

The Role Of Engineers In Tackling Climate Change And Mitigating Its Effect

Abstract

The Earth is warming and climate change is real, yet the average public's perception of this issue is greatly biased. There is currently very little actual threat, much less than what the media is predicting will happen in the future. It should be addressed in a manner that prioritises global issues more fairly. At this point, the media's and politicians' exaggeration and propaganda are more detrimental than global warming since they have only produced a segregated and divisive dichotomy of opposing viewpoints that have been pushed to such extremes that no compromise or advancement is imaginable. Our contribution is equivalent to adding a drop of red dye once a day to an Olympic-sized swimming pool. Our scientists have only now discovered the slightest difference in the pool water after 150 years of this. The rate of change is extremely slow, and the degree of change is hardly detectable, but if it is not stopped, it will ultimately turn the pool redder over a long period. With the help of this research, engineers will be better able to play their roles in combating climate change.

Keywords: Climate change, Earth, global issues, media, politicians and warming.

Author: Ebong, Ekemini Paul

Supervising Lecturer: Uduak Eyibio Promise

Introduction

Engineering is not merely knowing and being knowledgeable, like a walking encyclopaedia; engineering is not merely analysis; engineering is not merely the possession of the capacity to get elegant solutions to non-existent engineering problems; engineering is practising the art of the organizing forces of technological change ... Engineers operate at the interface between science and society as stated by Gordon Stanley Brown. This demonstrates that engineers have a crucial role in determining how we interact with the outside world and that the daily decisions we make at work can have a variety of environmental, social, and economic effects. For instance, natural resources used in the building process, such as energy, water, and raw materials used in the production of construction materials, are used up outside the confines of the actual construction site. Major infrastructure investments or innovative manufacturing might result in new jobs and revenue streams. However, the urban heat island effect in large cities can put residents under excessive stress during heat waves, especially the homeless. Engineers' work has a big impact on how much we humans contribute to climate change, both favourably and badly. Global political stability, infrastructure, and food security are all at risk due to climate change in addition to the environment. The engineering profession must commit to doing its part to mitigate the effects of climate change given that it is one of humanity's greatest concerns of the twenty-first century and its repercussions are already being felt all over the world. Engineers must take a central and active role in society's efforts to find solutions that reduce climate change.

Background to the Study

It is unnecessary to introduce climate change as a problem because it is likely well-known that human activity is causing it and that it will have several social repercussions.

According to a study conducted by the Nigerian Ministry of Environment in collaboration with the International Labour Organisation (ILO) and the United Nations Development Programme, 12 million green job possibilities might be made available by the year 2035 owing to carefully crafted climate legislation. This demonstrates that if Nigerian engineers can combat climate change and lessen its effects using both conventional and unconventional methods, we can build a better and more sustainable economy for our nation, where 39.1 per cent of the population lives in poverty. Green jobs may be the country's citizens' only hope.

According to a global survey, more than half of young people believe that climate change will lead to the extinction of humanity. Although it is quite reasonable to feel furious and fearful about the future, it seems that, in comparison to other problem areas (such as biorisk,

biosecurity, and civilisation resilience), climate change is considerably less likely to bring about the end of humanity or pose an existential danger to civilisation.

In a nutshell, there is a dearth of evidence and considerable speculativeness surrounding the extreme effects of climate change, although these outcomes are not likely to be directly attributed to the phenomenon. The mechanisms that support civilization would be put under tremendous strain as a result of climate change, which might also amplify the consequences of other global disasters and reduce international peace and cooperation, among other things.

However, there are more causes for concern about climate change. There is a greater than 1% probability that the Earth would suffer 6°C of warming, which would result in an almost unimaginable different planet from the one we currently live in. Current forecasts are for 2.8°C of warming (which would undoubtedly be terrible). More severe weather occurrences would seriously harm agriculture, ecosystems, the economy, communities, and housing. As temperatures increase, the oceans grow more acidic, invading pests, illnesses, wildfires, and extreme weather threaten the delicate balance of the ecosystem, many species on land and in the ocean would become endangered or extinct.

In addition to destroying the environment, climate change poses a serious threat to human health because of increased hunger and poor nutrition in areas where people cannot grow or find enough food, disease outbreaks, extreme weather events, forced relocation, and other factors. 13 million people die as a result of environmental conditions every year, according to the UN.

