Solving problems of climate change through energy conservation

**ABSTRACT**

Climate change is a global problem and it also acts as a hurdle to sustainable development. Energy and climate change are often linked together as their effects on each other are prominent .The energy generation capacity and the demand for energy both are equally affected by change in climate . In turn, changes in climate can disrupt energy networks, stress in infrastructure can occur and it can also develop safety risks for people. All countries are equally responsible in causing the factors. Thus, they'll have to bear the brunt of consequences of climate change. Greenhouse gas emission is one of the most prominent factor leading to climate change. Conservation of energy along with its proper utilisation is important for reducing greenhouse gas emissions and also leads to sustainable development. For attaining sustainable agriculture great efforts have to be taken such as, how to use renewables efficiently. The rising daily demand for energy by all living things on the planet is causing the globe to quickly transform into a global community. Energy and related services are becoming more and more necessary to meet the needs of the people worldwide .Thus, employing renewable energy sources is a unique strategy that must be sustainable in order to meet the energy needs of our future generation. It will also aid in the solution of climate change issues. Among the global energy usage today, fossil fuels dominates the spot, thus there is an urgency to reduce their usage in order to minimize serious climate change issues. Reducing energy usage plays a prominent part in prevent the climate change and also in avoiding the diminution of high energy return recoverable fossil fuels.

***Keywords***

*Climate change, Energy, Sustainable, Greenhouse gas emissions*

**INTRODUCTION**

Life on planet earth is going through a threat of mass extinction, mainly caused by human activities. Since the middle of the 18th century, despite the vast abundance of non-exhaustible resources like wind, solar, water, etc., human misuse of these resources has led to never before witnessed global changes in biodiversity, ecosystems, the earth's climate, etc. (Eisen MB and Brown PO, 2022, Wiebers DO et al, 2022). Although there are various environmental menaces but climate change among them is the greatest threat that is been faced by the humanity. Due to human induced release of greenhouse gases more than 1°C rise in the global average temperature has been recorded(Scholes Robert J et al, 2021). The side effects of this temperature rise can be seen as severe climatic events.. It is stated that a 45% reduction in greenhouse gas emissions by 2030 is necessary to mitigate global warming. (IPCC, 2021). Warming beyond 1.5%C, will be harmful and would get us into Un-rectifiable damages and climatic crisis (IPCC, 2021). Diminuition of climate change along with adaptation are among the biggest hurdles in ongoing environmental policy development. Given with the diverse nature of climate change mitigation, transformation should be taken at society levels, including small sectors like households as well. Energy and climate change are linked together commonly also use of fossil fuels have led to atmospheric alteration as they likely cause climate change. Energy is and will always continue as the basic engine for economic development. As a component it helps in fulfilling goals towards sustainable development. Socially economic development needs energy for improved lifestyle, increased productivity, better goods transportation and also acts as an input in a variety of other economic activities. Utilizing renewable energy sources is a smart way to lessen the effects of climate change on the environment and on people. It also helps to preserve carbon neutrality. However, the availability of renewable resources—such as wind, water, and the like—depends on both the current and upcoming fluctuations in the environment. While assessing the functionality of low-carbon and sustainable energy systems, it can be less doubtful to be able to predict future climate conditions and accurately estimate changes in renewable energy sources. This is worsened by the strong likelihood that current tactics won't be sufficient to meet energy targets in the future, particularly when taking forecasts of rising temperatures, rising sea levels and winds, and decreasing precipitation into account. Also decarbonization will become one of the significant societal challenges of the generation. Climate change nowadays is a common term used to address as a challenge which is alarming, due to its speed of causing damage in recent years. For the preceding 36 years, the rate of rise in carbon dioxide has been considerably greater, averaging 1.4 ppm per year prior to 1995 and 2.0 ppm per year following that year (Earth system research laboratory, 2015).According to the United Nations framework, climate change is defined as being attributed, either directly or indirectly, to human activities that alter the composition of the Earth's atmosphere. This, in turn, causes changes in the natural climate, which are then observed over various time periods and compared to one another. Global usage of fossil fuels have increased, leading to a significant rise in carbon dioxide emissions.

