Reduction of Green House Gases Emission: Towards a Sustainable Future

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Abstract. In the current time the climate change risk has continued to intensify such that sustainability of the world is difficult, hence urgent emission mitigation actions. An in-depth analysis of GHG emission reduction policies is provided in this paper, with a focus on strategies involving technology, policy, society, and the economy. Regulations play a significant role in reducing the amount of carbon in the atmosphere, which gives a framework for the development of incentives for all sectors. The social cost of carbon is internalized by carbon pricing strategies like carbon taxes and cap-and-trade programs, which promote businesses to invest in greener practices and technological advances. Based on market structures, standards for energy efficiency and mandates for emissions targets may act as catalysts for changes in the market that push towards such low-carbon options. If a significant reduction in greenhouse gas emissions from major economic sectors like agriculture, industry, transportation, or energy is to be achieved, technological advancement will continue to be crucial. Consequently, renewables including solar power wind turbine systems and hydroelectricity plus others replaced fossil fuelled-based sources thereby reducing emission in generation of electrical power. Further, this is to be achieved through efforts in grid modernization, smart infrastructural development and energy storage facilitating the penultimate connection of vast amount of renewable power to electricity grids especially during peak times. Again, industrial sector seems promising as far as decarbonizing production processes and reducing emissions are concerned by adopting clean technologies such as carbon capture and storage (CCS), electrification and sustainable manufacturing processes. Additionally, changes that result into modification in the transport sector like electric vehicles expansion of public transportation systems, promotion of active transport modes amongst

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others also reduces emission levels whilst enhancing air quality. Transitioning to a low-carbon economy through financing will therefore require significant mobilization of investments towards clean energy infrastructure, sustainable land use practices and climate-resilient development. To direct capital towards low-carbon investment green bonds, carbon markets and public-private partnerships provide innovative financing mechanisms.

Keyword-: GHG emissions, Climate change, Carbon taxes, Renewable energy, Sustainable technology, Transport sector, Electrification and Manufacturing.

1 Introduction

Development of humankind is believed to be facing a big challenge because of climate change,
which indicates deteriorating environment for living, diseases etc. There is a general agreement
that climate change and global warming are because of excessive GHG emissions. Many countries have pledged to take significant measures to decrease GHG in the next few years [1]. Following growing concerns over climate change, reducing greenhouse gas (GHG) emissions has become an urgent priority in world discussions. Green-house gases such as carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) have been increasing due to anthropogenic activities which include burning fossil fuels, industrial processes, deforestation and agriculture among other actions. It has caused unprecedented environmental changes for instance increased temperatures, extreme weather conditions and disturbance on ecosystems [2]. The last ten years have seen numerous strategies and technologies being developed with an aim lowering GHG emissions; these range from adoption of renewable energy sources, energy efficiency measures as well as carbon capture storage technologies [3]. Due to the potential for cutting electricity generation emissions alone solar thermal power or concentrated solar thermal power plants have increasingly gained acceptance by people against other forms such as solar photovoltaic cells or wind turbines [4]. The guidelines, standards, and best practices for energy efficiency in business, residential, and industrial settings have shown a notable potential to reduce emissions while at the same time fostering and assisting in economic growth [5]. The cutting-edge techniques for sequestering carbon dioxide produced by burning fossil fuels or certain industrial processes represent a significant advancement toward lowering emissions. To prevent CO_2 from being released back into the atmosphere, carbon dioxide capture technologies may involve capturing CO_2 released from point sources such as factories and power plants and then moving it underground into geological structures formations [6]. In agriculture where most of the emissions come from livestock production and soil management strategies transforming farming models and adjusting dietary habits has been suggested as one way to lower methane and nitrous oxide discharge. GHG emissions can be significantly decreased by implementing strategies like precision agriculture, better manure management practices, and elevated feed efficiency.