Given that weather-related disasters have displaced an estimated 21.5 million people annually on average over the previous ten years, climate change may worsen already existing global instability. This is more than twice as many people as have been displaced by war and violence. The majority of refugees originate from nations that are least prepared to adapt to the effects of climate change, are least responsible for greenhouse gas emissions, and are most vulnerable. These are all strong arguments in favour of caring about climate change. According to Johannes Ackva, a researcher at Founders Pledge, responses to comparatively minor perturbations can be exacerbated in societal processes. Whether society will be able to lessen the many effects of climate change or make them worse is unknown.

Research Problem Definition

The role of engineers in creating and implementing practical solutions has drawn a lot of attention as climate change becomes a more pressing global concern. With the help of renewable energy technology, resilient infrastructure designs, and sustainable urban planning, engineers have developed a variety of creative approaches and interventions to combat climate change. This project will comprehensively examine these approaches and interventions. This study aims to evaluate the sociological, economic, and policy repercussions of these engineering endeavours in addition to their technical components. This research aims to provide a thorough understanding of how engineers contribute to climate change mitigation and adaptation, as well as how their actions affect more general sustainability goals. It does this by examining the interactions between engineering innovations and their effects on society, the environment, and policy frameworks. The results of this research are expected to guide policy choices, encourage interdisciplinary collaborations, and help develop a more comprehensive strategy for resolving the intricate problems brought on by climate change.

Survey of Literature Review

The most highly represented topic in the literature, according to a classification of climate change research into selected topics of interest, is solar and renewable energy, which accounts for 30% of the total (Figure 1). 23% of the literature is devoted to research on ecosystems and agriculture, 17% is devoted to studies on resilient infrastructure, and 10% is devoted to studies on energy storage. Less than 2% of the climate change literature was devoted to studies on carbon sequestration, decarbonizing industry, geoengineering, and health and climate change.

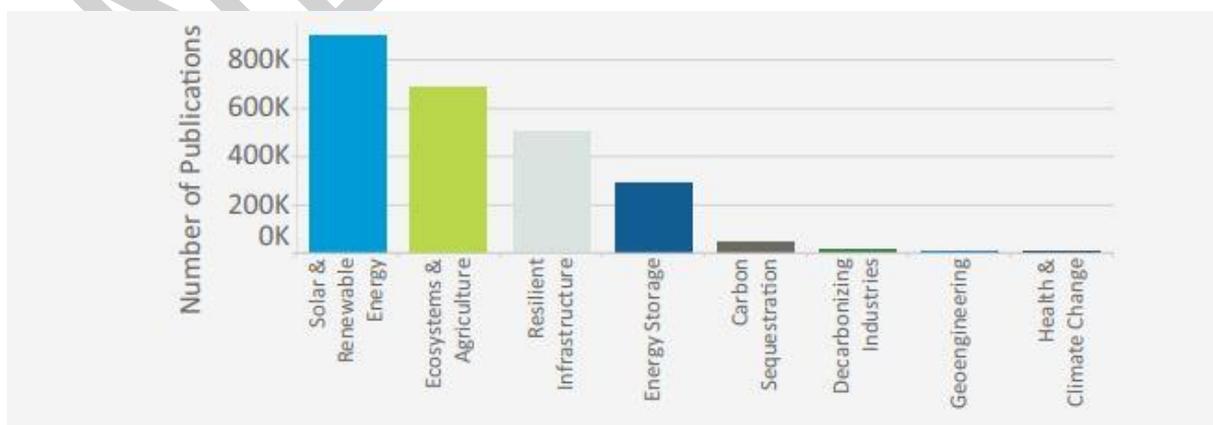


Figure 1: Total number of publications related to selected climate change topics, 2001–2020.

Source: Produced by Elsevier from Scopus data for ERVA.

According to this literature review, energy technologies are being studied by researchers all over the world much more than topics about carbon removal (such as carbon sequestration and decarbonizing industries), reducing the effects of GHGs through geoengineering, or dealing with the health effects of climate change. According to the number of publications, significant efforts are being made to improve infrastructure resilience and address effects on ecosystems and agriculture.