An information collected in 2010 concluded that use of fossil fuels have led to greenhouse gas emissions worldwide, where the concentrations have surpassed over 390ppm. It is widely accepted that renewable technologies are clean energy sources, and when used properly, they reduce waste production, protect the environment, and have a long lifespan. These energy sources show to be an excellent means of lowering greenhouse gas emissions, mitigating climate change, and reducing global warming by replacing traditional energy sources. As noted above, employment of renewable energy sources for energy generation helps to limit greenhouse emissions which in turn mitigates climate catastrophe, minimizes health and environmental degradation which are produced due to the pollutants from fossil fuel sources of energy.In low carbon energy economies, renewable energy sources have the potential to emerge as a major energy supply choice. Management of an energy transition from non- sustainable to sustainable (renewable energy) is sometimes described to be as a problem. All of this subsequently indicates that a positive strategy for renewable energy should address a range of issues that impact the sustainability of renewable energy supply.

**Fig 1. RELATIONSHIP BETWEEN CLIMATE CHANGE AND SUSTAINABLE ENERGY**

***Adapted from Dr.Elizabeth Green ,Dec-2023 (sustainable energy and climate change)***[***https://sigmaearth.com/sustainable-energy-and-climate-change/***](https://sigmaearth.com/sustainable-energy-and-climate-change/)

**EFFECT OF CLIMATE CHANGE ON RENEWABLE ENERGY SOURCES**

***Wind***

Since the production of wind power is directly correlated with the cube of wind speed, climate change has the potential to drastically alter wind speed and its pattern (Martinez A and Iglesis G, 2021). The escalation of extreme weather events and significant variations in wind speed pose a significant risk to wind power generation. Numerous hypotheses indicate that wind power still has a vast untapped potential in many different places, and the findings often show an increase in the amount of electricity that will be available in the future. The successful implementation of renewable energy sources has been made possible by technology advancements in offshore floating rigs, particularly in coastal locations where the depth of the ocean bottom acts as a barrier to offshore execution.

***Solar***

Among the three renewable power sources, solar power is the most prevalent and is also the one that is given the least thought when discussing its impact on climate change. this may be due to the fact that, in contrast to other sources, small-scale solar technologies are widely available and have cheap investment costs. (Zhao x et al, 2020). Solar energy has long been a clear choice for renewable applications at the urban scale since it can produce large amounts of electricity virtually anywhere in the world.Overall, there has been little documented impact of climate change on the production of solar electricity, with variances of up to 10% for regional study and 20% for worldwide assessment. For urban scale, solar power is the most basic option when considering the renewable execution, due to both ease in implementing and scaling of technology, making it suitable for developing areas (Pietzcker RC et al, 2014). Spatial restrictions may eventually provide a barrier to the installation of large-scale plants since solar farms need enough surface space, for example, to put up enormous plants. Its technological limits are comparable to those of wind power, and existing methods continue to create uncertainty in the fluctuation of power output (Oka K et al, 2020).

***HYDRO***

It is the highest contributor towards, worldwide power supply, including a 16% share (IEA, 2021). Apart from electricity generation it also helps in supplying water. Impacts of climate change on it is mainly due to the variation in precipitation amount, high temperature (Mello CR et al, 2021) . Frequent variations in rainfall, runoff, extreme weather conditions all plays important roles in contributing towards disruptions of hydro availability for power production (Madani K et al, 2014). Numerous studies have indicated that future hydro availability will generally decline, but some regions show increased water flow and access for the production of hydroelectricity, indicating that certain regions would undoubtedly benefit from climate change and also present investment opportunities (Turner SWD et al, 2017). Uncertain water flows may also have an impact on future projections due to outside influences such upstream modifications, which can have a substantial impact on a site's production capacity (Michels-Brito A etal, 2021).

**RENEWABLE ENERGY SOUCES AND IMPACT ON SUSTAINABILITY**

Examples of naturally replenishing energy sources that never run out on our globe are hydropower, geothermal energy, solar energy, wind energy, bioenergy, and ocean (tide and wave) energy. Due to the world's expanding energy needs and population growth, the continuous use of fossil fuel-based energy sources (coal, oil, and gas) became problematic because it led to a number of problems, such as the depletion of fossil fuel reserves, greenhouse gas emissions, and other environmental concerns, military and geopolitical crises, and the continuous fluctuations in gasoline prices. These challenges will lead to unsustainable scenarios that might ultimately pose an irreparable danger to human society (UNFCC, 2015). Still, renewable energy is the best option readily accessible and the only way to address the escalating problems. In all economies, a steady supply of energy is crucial for transportation, manufacturing machinery, lighting, heating, and other purposes (Tiwari GN and Mishra EK, 2012). Emissions of greenhouse gases are significantly lower when renewable energy sources replace fossil fuels. Because they derive from ongoing energy flows in the natural world, renewable energy sources must be sustainable. Renewable sources of energy must have boundless potential and supply ecological products and services in a non-harmful manner in order to be deemed sustainable. A sustainable biofuel, for example, shouldn't harm biodiversity, have a negative impact on food security, or raise net CO2 emissions (Twidell J and Weir T, 2015). The lack of consistency of generation due to seasonal variations is one of the numerous downsides of renewable energy sources, despite their many outstanding advantages. Since most renewable energy resources are dependent on the climate, their utilization necessitates the use of sophisticated design, planning, and control optimization techniques. Continued advancements in computer hardware and software technology allow scientists to address these optimization problems with computational resources applicable to the renewable and sustainable energy sector (Panwar N, Kaushik S and Kothari S, 2011).

