsible for roughly a quarter of global greenhouse gas emissions.

(iv) **Using transportation**: Most cars, trucks, ships, and planes run on fossil fuels. That makes transportation a major contributor of greenhouse gases, especially carbon-dioxide emissions. Road vehicles account for the largest part, due to the combustion of petroleum-based products, like gasoline, in internal combustion engines. Emissions from ships and planes continue to grow. Transport accounts for nearly one quarter of global energy-related carbon-dioxide emissions. And trends point to a significant increase in energy use for transport over the coming years.

7 United Nations Climate Action, "Causes and Effects of Climate Changer", https://www.un.org/en/climatechange/science/causes-effects-climate-change

(v) **Producing food**: Producing food causes emissions of carbon dioxide, methane, and other greenhouse gases in various ways, including through deforestation and clearing of land for agriculture and grazing, digestion by cows and sheep, the production and use of fertilizers and manure for growing crops, and the use of energy to run farm equipment or fishing boats, usually with fossil fuels. All this makes food production a major contributor to climate change. And greenhouse gas emissions also come from packaging and distributing food.

(vi) **Powering buildings**: Globally, residential and commercial buildings consume over half of all electricity. As they continue to draw on coal, oil, and natural gas for heating and cooling, they emit significant quantities of greenhouse gas emissions. Growing energy demand for heating and cooling, with rising air-conditioner ownership, as well as increased electricity consumption for lighting, appliances, and connected devices, has contributed to a rise in energy-related carbon-dioxide emissions from buildings in recent years.

(vii) **Consuming too much**: Your use of power, how you move around, what you eat and how much you throw away all contribute to greenhouse gas emissions. So does the consumption of goods such as clothing, electronics, and plastics. A large chunk of global greenhouse gas emissions are linked to private households. Our lifestyles have a profound impact on our planet. The wealthiest bear the greatest responsibility: the richest 1 per cent of the global population combined account for more greenhouse gas emissions than the poorest 50 per cent.

III. Consequences of Climate Change

Consequences of man-made climate change can be categorized into the following[8]

(a) Natural Consequences;
(b) Social Threats;
(c) Threats to Business;
(d) Territorial Threats.

(a) Natural Consequences. These include among others, high temperature, droughts and wildfires, availability of fresh water, floods, sea level rises and coastal areas and biodiversity:

High temperature, can cause among others, the following consequences:

(i) Increase mortality;
(ii) Reduced productivity;

8 European Commission, "Consequences of Climate Action" https://ec.europa.eu/clima/climate-change/consequences-climate-change_en

(iii) Damage to infrastructure;

(iv) Shift in geographical distributions of climate zones (altering the distribution and abundance of many plants and animal species);

(v) Influences the behavioral and lifecycles of animals and plants (this could increase number of pests and invasive species, and a higher incidence of certain human diseases);

(vi) Diminished supply of clean water or cool and clean air; and increased evaporation increasing the risk of severe drought;

(vii) **Droughts and wildfire:** Droughts often have knock-on effects, for example on transport infrastructure, agriculture, forestry, water and biodiversity. They reduce water levels in rivers and ground water, stunt tree and crop growth, increase pest attacks and fuel wildfire;

(viii) **Availability of fresh water:** As the climate heats up, rainfall patterns change, evaporation increases, glaciers melt, and sea levels rise. All these factors affect the availability of fresh water;

(ix) **Floods:** Increased rainfall over extended periods will mainly lead to fluvial (river) flooding, while short, intense cloudbursts can cause pluvial floods;

(x) **Sea level rise and coastal areas:** The rise is mostly due to thermal expansion of the oceans because of warming, but melting ice from glaciers and the Antarctic ice sheet is also contributing;

(xi) **Biodiversity:** Direct impacts include changes in phenology (the behavior and lifecycles of animal and plant species), species abundance and distribution, community composition, habitat structure and ecosystem processes. Climate change is also leading to indirect impacts on biodiversity through changes in the use of land and other resources. These may be more damaging than the direct impacts due to their scale, scope and speed. The indirect impacts include: habitat fragmentation and loss; over-exploitation; pollution of air, water and soil; and the spread of invasive species. They will further reduce the resilience of ecosystems to climate change and their capacity to deliver essential services; such as climate regulation, food, clean air and water, and the control of floods or erosion.