In response to a question about why he stressed the need for engineers to consider equity in their work on climate change, what are some examples of inequities in climate change impacts, and how might engineering decisions either contribute to or lessen them? NAE President John Anderson responded in a report published by the National Academy of Engineering on Engineering Responses to Climate Change in 2021. He replied, "In general, people living in poverty live in areas that no one else wants to live in — in low-lying areas that flood a lot, for example, and in old buildings that need to be retrofitted. That's where some inequity comes in. One important action to minimize inequity is to protect against flooding and wind destruction, and to make sure that when we go back in to rebuild, we build back better — and not rebuild in dangerous places where you know it's going to happen again. Protecting electrical power and potable water for all people is vital; that's what we have to focus on as engineers, citizens and political leaders. That means designing systems that protect those things."

The National Science Foundation (2022) conducted a study on the role of engineering in addressing climate change, noting that the issue is extremely complex and involves many engineered systems that affect not only CO₂ emissions from fuels but also human health, water systems, ecosystems, and infrastructure. This study serves as additional evidence for the mitigating effect of engineers. To combat climate change, the following fundamental research areas are given priority:

1. Energy Storage, Transmission, and Critical Materials,

- Nano-engineered materials for critical mineral separation, extraction, and recycling;
- Chemicals or materials for non-traditional energy storage such as reversible electron shuttles in flow batteries and hydrogen gas;
- Materials for extracting additional energy from heat cycles by harvesting low-grade heat in new ways, such as thermal flow batteries and thermoelectric; and

- Developing new ion exchange membranes to replace fluorinated membranes used in critical electrification systems, such as fuel cells, water electrolyzers, and other separation systems, with non-PFAS (per- and polyfluoroalkyl substances)-based membranes with sufficient durability to withstand harsh conditions.

2. Greenhouse Gas (GHG) Capture and Elimination

- Processes to capture and eliminate methane and nitrous oxide in agriculture operations and the environment by focusing on high-emission sites such as dams and water impoundments, mines, landfills, and farms;
- Researching bio- and genetic-engineering of plants or inclusive microbial communities for selective non-CO₂-based GHG capture (e.g., for methane and nitrous oxide); and
- Exploring the feasibility of intensive biotic ocean carbon capture to deep-sea sediments with an emphasis on preventing loss of nutrients, and electrochemical methods with a focus on devising materials suitable for challenging seawater conditions.

3. Resilient, Energy-Efficient, and Healthful Infrastructure

- Developing low-cost coatings for buildings, roads, and infrastructure that reduce heat island effects, increase self-cooling, and thermal energy transmission back into the exosphere;
- Infrastructure engineering that demonstrates positive impacts on health arising from defossilizing/decarbonizing the energy infrastructure and reducing transportation, industrial, and power plant emissions; and
- Extensive lifecycle analyses, frameworks, or Environmental Product Declarations of embodied carbon in our infrastructure, ranging from the existing built environment to commonly used materials.

4. Water, Ecosystems, and Geoengineering Assessment

- Sensing, measuring, and AI models for water flow analysis across large landscapes and proposing, through modelling and forecasting, future solutions to mitigate large swings in water availability due to increasingly disruptive events associated with climate change;
- Advancing solutions to threats of substantial losses of treated water in aging distribution systems through improved data collection and analytics, combined

with novel in-line and self-powered sensing feeding forward into AI models;
and

- Conceptualizing and testing at appropriate scales potential geoengineering solutions, with consideration of impacts on the environment and emphasis on economic and social costs of such technologies.

Aim and Objectives

This study aims to thoroughly investigate and analyse the varied roles played by engineers in tackling climate change's issues and in helping mitigate its consequences, while also taking into account the wider ramifications for society, policy, and sustainability.

Objectives

1. To recognize and classify the numerous fields in which engineers can actively support efforts to adapt to and mitigate climate change.
2. To look into the creative approaches, tools, and methods engineers use to tackle certain climate-related problems like the adoption of renewable energy, the resilience of infrastructure, and waste minimization.
3. To investigate the interdisciplinary partnerships that engineers form, both within the engineering community and between disciplines, to advance comprehensive and integrated approaches to combating climate change.
4. To examine the societal, economic, and policy ramifications of engineering interventions, taking into account how these initiatives affect the agendas for sustainable development, social fairness, and climate policy.
5. To investigate the impediments that engineers confront in their attempts to mitigate climate change, including those that are social, financial, and technical.
6. To share knowledge and suggestions on how to best utilize engineers' contributions to the development of comprehensive and successful plans for climate resilience with policymakers, stakeholders, and the engineering community.