**RENEWABLE ENERGY SOURCES AND CLIMATE CHANGE**

An effective measure that helps in solving of climate crisis is definitely through energy efficiency, it has undoubtedly become a cost effective way to challenge climate change along with reducing energy wastage ,money saving and has also helped in expanding the usage of renewable energy resources. Utilizing renewable resources to their fullest potential minimizes negative environmental consequences, produces the least amount of secondary waste, and is sustainable given current and future socioeconomic needs. Renewable energy technologies are acknowledged as clean energy sources. By supplementing traditional energy sources (those derived from fossil fuels), renewable energy technologies provide an unparalleled opportunity to mitigate greenhouse gas emissions as well as minimize globalwarming (Panwar N et al, 2011). The target of limiting global warming to less than 2°C has guided international climate discourse for more than ten years (Rogelj J et al, 2013). The world has relied significantly more on fossil fuels since 1850 to govern its energy supply, which has led to an alarming increase in carbon dioxide emissions.According to research, the usage of fossil fuels is mostly responsible for the world's greenhouse gas emissions; measurements before to industrialization increased to around 390 micro Pascals per million, or 39% of total emissions.

 **PROPOSED SOLUTIONS FOR CLIMATE CHANGE THROUGH ENERGY MANAGEMENT**

* ***CHANGING TO RENEWABLE ENERGY SOURCES***

Humans heavy dependence and consumption of fossil fuels has led to the increase in greenhouse gases ,particularly co2 (Adua l et al, 2021). Co2 is held responsible for 78% of total greenhouse gas emissions (IPPC, 2014). Whereas fossil fuels have estimated 68% of global greenhouse gases .examples of renewable energy sources such as fuelwood, biomass, solar drying etc. along with adoption of clean technology within the ,mineral sector such as cement, glass, etc.(Dincbas T et al, 2021). As long as the biomass used to produce energy is obtained responsibly, there is hope that burning biomass for energy production will help mitigate climate change. The process of switching to renewable energy sources include creating and broadly using reasonably priced renewable energy sources (such as solar and wind power) (Adua L et al, 2021). If nations are to become more dependent on renewable energy sources (such as solar, hydroelectric, wind, geothermal, and biomass), alternative energy-producing technologies will need to be developed in order to maintain the stability of the electrical grid during times when there is little to no production of renewable energy. Power-to-gas systems and batteries, which convert surplus renewable energy into hydrogen gas (Andrade C et al, 2022) are two strategies that researchers have suggested to deal with the frequent nature of renewable energy sources. The natural gas system may then be filled with hydrogen gas to lower greenhouse gas emissions and our dependency on high-carbon fuels. The need for energy is rising in LMICs (such as India) due to growing urbanization. It has been proposed that renewable energy sources might help LMICs eradicate energy poverty (Elizondo A et al, 2017). It has been suggested that LMICs and the international community use natural gas instead of coal and oil to cut down on black carbon emissions. Researchers have proposed integrating renewable energy into the grid using "smart" metering and grid-level storage in order to construct "smart" cities—environmentally sustainable communities in low- and middle-income nations. Rooftop solar farms and systems, "clean" coal, carbon capture and storage technology, and other renewable energy solutions such as cogeneration (i.e, the collection of waste heat), farm methane, landfill methane, and solar farm (Zhao Q et al, 2022).