(b) Social Threats: These include threats to health, vulnerable population, employment and education.

(i) Heath: Climate change is a significant threat not only to human health but also to animal and plant health. While a changing climate might not create many new or unknown health threats, existing effects will be exacerbated and more pronounced than currently seen.

(ii) Vulnerable population: People living in low-income urban areas with poor infrastructure, and, generally speaking, population groups with lower incomes and assets, are more exposed to climate impacts but

have less capacity to face them.

(iii) Employment: Climate change may affect workforce availability due to a decrease in the health conditions of the population and additional occupational health constraints (higher temperature at work, more frequent and intense natural hazards keeping people from reaching their workplace).

(iv) Education: Education and awareness-raising is therefore an important component of the adaptation process to manage the impacts of climate change, enhance adaptive capacity, and reduce overall vulnerability.

c) **Threats to Business:** Climate change represents threat to business through infrastructure and building, energy, agriculture insurance; tourism and cross cutting issues for business.

(i) **Infrastructure and Building:** Buildings and infrastructure can be vulnerable to climate change because of their design (low resistance to storms) or location (e.g. in flood-prone areas, landslides, avalanches). Indeed, they can be damaged or rendered unfit for use by any changing climatic condition or extreme weather event.

(ii) **Energy:** More intense and frequent heatwaves will shift energy supply and demand patterns, often in opposite directions. Further increases in temperature and droughts may limit the availability of cooling water for thermal power generation in summer (lowering energy supply), whereas demand for air conditioning will increase. Moreover, greater magnitude and frequency of extreme weather events will cause threats for physical energy infrastructure: overhead transmission and distribution, but also substations or transformers.

(iii) **Agriculture and Forestry:** Due to a combination of heat and drought, substantive agricultural production losses occur. The ability to adapt using irrigation will be increasingly limited by water availability. Effects on forestry due to climate change include increased risk of droughts, storms and fires (abiotic) and pests and diseases (biotic) – all leading to disturbances to forest health.

(iv) **Insurance:** The frequency and intensity of most types of extreme events is expected to change significantly as a result of climate change. In the short term, as long as due allowance is made for the underlying trend, premiums would rise gradually and the insurance market would absorb such changes without disruption. However, risk knowledge often advances in 'steps', which can lead to jumps in the price over a short period. In the longer term, particularly in most vulnerable sectors or areas, climate change could indirectly increase social disparities as insurance premiums become unaffordable for a fringe of the population.

(v) **Tourism:** The economic consequences of climate change for regions where tourism is important can be substantial.

(vi) **Cross Cutting Issues for Business:** Climate change threatens all businesses, as all exist on Earth. However, some are more vulnerable than others. Impacts are expected to fall disproportionately on small and medium enterprises (SMEs) including disrupting business operations, property damage, disruption to supply chains and infrastructure, leading to increased costs of maintenance and materials, and higher prices. However, climate action offers a wide range of new opportunities for businesses to develop products and services that would help both reduce emissions and adapt to a warming world.

IV. Macroeconomic Consequences:[9]

This section reviews the possible channels through which climate change and climate change policies may have an impact on the macro economy. The potentially wide-ranging economic impacts identified in this section are summarised in the figure below. Changing climate can have direct demand-side impacts (A). For instance, if businesses anticipate slower economic growth, they may scale back investment. Also, if households become more pessimistic about their future incomes, they may decide to save more and consume less. Trade may be affected as the warming planet has an impact on transport. While some transport links may improve in colder regions of the world, more violent storms, changes in precipitation patterns and extremely high temperatures may have adverse effects elsewhere.

