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Evaluating the effectiveness of climate change policies and initiatives in the United States: A comprehensive review

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Abstract

Climate change presents profound challenges, demanding effective policies to mitigate its impacts. This paper reviews the effectiveness of climate policies in the United States, analyzing scholarly articles, government reports, and relevant literature. The review covers diverse policies such as greenhouse gas regulations, renewable energy initiatives, energy efficiency programs, and adaptation measures. It assesses their success in reducing carbon emissions, advancing a low-carbon economy, and enhancing resilience to climate impacts. Key findings highlight significant successes, such as the rise in renewable energy due to renewable portfolio standards and reduced emissions from vehicle fuel efficiency standards. State-level initiatives, like carbon pricing and renewable energy targets, also show promising outcomes. However, the review identifies substantial challenges, including political and economic obstacles, inconsistent policies across states, and the need for better federal-state-local collaboration. Additionally, disparities in policy benefits, with marginalized communities facing greater burdens and limited access to renewable resources, are significant concerns. To enhance the effectiveness of climate policies, the study recommends fostering coherent policies across all government levels, promoting equitable and inclusive climate solutions, raising public awareness, and supporting innovation in clean technologies. This comprehensive review provides valuable insights for policymakers and stakeholders to develop strategies that effectively address climate change, promote sustainability, and ensure a fair transition to a low-carbon future.

Keywords: Policymakers; Climate; United States; Low-carbon; Greenhouse

1. Introduction

Climate change has emerged as one of the most pressing challenges facing humanity in the 21st century. As global temperatures rise, extreme weather events become more frequent, and ecosystems face unprecedented disruptions, governments worldwide have been compelled to act. The United States, as one of the largest contributors to greenhouse gas emissions, has implemented various climate change policies and initiatives in recent decades. However, evaluating the effectiveness of these measures is essential to inform future policy decisions and address the urgency of climate change mitigation and adaptation (Pham et al., 2023). This review paper aims to provide a comprehensive assessment

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of the effectiveness of climate change policies and initiatives in the United States. By analyzing a wide range of data and empirical studies, this review seeks to shed light on the successes, challenges, and areas for improvement within the realm of climate change action.

In response to the urgent need to mitigate and adapt to climate change, countries around the world have developed and implemented climate change policies and initiatives. These policies aim to reduce greenhouse gas emissions, transition to clean and renewable energy sources, increase resilience to climate impacts, and foster sustainable development. The United States, as one of the largest greenhouse gas emitters and a global economic leader, plays a crucial role in addressing climate change through its policies and initiatives.

The United States has witnessed significant changes in its federal climate change policies in recent years. The most notable development was the re-entry of the country into the Paris Agreement, signalling a renewed commitment to global climate action. Under this agreement, the U.S. pledged to reduce its greenhouse gas emissions and implement measures to adapt to the impacts of climate change. Additionally, the Biden administration has introduced several ambitious policies to combat climate change. The American Jobs Plan includes substantial investments in clean energy, infrastructure, and research and development, with the goal of achieving net-zero emissions by 2050. The administration has also proposed stricter emission standards for vehicles and set a target of conserving 30% of U.S. land and water by 2030 (Reichle, 2023).

Recognizing the need for local action, many states in the U.S. have implemented their own climate change initiatives. California, for instance, has been a leader in this regard, implementing comprehensive policies to reduce emissions and promote renewable energy. The state's cap-and-trade program and stringent vehicle emission standards have served as models for other regions (Sperling & Eggert, 2014). Other states, such as New York and Washington, have also adopted ambitious clean energy standards and established programs to support renewable energy development. These state-level initiatives not only contribute to national emission reduction goals but also stimulate innovation and economic growth in the clean energy sector.

(Saina Zheng et al., 2023) examined the energy policy trajectories of six prominent nations and assesses the efficacy of their respective approaches. The findings indicate that the worldwide climate policy has a substantial impact on mitigating carbon emissions, although the effectiveness of policies varies across countries. (Szasz, 2023) employed fixed effect panel models to evaluate the impact of ten distinct state-level climate policies, categorized into four approaches, on energy-related CO_2 emissions in the United States. By analyzing these outcomes, the study aimed to identify the policy approaches that have proven more successful in curbing fossil fuel consumption thus far. The findings consistently indicate that the implementation of cap and trade mechanisms and accounting for gas price increases are associated with the most significant reductions in emissions, surpassing the effectiveness of other policies examined. Lewis et al. (2023) incorporated input from community stakeholders to develop a comprehensive Climate Vulnerability Index (CVI) for the United States (U.S.) (Tee Lewis et al., 2023). The index integrated various data sets related to public health, social factors, economic conditions, environmental aspects, and climate information. The CVI consisted of four foundational vulnerabilities (health, social/economic, infrastructure, and environment) and three climate change risks (health, social/economic, and extreme events). The findings revealed substantial heterogeneity in vulnerability to and risks associated with climate change across the U.S., specifically at the census tract level. These variations formed distinct geographical clusters, where areas with similar climate risks exhibited contrasting baseline vulnerabilities.