Scope of the Research

The scope of the research is limited to a thorough examination of both conventional and unconventional approaches to the various contributions made by engineers in solving the global challenge of climate change. To counteract climate change and mitigate its negative effects, engineers use a variety of tactics, innovations, collaborations, and policy influences. The primary objective of the study is to examine the efficacy of engineering interventions like

the use of renewable energy, the development of environmentally friendly infrastructure, and the development of emissions reduction technology. Additionally, it will look at how engineers, scientists, policymakers, and communities can work together across disciplinary boundaries to address climate concerns holistically. In addition, the research will examine how engineers may affect policy agendas for the mitigation of climate change. By taking into account elements like job creation, economic growth, and community resilience, the study will evaluate the sociological, economic, and environmental ramifications of engineers' initiatives. The study will shed light on the adaptive techniques used to get around these limitations by evaluating the obstacles and difficulties engineers confront while putting climate solutions into practice. The findings of the study are intended to inform policy choices, stimulate teamwork, and advance knowledge of the critical function that engineers play in protecting the future of our world from the effects of climate change.

Feasibility of the Research

The feasibility of this study is based on its clear research focus on examining the many contributions of engineers to tackling climate change and its repercussions. The research's clearly stated goal is to thoroughly study the methods, discoveries, and teamwork that engineers use to lessen the effects of climate change. This narrow focus makes sure that the study stays within its specified scope and goals.

The availability of numerous and varied study materials improves the feasibility. A solid foundation for undertaking an extensive evaluation of the body of knowledge is provided by the wealth of literature on climate change, engineering interventions, and sustainable practices. The study's capacity to glean insightful information is also strengthened by access to engineering case studies, technical reports, and policy materials linked to mitigating climate change.

The anticipated use of mixed techniques in the research's methodology is supported by that approach. Rich and context-specific data can be collected using qualitative research techniques like worldwide reports and surveys of active engineers. Qualitative analysis will be used to supplement these data sources and show the efficacy and results of different engineering approaches in mitigating climate change.

The research proficiency in environmental engineering, sustainability, and social sciences further emphasises the study's viability. This multidisciplinary composition guarantees a thorough and nuanced consideration of the engineering profession's role in tackling climate change, emphasising working with other disciplines of study to combat climate change in

addition to technological techniques exclusively. The study's conclusions are more accurate and reliable because of the expertise with a variety of procedures and research techniques.

In conclusion, the study's viability is demonstrated by its clear research purpose, availability of a wide range of research resources, and utilisation of a variety of research techniques. A complete inquiry into how engineers can combat and lessen the consequences of climate change may be conducted thanks to the study's careful planning and alignment with these elements.

The intention of the Research

The research is driven by the passion to deeply examine and comprehend the crucial roles played by engineers in addressing the difficult problems caused by climate change. The main objective is to clarify the many different ways that engineers are actively involved in reducing the negative consequences of climate change and influencing the development of a more resilient and sustainable society.

It is impossible to determine the 'optimal' option for what to work on and where to work on it, as Martin Hare Robertson proposes in his recommendations for technologists who wish to work with climate change. His advice is to do something that has a clear connection to reducing emissions. Choose the option with the greatest plausible impact if you have a choice. There are no simple solutions, but a high level of uncertainty does not equal stupidity; we can still base our decisions on the knowledge at our disposal.

To combat climate change and lessen its effects, engineers use a variety of techniques, inventions, and interventions. This research paper aims to investigate and document these methods. The research aims to reveal the real-world applications of engineering solutions in a variety of fields, such as the adoption of renewable energy, the design of sustainable infrastructure, and revolutionary technologies for carbon capture and emission reduction.

According to recent studies, switching to nearby zero-emission energy technologies during this century is necessary to combat climate change. By pledging to keep global warming to 2 degrees Celsius above pre-industrial levels by 2100, the EU has decided to lead the way internationally (Tiina Koljonen et al., 2009). According to the Intergovernmental Panel on Climate Change, by 2050, emissions must be reduced by between 50 and 85 per cent from current levels to stay below the 2 °C threshold.

The study also attempts to show how engineering is tied to societal, economic, and policy factors. The research aims to shed light on the comprehensive advantages that engineers bring

to the table in the battle against climate change by examining the broader ramifications of technical interventions, including job creation, economic growth, and policy impact.