* ***IMPROVING THE ENERGY EFFICIENCY***

There are several technologies that may be used to satisfy the energy demands of industrial, residential, and commercial settings while consuming less energy, such as low-water devices and fluorescent lights for refrigeration, heating, and lighting. Although increasing energy efficiency might have the unintended consequence of increasing consumption, this tactic has been challenged as the only way to address the CO2 problem (Adua L et al, 2021). The wealthy segments of society should bear the brunt of the reduction in consumption. For instance, adopting a vegan diet and lifestyle, moving to an electric car, cutting back on long-haul travel, and switching to renewable energy sources are some changes in consumption patterns in high-income contexts that have the greatest potential for mitigation (Ivanova D et al, 2020). This notion is supported by data demonstrating that the main predictor of energy usage and greenhouse gas emissions is income level. In particular, more energy is being used and greenhouse gas emissions rise with affluence. On the contrary, strategies for cutting consumption in low-income countries might focus on providing for basic needs while encouraging wise spending habits, such as using modern, "clean" fuels for cooking instead of solid fuel, like solar power plants, to reduce cooking-related emissions (Mazorra J et al, 2020).

* ***CHANGE IN TRANSPORTATION SECTOR***

Worldwide transportation accounts for 19–26% of greenhouse gas emissions due to energy use. Aircraft, automobile use, and road freight are some of the primary sources. 81% of the transportation sector's greenhouse gas emissions come from road transportation, with motor vehicles being the second-largest emitter at 27% and road freight at 43%. One of the prominent obstacles to mitigating climate change in emerging economies is decarbonizing land transportation, partially as a result of these economies' rising need for motorization and mobility (Arioli M et al, 2020). It has been proposed that increasing fuel efficiency (e.g. by using electric and hybrid vehicles) (Claude F et al, 2017), can reduce CO2 emissions in growing economies motors powered by hydrogen and natural gas and doing away with oil product subsidies to encourage the use of other fuels .For example biofuels. The aviation sector, which is responsible for 5% of total global warming and 2% of man-made CO2 emissions, stands to gain significantly from the development of biofuels (Abdullah MA et al, 2016). It has been suggested that using sustainable aviation fuels, such as biofuels, in place of fossil fuels might provide a temporary solution. In general, the global transportation industry has to be reviewed and restructured in order to lessen its influence on climate change. Major changes in public and private consumption patterns are needed, in addition to the decarbonization of land transportation and the switch to renewable energies. For Achieving climate change mitigation objectives within the global transportation industries, it demands considerable investment in alternative modes of transportation, regulatory changes and national collaboration, technical developments, and a generalization of sustainable transport habits.

* ***MANAGEMENT OF TREES***

Along with preventing CO2 from being sequestered from the atmosphere, deforestation is a major source of anthropogenic CO2 emissions, accounting for up to 18% of emissions worldwide (De Sy V et al, 2015). The greatest way to address climate change, biodiversity loss, and infectious illnesses is to prevent deforestation, reduce livestock, and expand agriculture (Morand S and Lajaunie C, 2021). Forests provide significant advantages for mitigating climate change through storage, sequestration, and replacement (Hisano M et al, 2018). Reforestation has been considered to have the largest maximum mitigation potential globally since it reforests grasslands and formerly forested areas, creating a significant sink for carbon. The second highest mitigation potential, according to some, is found in natural forest management of privately held forests, which includes prolonged harvest cycles, reduced impact logging, increased silvicultural approaches, and control of forest fires. Reducing additional land conversion for grazing, croplands, or urban growth is an additional potentially advantageous tactic. Additional tactics include enhancing farmland nutrient management, employing crops with higher capacity for storing carbon, and implementing carbon credits schemes to permit carbon exchange.

Countries may create specific strategies with the goal of reducing the effects of deforestation and carbon emissions by having a better understanding of the primary causes of deforestation (De Sy V et al, 2015)

* ***BIOTECHNOLOGY***

The idea of terraforming with artificial life has put into question the idea of just employing naturally occurring creatures and ecosystems for climate mitigation (Adams WM, 2020). This idea is about creating artificial microorganisms and releasing them into the environment to aid in enhancing carbon sequestration and lower greenhouse gas emissions. Biotechnology examples include genetically modified crops (GMCs) , soil carbon sequestration, decreased fertilizer usage, and the utilization of enzymes and microorganisms to produce bio-based products (e.g. in food, chemicals, and bioenergy). For instance, switching to biofertilizers and biopesticides instead of conventional pesticides and fertilizers is thought to reduce pollution and greenhouse gas emissions (Arora NK, 2019). It has been suggested by biotechnology businesses to bioengineer trees to become "super carbon absorbing trees". Supporters of super carbon-absorbing trees, on the other hand, argue that they are not very good at storing carbon and raise concerns about the biodiversity of large-scale monoculture plantations, which are particularly sensitive to climate change. Many biotechnology solutions to climate change are still in the experimental stage, much like super carbon trees. The current state of scientific understanding makes it impossible to evaluate if some biotechnology-based solutions genuinely assist reduce climate change or merely offer the "illusion" of doing so, which can boost the carbon cost of putting these solutions into practice ( Adams WM, 2020).

