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Mitigation of Environmental Crisis through Renewable Energy

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ABSTRACT: Energy is at the heart of the climate challenge – and key to the solution.A large chunk of the greenhouse gases that blanket the Earth and trap the sun's heat are generated through energy production, by burning fossil fuels to generate electricity and heat.Fossil fuels, such as coal, oil and gas, are by far the largest contributor to global climate change, accounting for over 75 percent of global greenhouse gas emissions and nearly 90 percent of all carbon dioxide emissions.The science is clear: to avoid the worst impacts of climate change, emissions need to be reduced by almost half and reach net-zero in future. To achieve this, we need to end our reliance on fossil fuels and invest in alternative sources of energy that are clean, accessible, affordable, sustainable, and reliable.Renewable energy sources – which are available in abundance all around us, provided by the sun, wind, water, waste, and heat from the Earth – are replenished by nature and emit little to no greenhouse gases or pollutants into the air.Fossil fuels still account for more than 80 percent of global energy production, but cleaner sources of energy are gaining ground. About 29 percent of electricity currently comes from renewable sources.

KEYWORDS: renewable energy, mitigation, environmental crisis, climate change, greenhouse gases, earth

I. INTRODUCTION

About 80 percent of the global population lives in countries that are net-importers of fossil fuels -- that's about 6 billion people who are dependent on fossil fuels from other countries, which makes them vulnerable to geopolitical shocks and crises.In contrast, renewable energy sources are available in all countries, and their potential is yet to be fully harnessed.[1,2,3]

The 150 MW Andasol solar power station is a commercial parabolic trough solar thermal power plant, located in Spain. The Andasol plant uses tanks of molten salt to store solar energy so that it can continue generating electricity for 7.5 hours after the sun has stopped shining

The International Renewable Energy Agency (IRENA) estimates that 90 percent of the world's electricity can and should come from renewable energy by future.Renewables offer a way out of import dependency, allowing countries to diversify their economies and protect them from the unpredictable price swings of fossil fuels, while driving inclusive economic growth, new jobs, and poverty alleviation. [4,5,6]Renewable energy actually is the cheapest power option in most parts of the world today. Prices for renewable energy technologies are dropping rapidly. The cost of electricity from solar power fell by 85 percent between 2010 and 2015. Costs of onshore and offshore wind energy fell by 56 percent and 48 percent respectively.Falling prices make renewable energy more attractive all around – including to low- and middle-income countries, where most of the additional demand for new electricity will come from. With falling costs, there is a real opportunity for much of the new power supply over the coming years to be provided by low-carbon sources.Cheap electricity from renewable sources could provide 65

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percent of the world's total electricity supply by future. It could decarbonize 90 percent of the power sector by the future, massively cutting carbon emissions and helping to mitigate climate change.Although solar and wind power costs are expected to remain higher in 2016 and 2017 then pre-pandemic levels due to general elevated commodity and freight prices, their competitiveness actually improves due to much sharper increases in gas and coal prices, says the International Energy Agency (IEA).[7,8,9]

The Shepherds Flat Wind Farm is an 845 megawatt (MW) nameplate capacity, wind farm in the US state of Oregon, each turbine is a nameplate 2 or 2.5 MW electricity generator.

According to the World Health Organization (WHO), about 99 percent of people in the world breathe air that exceeds air quality limits and threatens their health, and more than 13 million deaths around the world each year are due to avoidable environmental causes, including air pollution.The unhealthy levels of fine particulate matter and nitrogen dioxide originate mainly from the burning of fossil fuels. In 2016, air pollution from fossil fuels caused $2.9 trillion in health and economic costs, about $8 billion a day.Switching to clean sources of energy, such as wind and solar, thus helps address not only climate change but also air pollution and health. Every dollar of investment in renewables creates three times more jobs than in the fossil fuel industry. The IEA estimates that the transition towards net-zero emissions will lead to an overall increase in energy sector jobs: while about 5 million jobs in fossil fuel production could be lost by the future, an estimated 14 million new jobs would be created in clean energy, resulting in a net gain of 9 million jobs.In addition, energy-related industries would require a further 16 million workers, for instance to take on new roles in manufacturing of electric vehicles and hyper-efficient appliances or in innovative technologies such as hydrogen. This means that a total of more than 30 million jobs could be created in clean energy, efficiency, and low-emissions technologies by the future.Ensuring a just transition, placing the needs and rights of people at the heart of the energy transition, will be paramount to make sure no one is left behind.[10,11,12]