This demanded that engineers need to be knowledgeable about current issues, wisdom, and insight to serve the nation, as well as how to bridge the gap between engineering practice and policy-making by highlighting instances where engineering expertise serves as a catalyst for policy change and aligns technological advancements with sustainable development goals.

Impact of the Study

Svante Arrhenius, a Swedish scientist, released a ground-breaking study in 1896 that served as the cornerstone for our knowledge of how greenhouse gases contribute to climate change. One of the first attempts to estimate the potential influence of carbon dioxide (CO₂) emissions from human activities on the climate of Earth was made by Arrhenius.

$$\Delta F = \alpha \ln\left(\frac{c}{c_0}\right) \quad \text{eqn. (1)}$$

This means that if the amount of carbonic acid increases geometrically, the temperature will increase almost exactly in an arithmetic way. However, that doesn't address the other aspects of global warming, such as land-use changes or potential solutions. His findings are regarded as a ground-breaking addition to the study of anthropogenic (human-caused) global warming and the subject of climate change.

The research findings can considerably add to the body of knowledge already known about climate change mitigation at this fundamental level. The results can drive more research efforts and academic conversation, creating a deeper comprehension of the applicability and scalability of different engineering approaches to solving climate change concerns. The study's empirical evidence is useful for engineers who work in academia, business, or the public sector. The results of the research can also affect how policies are developed and put into practice at the local, national, and international levels.

Traditional Ways Engineers Can Tackle Climate Change

The traditional tactics that engineers can use to combat climate change and lessen its consequences refer to tried-and-true methods that have been used for a long time to handle the problems brought on by climate change. These procedures frequently make use of tried-and-true methods, techniques, and technologies that have been created and improved over time. The following are some conventional ways that engineers can help to mitigate climate change:

1. Manufacturing goods:

One of the main causes of greenhouse gas emissions worldwide is the manufacturing process, which includes the extraction of raw materials and the creation of goods like cement, aluminium, steel, electronics, plastics, clothing, etc. Machines used in manufacturing frequently use fossil fuels. Additionally, some materials, such as plastics, are produced using chemicals that come from fossil fuels. According to this, industry uses 24.2% of the world's energy and contributes 5.2% of the planet's greenhouse gas emissions.

Industrious Labs, a newly formed environmental organisation (publicly unveiled in October 2022) that seeks to strategically coordinate other organisations to decarbonize heavy industry, is attempting to address this issue. It anticipates that through its actions, more heavy industry producers will switch to low-carbon production.

2. Transportation:

16.2% of worldwide GHG emissions are related to transportation (excluding emissions from the production of motor vehicles and other transport equipment, which are covered in the previous paragraph, "Manufacturing goods"). Currently, the main source of GHGs for transportation is vehicle travel. 60% of road transport emissions are brought on by passenger vehicles (cars, motorcycles, and buses). The remainder is transported by trucks and lorries on the road. Passenger travel accounts for 81% of aviation emissions, or 1.9% of all global greenhouse gas emissions, of which 60% are attributable to international travel and 40% to domestic travel. Freight accounts for 19% of aircraft emissions.

In the transportation industry, engineers are playing a critical role in combating climate change by creating novel solutions that reduce greenhouse gas emissions, exploring and developing alternative fuels like biofuels, hydrogen, and synthetic fuels, and increasing the efficiency of internal combustion engines by optimising design features for electric and hybrid vehicles that produce fewer emissions than conventional internal combustion engine vehicles; establishing data-driven, sensor-based, and real-time transportation systems to improve traffic flow, ease congestion, and reduce energy waste from idle vehicles; Active transport is promoted by creating bike lanes, pedestrian-friendly streets and other urban infrastructure that promotes walking and cycling. lessens the reliance on fossil fuel-powered vehicles and designs and implements an electric vehicle charging infrastructure, making the switch to electric transportation more convenient and accessible.

3. Agriculture:

18.4% of the world's GHG emissions are directly caused by forestry, agriculture, and land use. This figure rises to nearly 25% of global GHG emissions when GHG emissions for the entire food system are considered, which includes food processing, packaging, and transport. The two largest direct contributions to agricultural GHGs are livestock and manure. Due to the methane produced as a by-product of their digestion process, cows and sheep in particular tend to have substantial carbon footprints. This indicates that cutting back on beef and lamb intake is a successful individual action to lessen the impact on the environment.