* ***IT SECTOR***

Nearly 2 percent of continuous anthropogenic environmental contamination is attributed to information and communication technology services (ICTs) (Andreopoulou Z, 2016). It is projected that ICTs would use more power overall, and recent evidence appears to support this expectation (Andreopoulou Z, 2016). There are many areas in which Green ICTs and Green ISs (Information Systems) are put forward. These include zero power ICT solutions, creative energy saver systems, renewable energy sources, recycling, reusing, cutting down on e-waste, and mobile/internet services to reduce energy consumption (e.g. teleconferencing, cloud computing, digital publication), as well as designing and implementing ISs that help achieve sustainability goal (Lange S et al, 2020). Utilizing green ICTs can help to secure and restore natural ecosystems by facilitating the creation and upkeep of resource and environmental monitoring systems (Andreopoulou Z, 2016). The analytics of big data also have the potential for more effective use of resources like water and precision agriculture. Annual breakthroughs in information technology (IT) also support a decrease in energy use (Dwivedi YK et al, 2022).Energy usage has grown due to technological advances, and this increase has outpaced ICTs' capacity to lower energy consumption(Lange S et al, 2020). Web-based social media and games have been suggested as a means of educating the public about climate change and inspiring them to become involved in sustainability and climate action. Massive Open Online Courses, for instance, offer a concentrated platform for analysis on climate change and possible remedies. Additionally, it has been suggested that artificial intelligence (AI) be used as a weapon to battle climate change. The possible benefits of AI for combating climate change include influencing policy-making, facilitating environmental governance, and comprehending and supporting efficient solutions, particularly for complex tasks (Nishant R et al, 2020).

* ***GEO-ENGINEERING***

Climate engineering, or geoengineering, is the term for several types of significant technical advancements intended to slow down global warming by reflecting more solar radiation or making the Earth's atmosphere more transparent (Manoussi V and Xepapadeas A, 2017). In an emergency, geoengineering is seen to be the most promising way to quickly cool the earth since it is low-cost and technically possible (Reynolds J 2019). Worries about acid deposition, ocean acidification, ozone depletion, detrimental impact on plants, and the sunlight availability for solar power systems are among the allegations levelled at the inability to modify the area climate to acceptable level ( Manoussi V and Xepapadeas A, 2017). Geoengineering strategies are post-emission remedies, similar to carbon capture and storage options, and may not significantly reduce greenhouse gas emissions or change policy and consumption patterns. In actuality, geoengineering may promote complacency and lessen the incentive for people to take individual actions such as employing "climate-friendly" forms of transportation, minimizing air travel, cutting back on meat intake, and using less energy (Murray E and DiGiorgio A, 2021).

* ***MANUFACTURING SECTOR***

Building-related activities, such as building construction and material manufacture, account for around 38% of worldwide greenhouse gas emissions (UNEP, 2020). Thus, waste management—which includes wastewater treatment—recycling, renewable goods, lower-carbon building, denser housing, a decrease in the amount of floor space per person, and building energy efficiency are crucial factors for combating climate change in the building industry. Ultra-high performance cement composites, nanofibers in place of steel, sustainable wood products, and geosynthetics (Dixon N et al, 2017) are a few examples of how to decarbonize and improve the energy effectiveness within the construction industry. However, a greater demand for forest products may be harmful to populations that live in forests, old growth forests, which trap more carbon than monoculture forests and ecological diversity in forests (Clay K and Cooper l, 2022). With better urban planning, architecture, and administration, increasing urbanization worldwide offers opportunities to mitigate climate change while maintaining high standards of living and reducing emissions (Tayarani M et al, 2018).Building heating and cooling systems, transportation networks, and energy generation account for the majority of urban greenhouse gas emissions (Heikkinen M et al, 2019). Urban GHG emissions may be addressed by developing urban solutions to climate change using current, future, and existing urban infrastructure*.*