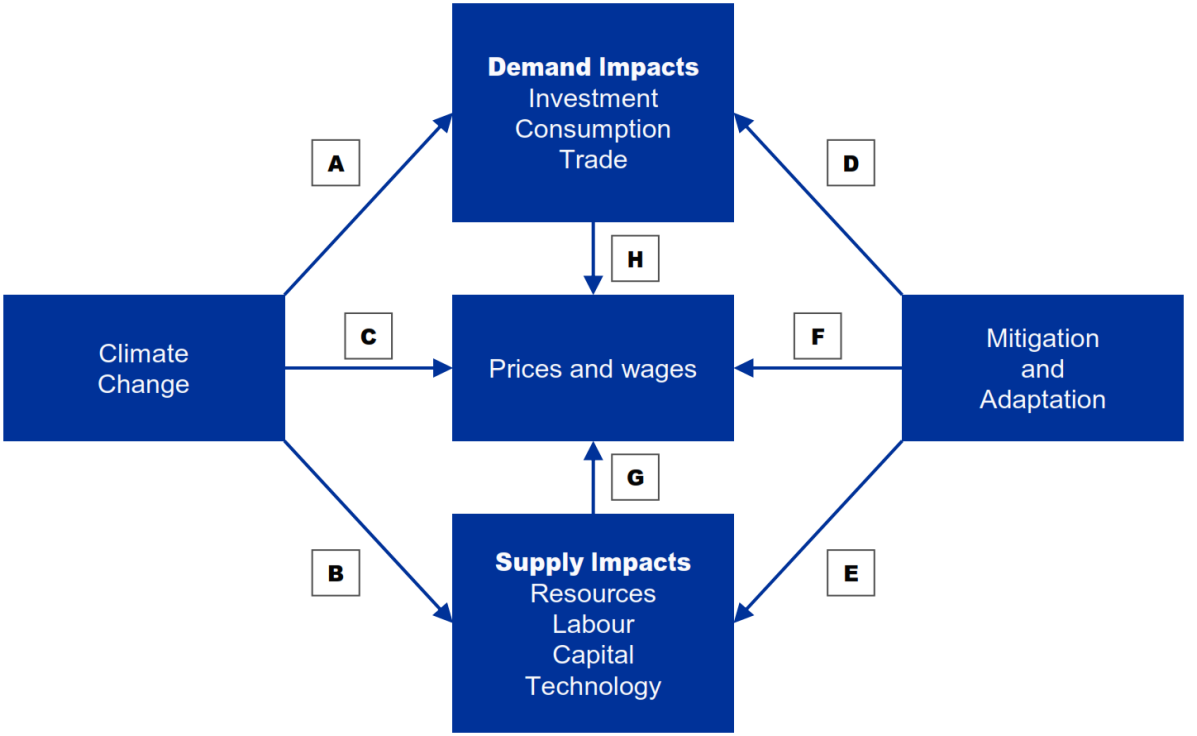
Potential effects can be expected on the supply-side of the economy (B). In particular, there may be significant impacts on the availability of some natural resources (agriculture, fisheries and forestry), and the capital stock may be adversely affected by climate-related damage and reduced investment. Rising temperatures may also have an impact on health and the ability of people to work at higher temperatures, leading to lower labour input.

At the same time, climate change policies may also have a potential impact on the wider economy. Mitigation and adaptation policies will require substantial amounts of investment, which can be expected to have an impact on the demand side of the economy (D). Paying for this type of investment may imply a rise in the costs of energy (e.g. through taxation, levies or carbon pricing), which may lead to lower real incomes and thereby adversely affect consumption. Mitigation policies may in particular have an impact on the supply side of the economy (E). As already discussed, mitigation essentially involves the replacement of an old fossil fuel-based technology with a new technology based on renewable forms of energy. This transition will likely have

9 Malin Anderson, Clauio Baccianti, Julian Morgan, " Climate Change and the Macro-economy" European Central Bank Occasional Paper No.243/June 2020, https://www.ecb.europa.eu/pub/pdf/scpops/ecb.op243_2ce3c7c4e1.en.pdf

Figure 3

Broad linkages between the climate, policies and the economy



major implications for the capital stock and the nature of innovation. Changes in the structure of the economy are also likely to imply a reallocation of employment from declining high-carbon industries to expanding low-carbon sectors.

From a central bank perspective, both climate change and climate change policies are likely to have direct and indirect impacts on inflation, also increasing its volatility. If climate change affects agricultural yields and more volatile weather patterns affect harvests, then there may be significant impacts on prices and inflation (C). Climate policies that involve raising the price of carbon through taxation or market-based mechanisms are also likely to have a direct impact on inflation and its volatility (F). Finally, there are likely to be indirect impacts via both demand (H) and supply (G) impacts from climate change and policies.