About $5.9 trillion was spent on subsidizing the fossil fuel industry, including through explicit subsidies, tax breaks, and health and environmental damages that were not priced into the cost of fossil fuels.In comparison, about $4 trillion a year needs to be invested in renewable energy until the future, including investments in technology and infrastructure – to allow us to reach net-zero emissions .The upfront cost can be daunting for many countries with limited resources, and many will need financial and technical support to make the transition. But investments in renewable energy will pay off. The reduction of pollution and climate impacts alone could save the world up to $4.2 trillion per year .Moreover, efficient, reliable renewable technologies can create a system less prone to market shocks and improve resilience and energy security by diversifying power supply options.Learn more about how many communities and countries are realizing the economic, societal, and environmental benefits of renewable energy.[13,14,15]

Solar energy and wind power have the highest climate change mitigation potential at lowest cost compared to a range of other options.[4] Variable availability of sunshine and wind is addressed by energy storage and improved electrical grids, including long-distance electricity transmission, demand management and diversification of renewables. As low-carbon power is more widely available, transportation and heating can increasingly rely on these sources. Energy efficiency is improved using heat pumps and electric vehicles. If industrial processes must create carbon dioxide, carbon capture and storage can reduce net emissions.[6]Greenhouse gas emissions from agriculture include methane as well as nitrous oxide. Emissions from agriculture can be mitigated by reducing food waste, switching to a more plant-based diet, by protecting ecosystems and by improving farming processes. Climate change mitigation policies include: carbon pricing by carbon taxes and carbon emission trading,

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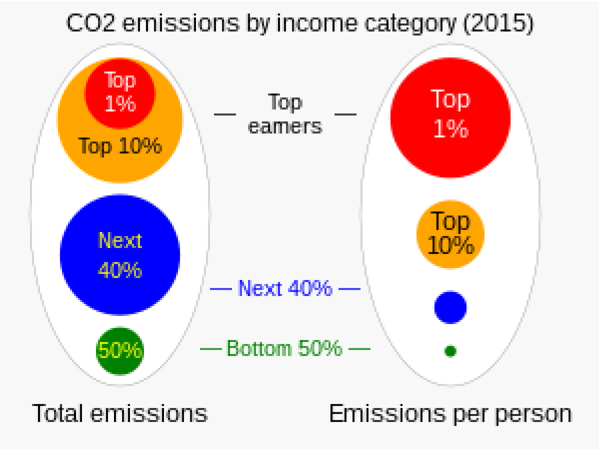
easing regulations for renewable energy deployment, reductions of fossil fuel subsidies, and divestment from fossil fuels, and subsidies for clean energy.[8] Current policies are estimated to produce global warming of about 2.7 °C by future.[9] This warming is significantly above the 2015 Paris Agreement's goal of limiting global warming to well below 2 °C and preferably to 1.5 °C.[10][11] Globally, limiting warming to 2 °C may result in higher economic benefits than economic costs.[12][16,17,18]

II. DISCUSSION

Climate change is bringing about rising temperatures, which have significant negative impacts on humans and the environment, and transitioning to renewable energy sources, such as biofuels, can help meet this challenge. One consequence of higher global temperatures is the increasing frequency of extreme weather events that cause massive amounts of harm and damage. Moreover, the World Health Organization estimates that, globally, climate change is responsible for over 150,000 deaths per year. This is because in addition to extreme weather events, climate change contributes to the spread of diseases, reduced food production, and many other problems.Transitioning to renewable energy, and reducing reliance on fossil fuels, is one way to help slow down the effects of climate change. While renewables used to be a more expensive option, new clean energy technologies are lowering costs and helping to move economies away from fossil fuels.[19,20,21] For example, solar panel prices decreased 75 to 80 percent between 2009 and 2015. Due to similar trends in other renewables like wind and hydropower, renewable energy generation technology accounts for over half of all new power generation capacity brought online worldwide every year since 2011. More must be done to ensure that renewable energy technologies are key contributors to the mitigation of climate change. As of 2017, solar and wind accounted for less than 4% of all the energy used in the U.S. [22,23,24]

The amount of energy generated by solar panels has increased almost 46-fold since 2008, but still only amounts to about 1% of the total energy generated in the country. Unfortunately, renewables currently provide only a small fraction of the total energy produced, and to counter climate change, this contribution must drastically increase.Nonrenewable sources are still frequently used because they are very dense in energy. In the transportation sector, for example, gas or diesel fuels have about 40 times more energy, pound for pound, than the leading electric battery technologies. In order for an electric car to travel 360 miles, which is the average distance traveled on a full 12.4 gallon tank of gas, the car would need a battery weighing over 1,300 pounds.[25,26,27]