**CONCLUSION**

In order to improve human development and promote prosperity and growth in the economy, energy is a necessity in our daily lives. Reverting to renewable energy is an excellent option to mitigate the effects of climate change, but in order to continue providing energy to future generation, this approach needs to be sustainable. There is still much to learn about the relationships in particular between renewable energy and sustainable development. The article sought to determine the Environmentally conscious renewable energy sources and the ways in which transitioning from fossil fuel-based to renewable energy sources might mitigate the effects of climate change. However, during the course of their usage, renewable energy sources produce no net emissions, which will help lower greenhouse gas emissions in the future. Nevertheless, industrialized, least developed, and rising countries are unable to reach their full potential due to issues with cost, pricing, changing climate , and market conditions. As a result, the price of renewable energy will decrease, obstacles to energy efficiency (such a high discount rate) will be lifted, and fresh approaches to reducing climate change will be promoted. This will be accomplished through international cooperation that aids developing and least developed countries in their attempts to get energy from renewable sources, enhance energy efficiency, develop clean energy technologies, and conduct energy infrastructure research. The study highlighted the advantages of utilizing renewable energy sources, such as access, social and economic progress, and electricity dependability. It also highlighted how using renewable energy sources may help mitigate the consequences of climate change and its detrimental effects on both the environment and human health. The long-term viability of eco-friendly sources and their capacity to slow down climate change are frequently impeded by particular challenges. These difficulties include: insufficient knowledge, market failures, obtaining raw materials for the commercialization of future renewable resources, and—above all—the inefficient use of energy by people.

**Disclaimer** (Artificial Intelligence)

We hereby declare that No generative AI technologies such as large language models (ChatGPT, COPILOT, etc,) and text-to-image generators have been used during the writing or editing of this manuscript.

**REFERENCES**

 Eisen, M.B & Brown, P.O. (2022). Rapid global phase out of animal agriculture has the potential to stabilize greenhouse gas levels for 30 years and offset 68 percent of CO2 emissions this century. PLoS Climate, 1(2) <https://doi.org/10.1371/journal.pclm.0000010>

Wiebers, D.O., Feigin, V.L & Winkler, A.S. (2022). All life protection and our collective future. Neuroepidemiology, 56(3), 147–150. <https://doi.org/10.1159/000525021>

Pörtner, H.O., Scholes Robert, J., Agard, J., Archer E., Arneth A., et al. (2021). Scientific Outcome of the IPBES-IPCC Co-sponsored Workshop on Biodiversity and Climate Change. Version 5, <https://boris.unibe.ch/id/eprint/185025>

IPCC . (2021). Climate Change: the Physical Science Basis. Intergovernmental panel on climate change. Summary for policymakers, <https://doi.org/10.1017/9781009157896>

Martinez, A., & Iglesias, G. (2021). Wind resource evolution in Europe under different scenarios of climate change characterised by the novel Shared Socioeconomic Pathways Energy Conversion Management. 234, 113961. <https://doi.org/10.1016/j.enconman.2021.113961>

Zhao, X., Huang, G., Lu, C., Zhou, X. (2020). Impacts of climate change on photovoltaic energy potential: a case study of China Apple Energy, 280, Article 115888. <https://doi.org/10.1016/j.apenergy.2020.115888>

Pietzcker, R.C., Stetter,D. et al. (2014). Using the sun to decarbonize the power sector: the economic potential of photovoltaics and concentrating solar power . Appl Energy, 135 , 704-720. <https://doi.org/10.1016/j.apenergy.2014.08.011>

Oka, K., Mizutani, W., Ashina, S. (2020). Climate change impacts on potential solar energy production: a study case in Fukushima. Japan Renewable Energy, 153, 249-260. <https://doi.org/10.1016/j.renene.2020.01.126>

International Energy Agency (IEA). (2021). Electricity Information: Overview. <https://www.iea.org/reports/electricity-information-overview>

 Mello, C.R., Vieira, N.P.A., Guzman, J.A. et al. (2021). Climate change impacts on water resources of the largest hydropower plant reservoir in Southeast Brazil Water (Switzerland), 13, 1-22. <https://doi.org/10.3390/w13111560>

 Madani, K., Guégan, M., Uvo, C.B.(2014). Climate change impacts on high-elevation hydroelectricity in California

 Turner, S.W.D., Hejazi, M., Kim, S.H., Clarke, L., Edmonds, J. (2017). Climate impacts on hydropower and consequences for global electricity supply investment needs Energy, 141, 2081-2090, <https://doi.org/10.1016/j.energy.2017.11.089>

Michels-Brito, A., Rodriguez, D.A., Cruz Junior, W.L., de Souza, N., Vianna, J. (2021). The climate change potential effects on the run-of-river plant and the environmental and economic dimensions of sustainability. Renew Sustain Energy Rev, 147 , <https://doi.org/10.1016/j.rser.2021.111238>