According to Project Drawdown, between 2020 and 2050, diets high in plants could reduce 78–103 gigatons of CO₂ equivalent. By introducing meat substitutes that are competitively priced to the market, the development and marketing of Alternative Protein could spur a shift in society towards diets that are rich in plants. Additionally, engineers and farmers can work together to put climate-smart farming practices like crop rotation, intercropping, and agroforestry into practice. These methods improve the biodiversity, resilience, and soil health to climate change.

4. Powering buildings:

Commercial buildings contribute 6.6% of the world's GHGs, whereas residential structures produce 10.9%. The production of electricity for use in lighting, appliances, cooking, and heating might result in the emission of these GHGs. The biggest barriers to decarbonizing power are not technological; rather, they are political.

Engineers could design structures with energy efficiency in mind to combat this. To optimise building orientation, insulation, window placement, and ventilation systems, they can use cutting-edge simulation technologies. the use of passive design concepts, which make use of renewable resources like sunlight and wind to cut down on energy usage; the reduction of the need for artificial heating and cooling as a result; developing Combined Heat and Power (CHP) systems that employ a single energy source to produce both electricity and useful heat. By utilising waste heat that would otherwise be lost, this method increases energy efficiency. emphasizing the use of environmentally friendly, low-carbon building materials while investigating cutting-edge methods like modular construction and green building certifications. creating district energy systems that distribute electricity, heating, and cooling from a single source to groups of buildings. To monitor and regulate energy use in real-time, engineers can incorporate smart technologies like sensors, automation, and building

management systems. Precision modifications based on occupancy, weather, and energy demand are made possible by these systems.

5. Superhot rock geothermal energy

Superhot rock geothermal energy is a cutting-edge technology that can satiate future needs for zero-carbon, continuous power. Dry rock that is 400C or higher can produce superhot rock geothermal energy. It can be found all over the planet at depths of 2–12 miles (3–20 km). But it is hardly ever acknowledged in the decarbonisation landscape.

The climate non-profit Clean Air Task Force discovers that superhot rock geothermal energy may be commercialised and deployed quickly in the 2030s with an investment in innovation. It might be affordable compared to existing zero-carbon technologies and, more significantly, have a minor environmental impact. Petroleum engineers who specialise in reservoir engineering are likely to have transferrable abilities (such as knowledge of deep drilling) that could be useful in this field.

6. Carbon capture, removal and storage technologies

The majority of net-zero solutions require technology for carbon capture, removal, and storage. The carbon dioxide removal (CDR) technologies, which remove carbon dioxide directly from the atmosphere, are the most promising ones. These have the best chance of developing into the low-emissions technology required to combat climate change. We have a low degree of confidence that CDR is the most crucial and underutilised of these carbon capture, removal, and storage technologies, and the existing technological hurdles in research and deployment. The risk of carbon capture being exploited for enhanced oil recovery (EOR) and other fossil fuel purposes, however, is present and is likely to be detrimental overall.

However, under strict climate policy scenarios, the use of CCS will significantly increase. This can be assessed in terms of both annual capital costs and electrical capacity. Even while the electrical capacity of the fossil fuel base will decline significantly until the middle of the century, its monetary value in terms of yearly capacity costs will be quite low.

Role of Engineers in Tackling Climate Changes via Non-Traditional Methods

To quote Napoleon Hill, "Great achievement is usually born of great sacrifices, and is never the result of selfishness," we cannot combat climate change solely by thinking of innovation, technologies, and practises without taking into account that the world is made up of mixed people from different backgrounds. This necessitates making the sacrifices of pursuing unconventional, innovative, and frequently interdisciplinary approaches that go beyond

current paradigms. These approaches entail using original thought processes and engineering expertise to solve complicated problems brought on by climate change. The following list outlines the responsibilities that engineers play in reducing the impact of climate change.

1. Policy Advocacy and Influence

Engineers may promote climate-friendly legislation by using their expertise. Engineers can have an impact on the creation and application of rules that promote sustainability by taking part in policy discussions, contributing technical knowledge, and working with policymakers. They help to create policies that are based on technical realities by sharing their experience. They can offer organizations' campaigns their technical know-how, bolstering the case for legislative reforms. Engineering professionals can utilize their platforms to inform the public about the scientific causes of climate change and potential remedies. This can entail utilizing social media, speaking engagements, podcasts, and article writing to increase public understanding and support for climate-friendly legislation.