V. Key Results of Climate Change Impacts on Africa's Economic Growth

The following are key results of the a study conducted by AfDB, UN and UNECA, on the impacts of Climate Change on African Economies:[10]

(i) Without action, there will be a significant adaptation deficit with the poorest countries in Africa displaying the highest adaptation deficit.

(ii) Climate change will exacerbate the high vulnerability, and limited adaptive capacity, of the majority of African countries, particularly the poorest potentially rolling back development efforts in the most-affected countries.

(iii) Climate change and climate variability could lead to severe macroeconomic consequences as early as 2030. In all African regions, negative climate change impacts would progressively compound and lead to decreasing GDP per capita. The warming scenarios entail losses by 2030 (as compared to a baseline GDP per capita scenario) that range from -0.6 per cent in Northern Africa in the low warming scenario, to -3.6 per cent in Eastern African in the high-warming scenario.

(iv) After the 2030s, the loss gap between the low and high-warming scenarios widens substantially. By 2050, losses in the high-warming scenarios range from 50 per cent higher for Central Africa, to around 85 per cent higher for Western African regions.

(v) The occurrence of climate extremes would lead to increased government expenditure and a reduction in the volume of collected taxes, ultimately resulting in a possible increase in government debt.

(vi) The increasing negative impacts of climate change on both the GDP per capita and the development capacity of African countries could reduce Africa's ability to cope with and adapt to the current and future impacts of climate change. Countries could be increasingly drawn into a downward spiral of risks and vulnerabilities.

(vii) While adapting to and coping with climate change will cost less under lower levels of warming, African Governments will still face residual damages with considerably higher costs, and those costs will rise substantially with more warming.

(viii) Adapting to climate change will necessitate closing African countries' existing adaptation deficit, including improved territorial and city planning, better agricultural practices or updated building codes, etc.

(ix) Leaving the current adaptation deficit unchecked will lead to significantly higher losses and vulnerabilities, given the limits to adaptation.

(x) For all African regions, the costs of residual damages are projected to be around five times higher than adaptation investments and costs combined. This reinforces the need for robust and binding global mitigation

10 AfDB,UN, UNECA "Climate Change Impacts on Africa's Economic Growth" https://www.afdb.org/sites/default/files/documents/publications/afdb-economics_of_climate_change_in_africa.pdf African Development Bank 2019

efforts, and an adequate provision for a loss and damage mechanism to deal with residual damages.

(xi) Adaptation protects communities and creates jobs. Adapting to climate change, even if warming is kept within the limits indicated in the Paris Agreement, will still require high costs, although they would be largely outweighed by the benefits. For example, in the high-warming scenario, by 2050, adaptation benefits are about five times greater than the costs in the health sector.

(xii) The implementation of adaptation measures would also lead to skilled and unskilled job-creation in a wide range of economic sectors, including construction, health and services.

(xiii) Mitigation limits climate change impacts and damages. By 2030, the low-warming pathway would cost sub-Saharan African countries between a tenth (in Northern Africa) and a third (in Central Africa) less than macroeconomic losses projected to be incurred in the high-warming scenario. This difference almost doubles by 2050, from being a third higher in Northern African (compared a tenth in 2030) to almost 85 per cent higher in Western Africa.

(xiv) Mitigation actions are also associated with at least three direct co-benefits: increased energy security, employment generation, and reduction in health risks related to direct exposure to pollution from fossil-fuel combustion.

VI. Linkages between Climate Action and Inclusive Growth[11]

The transition to a low-carbon economy is our only alternative and a major undertaking. It involves the rise of new sectors and industries and the retirement of older ones. It creates new jobs and offers new opportunities but requires altering our consumption habits and learning new skills. If the transition is inequitable or socially unjust, it will ultimately fail. But if implemented properly, it could unlock new sources of development – a growth story for the 21st century, which would not only be sustainable, but also inclusive. In this section we review the linkages between climate action and inclusive growth. Many climate policies bring about the following among others important inclusion co-benefits.