Adua, L., Zhang, K.X., Clark, B. (2014). Seeking a handle on climate change: examining the comparative effectiveness of energy efficiency improvement and renewable energy J Hydrol, 510,153-163, <https://doi.org/10.1016/j.jhydrol.2013.12.001>

IPCC , Climate Change. (2014). Synthesis Report Szwitzerland, Geneva, <https://hdl.handle.net/10013/epic.45156>

Dincbas, T., Ergeneli, A., & Yigitbasioglu, H. (2021). Clean technology adoption in the context of climate change; Application in the mineral products industry. Technology in Society, 64, 101478. <https://doi.org/10.1016/j.techsoc.2020.101478>

Adua, L., Zhang, K. X., & Clark, B. (2021). Seeking a handle on climate change: Examining the comparative effectiveness of energy efficiency improvement and renewable energy production in the United States. Global Environmental Change, 70, 102351. <https://doi.org/10.1016/j.gloenvcha.2021.102351>

Andrade, C., Selosse, S., & Maïzi, N. (2022). The role of power-to-gas in the integration of variable renewables. Applied Energy, 313, 118730. <https://doi.org/10.1016/j.apenergy.2022.118730>

Elizondo, A., Pérez-Cirera, V., Strapasson, A., Fernández, J. C., & Cruz-Cano, D. (2017). Mexico’s low carbon futures: An integrated assessment for energy planning and climate change mitigation by 2050. Futures, 93, 14-26. <https://doi.org/10.1016/j.futures.2017.08.003>

Zhao, Q., Yu, P., Mahendran, R., Huang, W., Gao, Y., Yang, Z., ... & Guo, Y. (2022). Global climate change and human health: Pathways and possible solutions. Eco-Environment & Health, 1(2), 53-62. <https://doi.org/10.1016/j.eehl.2022.04.004>

Ivanova, D., Barrett, J., Wiedenhofer, D., Macura, B., Callaghan, M., & Creutzig, F. (2020). Quantifying the potential for climate change mitigation of consumption options. Environmental Research Letters, 15(9), 093001. <https://iopscience.iop.org/article/10.1088/1748-9326/ab8589?&utm_medium=email&utm_source=52784&utm_campaign=Courrier+de+la+plan%C3%A8te+28+f%C3%A9vrier+2023#:~:text=10.1088/1748%2D9326/ab8589>

Mazorra, J., Sánchez-Jacob, E., de la Sota, C., Fernández, L., & Lumbreras, J. (2020). A comprehensive analysis of cooking solutions co-benefits at household level: Healthy lives and well-being, gender and climate change. Science of The Total Environment, 707, 135968. <https://www.sciencedirect.com/science/article/abs/pii/S0048969719359637#:~:text=https%3A//doi.org/10.1016/j.scitotenv.2019.135968>

Arioli, M., Fulton, L., & Lah, O. (2020). Transportation strategies for a 1.5° C world: a comparison of four countries. Transportation Research Part D: Transport and Environment, 87, 102526. <https://www.sciencedirect.com/science/article/abs/pii/S1361920920307136#:~:text=https%3A//doi.org/10.1016/j.trd.2020.102526>

Claude, F., Ramadan, H. S., Becherif, M., & Boulon, L. (2017). Heat management methodology for enhanced global efficiency in hybrid electric vehicles. Case studies in thermal engineering, 10, 325-334. <https://doi.org/10.1016/j.csite.2017.06.006>

Abdullah, M. A., Chew, B. C., & Hamid, S. R. (2016). Benchmarking key success factors for the future green airline industry. Procedia-Social and Behavioral Sciences, 224, 246-253. <https://doi.org/10.1016/j.sbspro.2016.05.456>

De Sy, V., Herold, M., Achard, F., Beuchle, R., Clevers, J. G. P. W., Lindquist, E., & Verchot, L. (2015). Land use patterns and related carbon losses following deforestation in South America. Environmental Research Letters, 10(12), 124004. <https://iopscience.iop.org/article/10.1088/1748-9326/10/12/124004/meta#:~:text=10.1088/1748%2D9326/10/12/124004>

Morand, S., & Lajaunie, C. (2021). Outbreaks of vector-borne and zoonotic diseases are associated with changes in forest cover and oil palm expansion at global scale. Frontiers in veterinary science, 8, 661063. <https://doi.org/10.3389/fvets.2021.661063>

Hisano, M., Searle, E. B., & Chen, H. Y. (2018). Biodiversity as a solution to mitigate climate change impacts on the functioning of forest ecosystems. Biological Reviews, 93(1), 439-456. <https://onlinelibrary.wiley.com/doi/abs/10.1111/brv.12351#:~:text=https%3A//doi.org/10.1111/brv.12351>