To increase their effect and highlight the advantages of climate-friendly policies for the economy and job development, engineers might also collaborate with environmental advocacy groups. Engineers can get the support of governments and stakeholders by demonstrating how renewable energy projects and sustainable infrastructure can boost regional economies. To conclude on this point, engineers can work with elected leaders to further the initiated policy.

2. Media and Journalism

Strong communicators in the engineering field can work as journalists, content producers, or climate reporters. To raise public knowledge and comprehension of the effects and solutions of climate change, they can publish articles, make videos, and participate in media channels.

The general public can more easily understand complex climate data thanks to the engaging infographics and visualizations that engineers can produce. These images can be used to illustrate the urgency and effects of climate change in news articles, on websites, and on social media. Additionally, they can create interactive tools and mobile apps that let consumers explore climate data, experiment with various results, and comprehend the links between human actions and climate outcomes.

3. Entrepreneurship and Innovation

Engineers can create startups focused on climate solutions. They can develop innovative technologies, services, or products that address specific climate challenges, from sustainable transportation to waste reduction and renewable energy integration.

Engineers can establish start-ups that focus on developing cutting-edge technologies, products, or services aimed at addressing specific climate challenges. These start-ups can be centred around renewable energy, sustainable transportation, waste reduction, circular economy solutions, and more. They can create new financial models and investment mechanisms to fund climate-related projects, organise hackathons focused on climate technology can bring together engineers, designers, and entrepreneurs to brainstorm and rapidly prototype solutions; participate in or establish accelerator programs that provide mentorship, resources, and funding to start-ups working on climate-related innovations. Meanwhile, Engineers working in academia can facilitate the transfer of innovative research and technologies from the lab to real-world applications.

4. Artificial Intelligence and Data Analytics

By establishing predictive models for climate trends, optimising resource allocation, and constructing intelligent systems for energy management, engineers with experience in AI and data analytics can support efforts to mitigate climate change.

These models will increase the precision of climate projections, assisting decision-makers and communities in getting ready for upcoming changes. Real-time weather data analysis and more accurate forecasting of extreme weather events are both possible with AI-driven data analytics. The use of AI algorithms to optimise energy use in homes, vehicles, and other structures can help lessen the effects of natural catastrophes. This information is essential for disaster response planning and early warning systems. Last but not least, engineers utilise AI to optimise reforestation and afforestation efforts, identifying appropriate planting places and calculating the capacity of various ecosystems to store carbon.

5. Collaboration with Indigenous Knowledge

Engineers can work with native people to combine traditional wisdom and methods into novel approaches for climate adaptation and mitigation. Indigenous groups frequently offer profound insights regarding how to coexist peacefully with the environment.

With respect and humility, engineers may effectively implement this strategy. It's important to comprehend and respect the worldview, beliefs, and traditions of Indigenous groups to develop partnerships with them. Involving Indigenous communities in the design process as equal partners. This entails engaging in constant communication with the community, listening intently, and seeking their opinions. Engineers can work with Indigenous knowledge holders to learn about traditional ecological knowledge, sustainable resource management techniques, and regional climate observations by exchanging expertise. By exchanging

engineering knowledge, one can assist in closing the gap between conventional methods and contemporary solutions.

To ensure that infrastructure projects are in harmony with the natural environment, engineers can very importantly include Indigenous perspectives in those projects. Creating structures and roadways, for instance, that respect sacred sites and the movement of water.

6. Partnerships with NGOs and Community Organizations

Engineers can partner with non-governmental organizations (NGOs) and community groups to implement climate resilience projects, such as designing sustainable water systems for underserved areas or building disaster-resistant shelters.

Collaborating with engineers allows NGOs and community organizations to build their technical capacity. Through knowledge transfer and skill-sharing, organizations can better understand and manage climate-related projects since climate change is a complex issue that requires collaboration across multiple disciplines.

By partnering with NGOs and community organizations, understanding the specific needs and vulnerabilities of communities will make it easier for engineers to develop tailored solutions that align with community goals. These efforts empower communities with the knowledge and skills to address climate issues, ranging from energy conservation to disaster preparedness.

7. Public Health Integration

To address the health effects of changing climatic patterns, such as heat stress, vector-borne diseases, and air quality challenges, engineers can work at the interface between climate change and public health.