a) **Sustainable use of natural resources**. Poor subsistence farmers are often owners and primary users of natural resources that are key to the mitigation and adaptation, namely, forests, wetlands, agricultural land, coastal waters. Sustainable use of these assets, investing in land restoration and sustainable agriculture, creating financial instruments to reflect the true social value of these assets, and paying for the provided ecosystem services helps our planet and provides sustainable livelihood for the owners. These policies also help empower women as they comprise more than 40 percent of agriculture labor force around the world and are often responsible for the food production and collection of fuel and water in the poorest households.

b) **Investment in sustainable urban infrastructure**, such as water and sanitation, slum upgrading and housing

11 IMF Online training on Inclusive Growth, Module 6. https://learning.edx.org/course/course-v1:IMFx+IGx+1T2021/home

retrofits, green areas, pedestrian and public transport are examples of policies with widely shared benefits.

c) **Job and training opportunities due to mitigation and adaptation policies**, including for youth, low-skilled, and long-term unemployed. Ethiopia's National Forest Sector Development Program for example, aims to reforest 15 percent of the country, contribute 50 percent to the national emission reduction target by 2030, and create over six hundred thousand jobs employing about 0.5% of the country's population. A carbon tax may reduce economic activity in the short run, but its effect on net creation of jobs is less clear, as the renewable energy industry is more labor-intensive than coal. In the U.S., solar and wind employ almost three times as many workers as coal despite a smaller share in total energy production.

d) **The potential for solar and wind energy production** is widely distributed across the globe and within countries. This creates opportunities to reduce disparities by investing and creating jobs in laggard regions, provide electricity supply where the grids are down or non-existent, together with the co-benefit of energy self-sufficiency and security for more countries.

The following are some climate policies, for which inclusion must be deliberate:

i) Social Transfer and Spending Programme: Carbon tax effects on the poor's purchasing power should be alleviated by well-targeted social transfers or other pro-poor public spending programs.

ii) The need to helping stranded workers and regions via job training, reallocation, and regional investment programs.

iii) Designing natural disaster evacuation plans, so that the most vulnerable have information and the means to escape and weather the disaster.

iv) Accompanying natural habitat and wildlife conservation by mitigating measures for the poor.

v) Providing financial incentives to the poor to enable compliance to regulations to promote energy efficiency or build up resilience should come with financial incentives for the poor to enable compliance.

VII. Structural Transformations Needed to make Climate Change Inclusive and Sustainable

Climate change is a major threat to the sustainability and inclusiveness of our societies, and to the planet's habitability. According to the Global Commission on Economy and climate change Report which was published in 2018, a sustainable , more inclusive and more resilient growth model involves accelerating transformation in the following key five Economic System.[12]

12 Amer Bhattacharya, Maksym Ivanyna, William Oman, and Nicholas Stern, "Climate Action to Unlock the Inclusive Growth Story of the 21st Century"IMF Working Paper WP/21/147, May 2021, pp16-18

(i) **Clean energy systems**: The decarbonisation of power systems combined with decentralised and digitally-enabled electrification technologies can provide access to modern energy services for the billion people who currently lack it; strengthen energy security and reduce exposure to energy price volatility globally; build overall system resilience to increasing natural hazards (especially in vulnerable, small island states); and cut the costs of outdoor air pollution worldwide. The clean energy transition is well underway, driven by market forces and plummeting costs of renewable and storage technologies. The world now adds more renewable power capacity annually than from all fossil fuels combined.

(ii) **Smarter urban development**: Better urban planning and strategic infrastructure investment, particularly the expansion of public and non-motorised transport networks, can overcome bottlenecks to economic growth, such as congestion and air pollution for more livable cities. More compact, connected, and coordinated cities are worth up to US$17 trillion in economic savings by 2050 and will stimulate economic growth by improving access to jobs and housing. They can strengthen resilience to physical climate risks and could deliver up to 3.7 gigatons per year of CO2 savings over the next 15 years, just shy of the total emissions of the European Union (EU) today. Integrated national urban policy frameworks can guide sustainable and inclusive urban development.

(iii) **Sustainable land use**: The shift to more sustainable forms of agriculture combined with strong forest protection could deliver over US$ 2 trillion per year of economic benefits; generate millions of jobs, mainly in the developing world; improve food security including reduction in food loss and waste (a third of all food produced is lost or wasted along the food chain); and deliver over a third of the climate change solution. At the same time, restoration of natural capital, especially our forests, degraded lands, and coastal zones, will strengthen our defenses and boost adaptation to climate impacts, from more extreme weather patterns to sea-level rise.