2 Global and Regional GHG Emissions Trends

The issue of Climate change has critically analyzed and scrutinized the global greenhouse gas (GHG) emissions which are regional [8]. Such has been observed that across the globe, GHG emissions have been mounting although this is taking place at different paces in

different areas [8]. Global emissions increased between 2016 and 2021 due to fast economic growth in developing countries, as well as industrialization and energy use increase, according to Intergovernmental Panel on Climate Change (IPCC) [9]. The most significant sectors contributing to overall GHG emissions globally are energy, transportation, agriculture and industrial processes [10]. Moreover, various socio-economic and policy contexts create different patterns in GHG emissions across regions. Indeed some regions have reduced their emission levels significantly while others have shown an increase. For instance, China which is the largest emitter globally has pumped billions into renewable investment opportunities besides tightening its emission standards hence leading to sluggishness in its carbon pollution rate's growth [11]. It is important to note or mention, however, that the favourable trend is reversing in some areas of South-East Asia as a result of increased industrialization, rapid urbanization, and an excessive reliance on coal for electricity production [12]. Clearly in sight that the deliberate efforts have been made throughout Europe to transition to low-carbon economies through initiatives like the European Green Deal and infrastructure investments for renewable energy sources. As a consequence or result, emissions in the area have gradually decreased and declined, particularly in the power industry [13]. Conversely, global initiatives like Paris Agreement have catalysed collective efforts towards addressing climate change with numerous countries pledging to ambitious emission reduction targets. On the other hand, these undertakings stand or fall on strong enforcement mechanisms and international cooperation [14]. Meanwhile, United States' emissions have seen fluctuations over time because of changes in patterns of energy consumption; regulatory frameworks; and economic dynamics. While this country has reduced its emissions from power sector because it has been increasingly using natural gas and renewable energy sources for electricity production (US EPA 2018), transportation-related and industrial CO2 emissions remained relatively constant [15]. Despite having the least number of emissions among continents, Africa still has special challenges regarding sustainability and mitigation of emissions. For policy makers, there's a problem of reconciling rapid population increases and increasing energy requirements with economic growth on one hand and environmental sustainability on the other [16]. In general, while there are significant developments that have been made in addressing GHG emissions at global and regional levels, much needs to be done to reach targets set in such international agreements as the Paris Agreement. It requires collaborative efforts involving governments, businesses as well as civil society to hasten transition into a low carbon future and also mitigate negative impacts resulting from climate change. Fig 1 describes the cycle of Global GHG Emissions Management