The emissions of the richest 1% of the global population account for more than twice the combined share of the poorest 50%

To reduce reliance on petroleum-based fuels, particularly for heavy-duty vehicles and airplanes, one potential solution is biofuels. Biofuels are produced by breaking down plant material and converting it into usable fuels, such as ethanol or biodiesel. Corn ethanol is already added to gas to cut down on greenhouse gas emissions. However, creating ethanol is not a zero-carbon process, and supplementing with corn ethanol averages just under 40 percent lower carbon emissions than using only gasoline. Corn ethanol also relies on land which could be used for growing other food crops. Researchers are currently studying how to use invasive plants, as well as plants that require little water, fertilizer, or land to grow, to create the next generation of biofuels. Some promising plant feedstock options include hemp, switchgrass, carrizo cane, jatropha shrubs, and algae. New biotechnologies are also being studied to develop more efficient ways to break down biomass into sugars, which microbes then convert into biofuels. There is also ongoing research to create microbes that can directly convert plants to biofuels, and to enable microbes to produce long-chain, energy-dense hydrocarbons that could be used to fuel heavy-duty vehicles and airplanes.[28,29,30]

The Information Technology and Innovation Foundation developed several recommendations which could bolster the implementation of biofuels. These recommendations include:

- Increasing investments in bioenergy and biomanufacturing research and development by 150 percent by the next five years;
- Engaging the Department of Energy and the Department of Agriculture to support the development of biofuels for aviation, shipping, and "other hard-to-electrify transportation sectors;" and
- Expanding research into gene-editing tools that can be used to improve biomass processing, increasing the diversity of plant feedstocks that could be leveraged for lower-cost biofuel production.

By improving the efficiency of renewable energy technologies like biofuels, wind, and solar, and further innovating in the renewables space, the U.S. science and technology community can help ensure that renewables are leveraged in the effort to counter the climate crisis. Mitigation measures can be approached in parallel, as there is no single pathway to limit global warming to 1.5 or 2°C. Such measures can be categorized as follows:

- Sustainable energy and sustainable transport
- Energy conservation (this includes efficient energy use)
- For agricultural production and industrial processes: sustainable agriculture and green industrial policy
- Enhancing carbon sinks: Carbon dioxide removal (this includes carbon sequestration)

Carbon dioxide removal (CDR) is defined as "Anthropogenic activities removing carbon dioxide (CO2) from the atmosphere and durably storing it in geological, terrestrial, or ocean reservoirs, or in products. It includes existing and potential anthropogenic enhancement of biological or geochemical CO2 sinks and direct air carbon dioxide capture and storage (DACCS), but excludes natural CO2 uptake not directly caused by human activities."[1] Greenhouse gas emissions from human activities strengthen the greenhouse effect, contributing to climate change. Most is carbon dioxide from burning fossil fuels: coal, oil, and natural gas. Human-caused emissions have increased atmospheric carbon dioxide by about 50% over pre-industrial levels. Emissions in the 2010s averaged 56 billion tons (Gt) a year, higher than ever before.[20]

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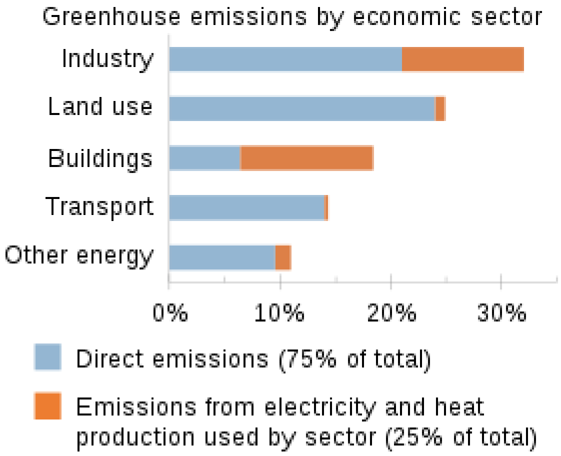

Taking into account direct and indirect emissions, industry is the sector with the highest share of global emissions.