(iv) **Wise water management**: Today, 2.1 billion live without readily available, safe water supplies at home, and 4.5 billion live without safely managed sanitation. Water scarce regions, notably the Middle East, the Sahel, Central Africa, and East Asia could see gross domestic product (GDP) declines of as much as 6 per cent by 2050 as a result of climate change, spurring migration and sparking conflict. There are enormous opportunities to curb these impacts by using water better, whether through deployment of improved technology (from drip irrigation

to remote sensors to water-efficient crops), planning and governance, use of water prices with targeted support to the poor, or by investing in public infrastructure. Today, poorly managed and often underpriced water results in the over-use and misallocation of resources across the economy. Addressing the water-energy-food nexus will be critical, particularly in increasingly water-stressed regions

(v) **A circular industrial economy**: From 1970 to 2010, annual global extraction of materials grew from almost 22 to 70 billion tons. Each year, at least eight million tons of plastics leak into the ocean, contributing to a major new challenge for the 21st Century. Micro-plastics have been discovered in 114 aquatic species, many of which end up in our dinners. This challenge, however, is not just a social or environmental issue; it is also economic. Today, 95 percent of plastic packaging material value as much as US$120 billion annually is lost after first use. Policies which encourage more circular, efficient use of materials (especially metals, petrochemicals and construction materials) could enhance global economic activity, as well as reduce waste and pollution. Shifting to a circular industrial economy, combined with increasing efficiency and electrification, including for hard-to-abate sectors and heavy transport, could decouple economic growth from material use and drive decarbonisation of industrial activities.

VIII. Climate Change Mitigation Policy Packages

The following are some of Climate Change policy packages, which enable the transition to sustainable and inclusive growth:[13]

(a) Put a Price on Carbon

The two key instruments to put a price on carbon are a **carbon tax** and an **Emission Trading Scheme (ETS).** Pricing carbon is essential for mitigation. If GHG emissions are free then there is no incentive to reduce them. The benefit accrues to the emitters, namely, coal power plants, cement factories, drivers of gasoline cars, and many others, while the cost is borne by everyone. By contrast, if GHG emissions are costly, they will lead to the following outcomes:

i) Carbon intensive goods become more expensive. This is an incentive to consume less of them, for example by saving energy, and to rebalance consumption patterns toward low-carbon goods and services.

ii) Carbon-intensive inputs also become more expensive for businesses. This incentivizes them to innovate and make their production processes more climate-friendly. Moreover, demand for low-carbon goods and services increases, and so does investment to expand their production.

iii) As a result of the direct influence of the above two outcomes, climate friendly investments and innovations become more attractive. This increases the demand for low carbon goods and services and so does the need to invest to expand their production and innovate to make these goods more affordable.

13 Ibid pp19-34

In the end, the price of carbon is a gauge that drives millions of decisions by multiple economic actors towards cutting GHG emissions and reaching mitigation goals in the most cost-effective way, given individual and local circumstances. Likely the most efficient instrument to put price on carbon is a carbon tax. A carbon tax is relatively simple to administer, as most governments can rely on the existing machinery of excise taxes.

(b) Emission Trading Scheme (ETS), also known as cap-and-trade scheme, which can work in a world with perfect information would be equivalent to carbon tax, with the tax rate being equal to the permit's market price,

In practice, there are differences:

- First, an ETS fixes the resulting amount of emissions but leaves the carbon price uncertain and volatile, which is bad for business planning. A carbon tax fixes the carbon price, but leaves the resulting emissions uncertain, so there is a risk that the mitigation target is not achieved.
- Second, an ETS is generally harder to administer than a carbon tax. The allocation of emission permits is less transparent than taxation. For example, general feature of most ETSs is that some businesses get permits for free due to lobbying or competitiveness concerns. Besides, there are fixed costs to trading the permits and verifying the emissions, so ETSs usually cover only the largest emitters.