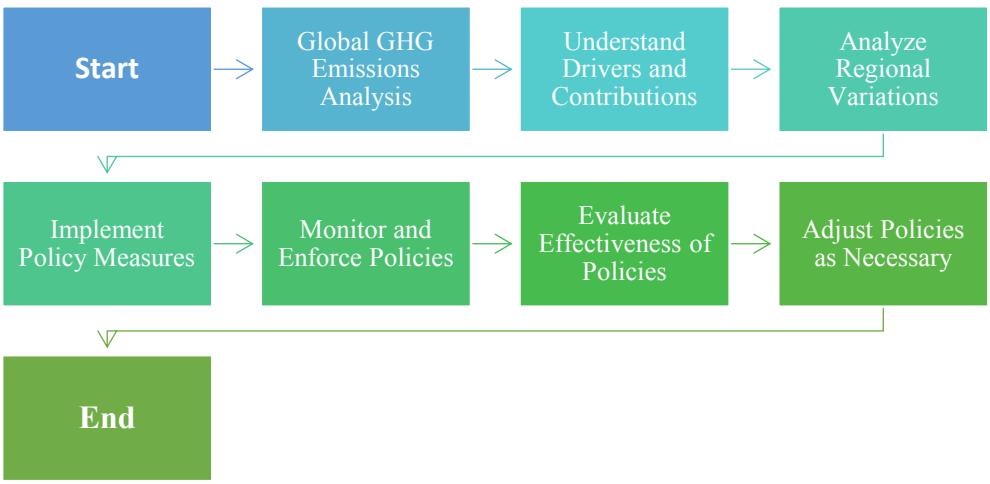

Fig. 1: Cycle of Global GHG Emissions Management

3 Effects of Green House Gases Emissions

The Earth's climate system is influenced heavily by Greenhouse gases (GHGs), leading to various environmental, social, and economic effects. These gases include carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) which trap heat in the atmosphere thereby causing global warming and climate change [17]. One important result of increased GHG emissions is the increase in global temperatures that lead to melting ice caps and glaciers; this results into sea level rise and poses a threat to coastal communities [18]. Furthermore, changes in precipitation patterns contribute to more frequent and severe weather events such as hurricanes, droughts, floods affecting ecosystems, agriculture, and human settlements [19]. Acidification of oceans occurs as they absorb a significant amount of atmospheric CO_2 thereby posing a threat to marine life together with coral reefs. Fisheries and biodiversity can be influenced by alterations in temperature along with acidity impacting on marine ecosystems [20]. Urban areas are particularly affected by the rise in greenhouse gas emissions and air pollution that causes diseases like respiratory ailments and cardiovascular diseases [21]. What's more, there have been changes in climatic patterns which have reduced the transmission of malaria and dengue fever among others that affects human health [22]. Greenhouse gases emissions also impact socio-economic systems. This is due to climate change factors which can lead to low agricultural productivity thus impacting food security as well as people's livelihoods in vulnerable regions [23]. Additionally, extreme weather conditions destroy infrastructure, disrupt supply chains and cause economic losses [24]. Addressing GHG therefore requires a holistic approach. The need for renewable energy sources presents a way of reducing emission. To do this, there is need to transition from fossil fuel based energy production systems to renewable energy alternatives, which will require improved forests' absorption capacity for CO_2 through reforestation programs [25]. Further investment should focus on climate-resilient infrastructures while adaptive capacity of the communities vulnerable to these impacts is reinforced [26]. The all and all effects of greenhouse gas emissions are extensive and affect human health, ecosystems, biodiversity and socioeconomic assistance or welfare. To promote or ensure a sustainable future for future generations, and immediate action must be taken to reduce emissions while adapting to a new climate conditions [27-31]. Fig 2 demonstrates the impacts of GFG emissions.

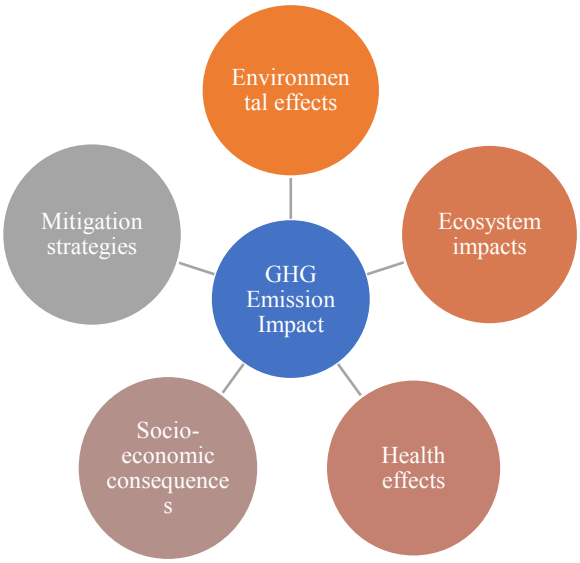

Fig. 2: GHG Emission Impact

4 Potential Reduction of Green House Gases Emissions

It has already been determined that reducing greenhouse gas (GHG) emissions is essential across many sectors in order to slow down climate change [32]. One of the main areas of concern is the energy sector, which has a significant impact on global GHG emissions. There seems to be a lot of potential for lowering emissions from sources like wind, solar, and hydroelectric electricity [33-36]. For an instance, switching to renewable energy sources instead of fossil fuels for the production of electricity can significantly reduce carbon dioxide (CO_2) emissions or gases [29]. By enhancing and improving energy efficiency is another practical strategy for lowering GHG emissions in a variety of industries and sectors, including transportation, housing developments, establishments, and industry [37]. Technologies and practices that increase energy efficiency can result in significant decreases in both energy consumption and related emissions [38-42].