In 2016, energy (electricity, heat and transport) was responsible for 73.2% of GHG emissions, direct industrial processes for 5.2%, waste for 3.2% and agriculture, forestry and land use for 18.4%.[3]Electricity generation and transport are major emitters: the largest single source is coal-fired power stations with 20% of greenhouse gas emissions.[21] Deforestation and other changes in land use also emit carbon dioxide and methane. The largest sources of anthropogenic methane emissions are agriculture, and gas venting and fugitive emissions from the fossil-fuel industry. The largest agricultural methane source is livestock. Agricultural soils emit nitrous oxide, partly due to fertilizers.[22] The problem of fluorinated gases from refrigerants has been politically solved now so many countries have ratified the Kigali Amendment.[23]Carbon dioxide (CO_2) is the dominant emitted greenhouse gas, while methane (CH_4) emissions almost have the same short-term impact.[24] Nitrous oxide (N_2O) and fluorinated gases (F-Gases) play a minor role. Livestock and manure produce 5.8% of all greenhouse gas emissions,[3] although this depends on the time frame used for calculating the global warming potential of the respective gas.[25][26]Greenhouse gas (GHG) emissions are measured in CO_2 equivalents determined by their global warming potential (GWP), which depends on their lifetime in the atmosphere. There are widely-used greenhouse gas accounting methods that convert volumes of methane, nitrous oxide and other greenhouse gases to carbon dioxide equivalents. Estimations largely depend on the ability of oceans and land sinks to absorb these gases. Short-lived climate pollutants (SLCPs) including methane, hydrofluorocarbons (HFCs), tropospheric ozone and black carbon persist in the atmosphere for a period ranging from days to 15 years, whereas carbon dioxide can remain in the atmosphere for millennia.[27]Satellites are increasingly being used for locating and measuring greenhouse gas emissions and deforestation. Earlier, scientists largely relied on or calculated estimates of greenhouse gas emissions and governments' self-reported data.[28][29]

III. RESULTS

Mitigating climate change is about reducing the release of greenhouse gas emissions that are warming our planet. Mitigation strategies include retrofitting buildings to make them more energy efficient; adopting renewable energy sources like solar, wind, and small hydro; helping cities develop more sustainable transport such as bus rapid transit, electric vehicles, and biofuels; and promoting more sustainable uses of land and forests.

About 1.4 billion people around the world rely on traditional fuels like coal and wood to meet their basic energy needs. This is not only harmful to the environment; it can also lead to premature deaths for millions of people, especially women and children. By the future, global energy demand is projected to grow by more than 50 percent, and even faster in developing countries. All these new consumers need clean energy that will not hurt them or the environment. The 2017 Intergovernmental Panel on Climate Change (IPCC) special report Global Warming of 1.5°C highlights the urgency of needed climate actions: global emissions will need to peak by the future and rapidly decrease to net-zero if we are to be able to stay within the safety limits established by the Paris Agreement. Mitigating climate change

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means reducing the flow of heat-trapping greenhouse gases into the atmosphere. This involves cutting greenhouse gases from main sources such as power plants, factories, cars, and farms. Forests, oceans, and soil also absorb and store these gases, and are an important part of the solution. Reducing and avoiding our emissions requires us to reshape everything we do — from how we power our economy and grow our food, to how we travel and live, and the products we consume. It is a problem felt locally and globally. [31]

Reducing emissions requires rethinking society, economics, science and politics. The faster we act to reduce these emissions, the better off we will be in the future. In the past decades, the EU took firm action against climate change, resulting in a more than 30% drop in EU emissions at present compared with 1990 levels — well beyond the target to reduce emissions by 20%. This is mainly a result of a growing use of renewable energy and decreased use of carbon-intensive fossil fuels. Improvements in energy efficiency and structural changes in the economy also contributed to meeting these goals.Now, more ambitious goals are set that include a net 55% or greater reduction below 1990 levels by future and a climate-neutrality objective. Reaching these goals will require even higher emission cuts through transitioning from fossil fuels to clean, renewable energy. It also means halting deforestation, using land sustainably and restoring nature until we reach the point where the release of greenhouse gases into the atmosphere is balanced with the capture and storage of these gases in our forests, oceans and soil.The EU emits 6% of global emissions and cannot act alone. Global cooperation is essential for all climate change mitigation. The United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement ensure cooperation across borders to tackle climate change and ensure a sustainable future.

While emissions of methane across the European Union have decreased over past years, the overall reduction in emissions needs to accelerate to EU climate objectives. Increased global efforts to reduce methane emissions would also be needed to mitigate global warming in the short term.According to the latest available official data, emissions of methane were down by 36% in the EU compared with 1990 levels. The largest reductions in emissions occurred in energy supply, which includes energy industries and fugitive (leaked or uncaptured) emissions (-65%), waste (-37%) and agriculture (-21%). Switching from coal to natural gas has advantages in terms of sustainability. For a given unit of energy produced, the life-cycle greenhouse-gas emissions of natural gas are around 40 times the emissions of wind or nuclear energy but are much less than coal. Natural gas produces around half the emissions of coal when used to generate electricity and around two-thirds the emissions of coal when used to produce heat. Reducing methane leaks in the process of extracting and transporting natural gas could further decrease its climate impact.[32] Natural gas produces less air pollution than coal.