Adams, W. M. (2020). Gene editing for climate: terraforming and biodiversity. Scottish Geographical Journal, 136(1-4), 24-30. <https://doi.org/10.1080/14702541.2020.1853869>

Arora, N. K. (2019). Impact of climate change on agriculture production and its sustainable solutions. Environmental sustainability, 2(2), 95-96. <https://link.springer.com/article/10.1007/s42398-019-00078-w#:~:text=DOI-,https%3A//doi.org/10.1007/s42398%2D019%2D00078%2Dw,-Share%20this%20article>

Andreopoulou, Z. (2016). Green ICTs for climate change mitigation and energy sustainability: EU challenge. Quality-Access to Success, 17, 492-496.

Lange, S., Pohl, J., & Santarius, T. (2020). Digitalization and energy consumption. Does ICT reduce energy demand?. Ecological economics, 176, 106760. <https://doi.org/10.1016/j.ecolecon.2020.106760>

Dwivedi, Y. K., Hughes, L., Kar, A. K., Baabdullah, A. M., Grover, P., Abbas, R., ... & Wade, M. (2022). Climate change and COP26: Are digital technologies and information management part of the problem or the solution? An editorial reflection and call to action. International Journal of Information Management, 63, 102456. <https://doi.org/10.1016/j.ijinfomgt.2021.102456>

Robbins, S., & van Wynsberghe, A. (2022). Our new artificial intelligence infrastructure: becoming locked into an unsustainable future. Sustainability, 14(8), 4829. <https://doi.org/10.3390/su14084829>

Manoussi, V., & Xepapadeas, A. (2017). Cooperation and competition in climate change policies: mitigation and climate engineering when countries are asymmetric. Environmental and Resource Economics, 66, 605-627.

Reynolds, J. L. (2019). Solar geoengineering to reduce climate change: a review of governance proposals. Proceedings of the Royal Society A, 475(2229), 20190255. <https://royalsocietypublishing.org/doi/full/10.1098/rspa.2019.0255#:~:text=https%3A//doi.org/10.1098/rspa.2019.0255>

Murray, E. G., & DiGiorgio, A. L. (2021). Will individual actions do the trick? comparing climate change mitigation through geoengineering versus reduced vehicle emissions. Earth's Future, 9(3), e2020EF001734. <https://doi.org/10.1029/2020EF001734>

UNEP, I. (2019). Global status report for buildings and construction: towards a zero-emission, efficient and resilient buildings and construction sector. Preprint at.

Dixon, N., Fowmes, G., & Frost, M. (2017). Global challenges, geosynthetic solutions and counting carbon. Geosynthetics International, 24(5), 451-464. <https://doi.org/10.1680/jgein.17.00014>

Clay, K., & Cooper, L. (2022). Safeguarding against harm in a climate-smart forest economy: definitions, challenges, and solutions. Sustainability, 14(7), 4209. <https://www.mdpi.com/2071-1050/14/7/4209#:~:text=(7)%2C%204209%3B-,https%3A//doi.org/10.3390/su14074209,-Submission%20received%3A%2019>

Tayarani, M., Poorfakhraei, A., Nadafianshahamabadi, R., & Rowangould, G. (2018). Can regional transportation and land-use planning achieve deep reductions in GHG emissions from vehicles?. Transportation Research Part D: Transport and Environment, 63, 222-235. <https://doi.org/10.1016/j.trd.2018.05.010>

Heikkinen, M., Ylä-Anttila, T., & Juhola, S. (2019). Incremental, reformistic or transformational: what kind of change do C40 cities advocate to deal with climate change?. Journal of Environmental Policy & Planning, 21(1), 90-103. <https://doi.org/10.1080/1523908X.2018.1473151>

Agreement, P. (2015). Adoption of the Paris Agreement. In United Nations Climate Change Secretariat (UNFCCC), FCCC/CP/2015/L. 9/Rev. 1. <http://unfccc.int/resource/docs/2015/cop21/eng/l09.pdf>

Tiwari, G. N., & Mishra, R. K. (2012). Advanced renewable energy sources. Royal Society of Chemistry,

Twidell, J. (2021). Renewable energy resources.

Panwar, N., Kaushik, S., & Kothari, S. (2011). Role of renewable energy sources in environmental protection: A review. Renewable and Sustainable Energy Reviews, 15, 1513–1524. <https://doi.org/10.1016/j.rser.2010.11.037>