Table 1: Mitigation Strategies

Sector	Mitigation Strategies	Study
Energy	Transition to renewable sources like wind, solar, and hydroelectric power. Improving energy efficiency in electricity generation to reduce carbon dioxide emissions.	[28,29]
Transport	Advancements in vehicle electrification and implementation of fuel efficiency standards.	[31]
Industry	Adoption of cleaner production technologies, enhancing energy efficiencies, and exploring alternative materials. Utilizing carbon capture and storage (CCS) technology to capture and store CO2 emissions underground.	[29] [30]
Land Use and Agriculture	Implementing sustainable land management practices such as afforestation, reforestation, and improved agricultural techniques. Reducing deforestation and curbing emissions from livestock and fertilizer use.	[32]
Policy	Interventions Implementation of carbon pricing, renewable energy subsidies, regulatory standards, and emissions trading systems. International agreements like the Paris Agreement to facilitate collaboration and set emission reduction targets.	[33-36]

Furthermore, advancements in vehicle electrification and fuel efficiency standards have potential to substantially reduce transportation sector's emissions [43]. Changes in land use and agricultural practices also present opportunities for GHG reduction. Sustainable land management techniques such as afforestation, reforestation, or improved agricultural practices may increase carbon sequestration into soils/vegetation hence mitigating those gasses [32]. Furthermore, reducing deforestation and curbing emissions from livestock and fertilizer use are essential for achieving emission reduction targets [44]. Through cement production and chemical manufacturing, the industrial sector contributes significantly to GHG emissions; cleaner production technologies, enhanced energy efficiencies and alternative materials are some of the ways that can be used to address these issues [45-48]. Apart from this, carbon capture and storage (CCS) technology is considered as a viable option

in reducing the release of CO_2 in the atmosphere by capturing them and storing them underground [49]. At the same time, policy interventions will be required for unlocking emission reduction potential in all sectors [50]. For instance, carbon pricing, renewable energy subsidies, regulatory standards and emissions trading systems may help to put incentives for emission cuts and facilitate adoption of clean technologies [50-54]. Paris agreement is also among other international agreements that enable countries to work together on their respective targets on greenhouse gases' reduction [55]. There are several areas such as agriculture, transportation, industry or even energy where greenhouse gas emissions can be cut down drastically [56]. This could however happen if there was a combination of technological changes and supportive policies as well as practices. Table No. 1 shows the mitigation strategies.

5 Conclusion

This paper emphasizes the need to have a multi-faceted approach in order to mitigate greenhouse gas emissions. The paper has made four major points:

- Renewable Energy Adoption: Towards this end, shifting to wind, solar and hydroelectric power can significantly cut down the energy sector's emissions. These technologies substitute carbon intensive fuels for cleaner, more sustainable energy sources. In addition, directing funds towards renewable-energy installations increases employment opportunities while securing energy and boosting economic development hence addressing both environmental and economic problems.
- Energy Efficiency Improvements: Therefore, improving energy efficiency across different sectors is crucial toward reduction of energy use and related carbon emissions. In fact technological advancements have resulted in high efficient appliances, industrial processes as well as building materials that consume less electricity thus reducing demand for it by a substantial percentage through behaviour change urging people to save electricity besides reducing emission oils at an affordable cost within time taken directly by consumers also using less amount of power meaning it will enable them to be competitive in terms of economy which is growing fast and resilient too.
- Sustainable Land Management: Opportunities for carbon sequestration and emission reduction are presented by implementing sustainable land management practices. By improving soil carbon storage through afforestation, reforestation, and sustainable agricultural techniques, greenhouse gas emissions from land use and agriculture can be addressed. Moreover, the adoption of sustainable land management practices also supports biodiversity conservation, soil health improvement and resilience to climate change impacts thereby reinforcing the need for holistic ecosystem management as a basis for sustainable development.
- Policy Interventions: Policy mechanisms have been found to be crucial in promoting low-carbon growth and adoption of cleaner technologies.

In conclusion there is a need for coordinated action at all levels including among other things promotion of renewable energies use in addressing GHG emission, including renewable energy adoption, energy efficiency improvements, sustainable land management, and supportive policy frameworks. By embracing these strategies and working collaboratively at the international, national, and local levels, societies can advance towards a low-carbon, resilient future and mitigate the impacts of climate change on a global scale which prevents newer generations from harmful effects.

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