Energy conservation is the effort made to reduce the consumption of energy by using less of an energy service. This can be achieved either by using energy more efficiently (using less energy for a constant service) or by reducing the amount of service used (for example, by driving less). Energy conservation is at the top of the sustainable energy hierarchy. Energy can be conserved by reducing wastage and losses, improving efficiency through technological upgrades, and improved operations and maintenance.Efficient energy use, sometimes simply called energy efficiency, is the process of reducing the amount of energy required to provide products and services. Improved energy efficiency in buildings ("green buildings"), industrial processes and transportation could reduce the world's energy needs in future by one third, and thus help reduce global emissions of greenhouse gases. For example, insulating a building allows it to use less heating and cooling energy to achieve and maintain thermal comfort. Improvements in energy efficiency are generally achieved by adopting a more efficient technology or production process or by application of commonly accepted methods to reduce energy losses. Afforestation is the establishment of trees where there was previously no tree cover. Scenarios for new plantations covering up to 4000 Mha (6300 x 6300 km) calculate with a cumulative carbon storage of more than 900 GtC (2300 $GtCO_2$). Helping native species sprout naturally is cheaper and they are more likely to survive, with even long deforested areas still containing an "underground forest" of living roots and tree stumps. This could include pruning and coppicing to accelerate growth and this also provides woodfuel, which is otherwise a major source of deforestation. Such practices, called farmer-managed natural regeneration, are centuries old but the biggest obstacle towards implementation is the ownership of the trees by the state, who often sell timber rights to businesses. This leads to seedlings being uprooted by locals who saw them as a liability. Another mitigation option is the production of biochar, the solid remaining after the pyrolysis of biomass, and its storage in soils. Biochar production releases half of the carbon from the biomass—either released into the atmosphere or captured with CCS—and retains most the other half in the stable biochar. It can endure in soil for thousands of years. Biochar may increase the soil fertility of acidic soils and increase agricultural productivity. During production of biochar, heat is released which may be used as bioenergy.[25,28,30]

IV. CONCLUSIONS

Environmental mitigation is typically a part of an environmental crediting system established by governing bodies which involves allocating debits and credits. Debits occur in situations where a natural resource has been destroyed or severely impaired and credits are given in situations where a natural resource has been deemed to be improved or preserved. Therefore, when an entity such as a business or individual has a "debit" they are required to purchase a "credit". In some cases credits are bought from "mitigation banks" which are large mitigation projects established to provide credit to multiple parties in advance of development when such compensation cannot be achieved at the development site or is not seen as beneficial to the environment. Crediting systems can allow credit to be generated in different ways. For example, in the United States, projects are valued based on what the intentions of the project are which may be to preserve, enhance, restore or create (PERC) a natural resource. Mitigation could be seen as contributing to the increasing cost of land because some mitigation work requires that large amounts of land be purchased or put into conservation easements. Mitigation can therefore compete with other rural land uses such as agriculture and residential development. This suggests that land owners must be alert to find the highest and best use for their properties given the potential market value that mitigation credits represent.[30,31,32]

Wetland restoration is an important mitigation measure which has moderate to big mitigation potential on a limited land area with low trade-offs and costs. Wetlands perform two important functions in relation to climate change. They can sequester carbon, converting carbon dioxide to solid plant material through photosynthesis, but they also store and regulate water. Wetlands store approximately 44.6 million tonnes of carbon per year globally. Bioenergy with carbon capture and storage (BECCS) expands on the potential of CCS and is intended to lower atmospheric CO_2 levels. In this process biomass grown for bioenergy is used. The biomass energy is extracted in useful forms (electricity, heat, biofuels, etc.) as the biomass is consumed via combustion, fermentation, or pyrolysis. The CO_2 that was extracted from the atmosphere by the biomass when it grew is captured and stored underground, or via land application as biochar . This effectively removes it from the atmosphere. Aviation's environmental footprint can be reduced by better fuel economy in aircraft, and by optimising flight routes to lower non-CO_2 effects on climate from NO_x, particulates or contrails. Aviation biofuel, emissions trading and carbon offsetting, part of the 191 nation ICAO's Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), can lower CO_2 emissions. Aviation usage can be lowered by short-haul flight bans, train connections, personal choices and taxation on flights. Fuel-powered aircraft may be replaced by hybrid electric aircraft and electric aircraft or by hydrogen-powered aircraft.[32]

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