In many countries carbon pricing and energy subsidy reforms were met with broad public opposition and eventually went off track. Households are worried about losing jobs and spending too much of their income on energy, which is especially important for the poor. Businesses are worried about competitiveness. Both are worried about inflation. All these concerns are valid and need to be addressed to make the reform socially just, politically acceptable, and inclusive. And success is not impossible: many countries and jurisdictions, starting with Finland in 1990, have been able to introduce and maintain a carbon tax, and many others were able to implement a sustainable and effective energy subsidy reform (for example, Brazil, Turkey, Namibia).

(c) Regulate and Set Standards

An important complement to carbon taxation is the direct regulation of GHG emissions or energy efficiency. For example, building energy codes, energy efficiency standards for appliances, and emission standards for cars are a commonplace in many countries. Similar to carbon pricing, regulations and standards should come with financial incentives or government programs for the poor to enable them to comply. At the same time, it is important to

remove regulations that create barriers to investment in low carbon technologies, such as regulations that require the use of specific fuels for electric buses used in public transportation systems. International coordination can play an important role in setting expectations, for example by setting proximate dates for the phase-out of coal or internal combustion engines for road transport.

c) Price Other Environmental "Goods" and "Bads"

Pricing and regulations are also the primary policy responses to other environmental issues. Some of them require corrective taxation (increasing price) of "bads", like in case with GHG emissions and climate change. Some could be better resolved by corrective subsidizing (decreasing price) of environmental "goods". Forests, wetlands, and other ecosystems need to be protected and restored. Not only are they carbon sinks helping us with climate change, but they also shelter biodiversity, protect local climate, air, water, and soil, serve as a buffer against natural disasters, and provide recreational services. One way to protect them is to pay farmers and other landowners for their sustainable management and conservation. So-called payments for ecosystem services is an increasingly common practice in many countries at a national and local level

d) Other Measures

The following are some of the additional reform measures which need to be taken to mitigate climate change:

i) Agricultural subsidies must be reformed to fully reflect the social cost of food production, and to promote climate-smart agricultural practices, such as agroforestry, crop diversification, conservation of soil and water, local animal feed, and a sustainable way to increase agricultural yields and support subsistence farmers.

ii) Sustainable and equitable allocation of water permits is especially important as over four billion people around the world are currently living in areas where demand of water outstrips supply, thus depleting reservoirs and aquifers.

iii) Governments should also price chemical pollution and incentivize "circular economy", an economic system aimed at eliminating waste and pollution, and keeping products and materials in use. Limiting air and water pollution can be done through corrective taxes, regulations, outright bans, or issuing emissions quotas, which can then be traded. Use of single-use plastic can be reduced if governments ban it or charge a disposal fee. Many countries in the world currently have outright ban of plastic bags.

iv) Accelerate Public Investment in Sustainable Infrastructure: Public investment speeds up the transition and enables investment in projects with low private returns but large environmental co-benefits, as is the case with many nature-based climate solutions. Public investment is also needed to coordinate and scale up private investment, even in the presence of a high carbon price.

v) A successful climate-friendly public investment strategy requires effective public finance management (PFM). Besides following the best general practices, governments should incorporate climate change considerations focusing on the entire PFM cycle, from macroeconomic analysis and planning to revenue, investment and spending management and policy, i.e., climate-responsive PFM (PEFA 2020). PFM practices should be aligned with climate objectives, as advocated in "Helsinki Principles" (The Coalition of Ministers for Climate Action 2019), for example by introducing climate-related procedures to evaluate performance of expenditure and taxes, and climate-related provisions in regulatory framework for public investment or procurement (Schwartz, et al. 2020). Fiscal rules may have to be aligned with climate objectives.

vi) Reforming finance and ensuring that it enables, rather than hinders deep decarbonization is critical for the transition to inclusive, resilient and sustainable growth. Aligning financial system with climate objectives is the primary goal of The Network of Central Banks and Supervisors for Greening the Financial System (NGFS), the Coalition of Finance Ministers on Climate Action, and COP26 Private Finance Agenda.

vii) The role of financial and monetary policies in the fight against climate change are among others the following: First, managing the financial stability risks posed by climate change; second, mobilizing resources for investment to address climate change, issues; third, making supervisory and monetary policies consistent with net-zero emission objectives.