Engineers can create infrastructure that reduces its negative environmental effects while simultaneously considering any potential health hazards brought on by climate change. For instance, designing cool roofs, green spaces, and efficient ventilation systems to lower temperatures in urban areas, designing filtration systems for buildings and transportation systems to reduce exposure to harmful air pollutants and allergens, and designing flood-resistant buildings and water management systems which can prevent waterborne diseases during extreme weather events. This guarantees continuous medical care during emergencies.

8. Art and Creativity

Speaking of art and creativity, this entails using music, literature, art, or film to express concerns about climate change. Engineers may not be fully involved in this scenario, but they

may collaborate with those who are and approach negotiations knowing that this is our planet and not just limited to one field. Reviewing their songs' lyrics, contents, and literature may contribute in mitigating the impact of climate change.

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Conclusion

- Engineers have long been at the forefront of creating and putting into practice conventional techniques to combat climate change. Engineers have been instrumental in reducing greenhouse gas emissions through the design of energy-efficient buildings, the use of renewable energy sources, and the optimisation of industrial processes. They also make contributions to developing robust infrastructure, sustainable transportation systems, and improved waste management techniques. These conventional methods are the cornerstone of attempts to mitigate climate change since they are based on engineering knowledge and concepts.
- However, the complexity and urgency of climate change necessitate novel and unusual viewpoints. If engineers adopt the unconventional strategies outlined in this study, utilising interdisciplinary cooperation, and thinking outside the box by incorporating public health concerns into climate solutions to advocating for policy change and taking part in behavioural engineering, engineers will be showcasing their flexibility and innovation. The dynamic role of engineers as agents of change who handle climate concerns holistically while taking into account the complex relationships between technology, society, and the environment will exponentially increase as a result of these non-traditional approaches.
- The complementary nature of engineers' contributions to climate change mitigation is highlighted by the synergy between conventional and unconventional methods. Engineers work to improve renewable energy technologies while also promoting sustainability through public awareness campaigns. Engineers work with healthcare professionals to create buildings that are energy-efficient while also ensuring that the indoor environment is healthy. This all-encompassing strategy acknowledges that combating climate change is not just a technical problem but also a moral, ethical, and environmental one.
- As a result, in a world that is changing quickly, engineers' roles in mitigating climate change are shifting and must emphasise adaptation, inventiveness, and teamwork. Engineers act as influencers who promote sustainable policies and as innovators who constantly seek fresh solutions. By building links between research, technology, society, and policy, they serve as change agents. Engineers will advance towards a more resilient, equitable, and sustainable future where the effects of climate change are lessened, communities prosper, and the Earth's ecosystems are protected for future

generations by embracing both traditional and non-traditional ways. Engineers' combined efforts, motivated by knowledge, compassion, and vision, hold the potential of a society more prepared to face the problems of climate change and ensure a more affluent future.

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References

- International Atomic Energy Agency (2003). *Country nuclear power profiles*. Retrieved from <http://www-pub.iaea.org/MTCD/publications/PDF/cnpp2002/index.htm>
- Engineering Research Visioning Alliance (2022). *The Role of Engineering to Address Climate Change: A Visioning Report*. Columbia, SC: SSRN. doi:<http://dx.doi.org/10.2139/ssrn.4173381>.
- G, B. (1996). *Renewable Energy: Power for a sustainable future*. Oxford University Press.
- (November, 2022). *Industrious Labs recommendation summary*. Giving Green Earth. Retrieved from <https://www.givinggreen.earth/mitigation-research/industrious-labs%3A-recommendation>
- IPCC. (2001). *Climate Change 2001: The Scientific Basis. Second Assessment Report. Working Group I of the Intergovernmental Panel on Climate Change. Summary for Policymakers*. Retrieved from <http://www.ipcc.ch/>
- Parkinson, D. S. (2003). Tackling Climate Change - the role of the engineer. *Women's Engineering Society annual conference*. Doncaster, UK.
- Tiina Koljonen, Martti Flyktmana, Antti Lehtilää, Katri Pahkalab, Esa Peltolaa, Ilkka Savolainen. (2009). The role of CCS and renewables in tackling climate change. *Energy Procedia*, 4323–4330. doi:[doi:10.1016/j.egypro.2009.02.245](https://doi.org/10.1016/j.egypro.2009.02.245)