viii) Address the lack of transparency around climate risks. This is the key intermediary step needed to enable other policies in the financial sector. It involves gathering high-quality climate-related financial data; introducing mandatory climate-related financial risk disclosures (regarding both physical and transition risks) by firms and financial institutions; conducting climate-related stress tests of financial institutions and financial systems. Financial Stability Board's Task-Force on Climate-related Financial Disclosures is an important step in this direction.

ix) Manage financial stability risks posed by climate change. This means reflecting climate risks in micro-prudential and macro-prudential policies (policies aimed at safeguarding the financial system), such as liquidity and capital requirements and sectoral capital buffers targeting credit to climate-exposed sectors. Central banks must ensure that their collateral frameworks fully reflect climate risks. Additionally, governments should reduce the short-term bias in the financial sector. This involves prudential and corporate governance reforms to reduce the role of short-term shareholder value maximization in firms' behavior and strategies.

x) Mobilize resources for investment. It is key to channel capital flows to the geographies with climate-friendly investment opportunities, including those in developing countries. The low-carbon infrastructure investment gap in developing countries could reach USD$15 - 30 trillion by 2040. A pillar of the Paris Agreement is the pledge by developed countries to jointly mobilize US$100 billion per year to address the needs of developing countries. Yet, this pledge is unlikely to be met in 2020. Policy instruments to close the financing gap include concessional and non-concessional loans, bilateral and multilateral grants, guarantees provided by governments and multilateral development banks, and debt-for-nature swaps.

xi) Close the gap between social and private return to green investment. This again includes proper regulation of climate risks using micro-prudential and macro-prudential policies. This also includes de-risking and incentives for green private investment; loan guarantees and subsidies, feed-in tariffs[14] with transparent phase-out horizon, risk guarantees (e.g., first-loss capital)[15]. While de-risking measures can increase green private investment, frameworks must be developed to assess and monitor related fiscal risks and costs, notably ensuring the transparency of direct and contingent long-term public liabilities. Central bank purchases of low carbon bonds would also lower upfront capital cost of green investment. Finally, governments should create new low-carbon financial assets, the value of which would depend on the amount of GHG emissions they help avoid at a predetermined notional/shadow carbon price.

xii) Innovation is key to sustainable growth and to address climate related challenges: There is need to subsidize innovation, and many governments are doing so for basic research. With climate change mitigation, the role of government is even more important, as the private return to innovation in this area can be low. Policy instruments to support innovation include:

- Incentives for Private Climate Friendly Innovation. This includes de-risking (loan guarantees, feed in tariffs, with transparent phase-out horizon; public procurement to guarantee initial demand for new products and services); inward investment promotion; and Research and Development tax deductions and credits;

- Public-Funding of Climate friendly innovation: this includes among others strategic investment funds, funding centers of expertise, funding of universities and research institutes, grants for basic research, including sustainable innovations contests, spending on education, and job training in climate friendly industries.

14 **Definition:** A **feed-in tariff** is a price for generated electricity that is fixed for producers at a lower than market price level, whereas the difference between the market price and the tariff is paid by government.

15 **Definition: First-loss capital** refers to arrangement by which an investor or grant-maker agrees to bear first losses in an investment in order to crowd-in co-investors.

IX. Conclusions

The following are the major conclusions:

(i) The success of reforms depends on general policies and factors. It is key to maintain an inclusive decision-making process: communication about the reform's risks and benefits and consultations with stakeholders.

(ii) Macroeconomic stability and secure property rights are necessary conditions for investment to take place. Effective decentralization frameworks are needed to spur investment by local governments.

(iii) Structural reform and social safety nets are key to smooth structural transformation. The backbone of all policies are effective governance and anti-corruption frameworks.

(iv) Applying all the above policy instruments must be accompanied by frameworks to monitor and assess fiscal risks. Policies like aligning finance with climate objectives and pricing carbon are essential too.

(v) The timing of the reform matters too. The pain from increased carbon taxation would be felt less in times of low commodity prices when electricity and gasoline are cheap. Increases in taxation and structural reform are better implemented during economic booms, when the cost of adjustment to the new rules is attenuated by faster economic growth. Recessions on the contrary provide the most appropriate time to expand financial incentives and boost investment in sustainable infrastructure – helping to tackle climate change and expand the economy when most needed, while contributing little to inflation.

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