According to a recent study conducted by (Gillis et al., 2021), it was observed in an experiment involving participants from the United States that conservatives and moderates show increased levels of support for climate change mitigation efforts when presented with information about actions taken by the private sector. (Adua et al., 2021) conducted a study that investigated the effectiveness of two significant strategies in addressing climate change: enhancing energy efficiency and promoting the development and utilization of renewable energy sources. The specific focus of their research was to examine the impact of these solutions on carbon dioxide emissions. To achieve this, they employed fixed effects regression analysis on panel data concerning various U.S. states. The findings of their analysis indicated a clear negative correlation between both approaches and carbon dioxide emissions. (Lacroix et al., 2022) conducted a comprehensive investigation consisting of three studies to explore the potential influence of individual-level actions on individuals' inclination to participate in collective-level behaviors. The findings of their research indicate that personal mitigation behaviors do not have significant spillover effects on collective behavioral intentions aimed at mitigation. It appears that messages emphasizing collective mitigation behaviors directly may be more successful in promoting such behaviors compared to messages that highlight past personal behaviors.

In a study conducted by (Lacroix et al., 2022), an assessment was made regarding the effectiveness of the existing generation of state-level Climate Action Plans (CAPs) in terms of their implementation and the actual reduction of

carbon emissions. The research findings indicate that regardless of the specific targets and implementation progress of CAPs, all types of these plans lead to observable but moderate decreases in carbon emissions, after accounting for various economic, climatic, political, and geographic factors. (Adua, 2021) explore the impact of political partisanship on energy efficiency policies at the state level. The research findings, along with previous studies, highlight the crucial importance of encouraging individuals who identify as Republicans to recognize the significance of environmental protection in addressing the present-day environmental challenges we face. (Fu & Li, 2022) introduced a conceptual framework of resilience comprising five essential elements. They subsequently devised a coding protocol based on these elements and employed it to assess a sample of 50 climate change plans in the United States (US) with a significant focus on adaptation. The findings revealed that the incorporation of resilience within US climate change plans has been insufficient, and the prevailing notions of resilience have limited impact on the level of integration within these plans.

Despite progress, there are challenges and criticisms surrounding climate change policies in the United States. A significant obstacle is the partisan divide on the issue, which has hindered the enactment of comprehensive federal legislation. This has resulted in a fragmented approach, with policies varying significantly across states. Achieving a unified national strategy remains a critical task.

Furthermore, critics argue that the pace of implementation and the scale of investment fall short of what is necessary to effectively address climate change. Some suggest that the reliance on market-based mechanisms, such as carbon pricing, should be coupled with stronger regulations and incentives to drive the transition to clean energy.

What sets this review apart is its novel approach to evaluating the effectiveness of climate change policies. While previous studies have often focused on individual policies or specific sectors, this review takes a holistic view, examining the collective impact of various initiatives across the nation. By considering the interplay between federal, state, and local efforts, as well as public-private partnerships, this review provides a comprehensive understanding of the complex landscape of climate change policy in the United States.

Moreover, this review paper takes into account the most recent data available, ensuring that the evaluation is up-to-date and reflective of the evolving nature of climate change policies. By including information up until 2023, this review captures the latest developments and policy shifts that have taken place, allowing for a comprehensive analysis of the ongoing efforts to combat climate change in the United States.

The primary objective of this review paper is to identify successful strategies and approaches, as well as areas where improvements are needed, to guide policymakers, stakeholders, and researchers in developing and implementing effective climate change policies. By critically analyzing the strengths and weaknesses of existing initiatives, this review aims to inform evidence-based decision-making and facilitate the design of more impactful and sustainable climate change measures.

Overall, this comprehensive review fills a crucial gap in the existing literature by offering a holistic assessment of the effectiveness of climate change policies and initiatives in the United States. Through its novel approach, inclusion of the latest data, and comprehensive analysis, this review contributes to the growing body of knowledge on climate change policy evaluation. Ultimately, the findings and insights presented in this paper will play a crucial role in shaping future climate change policies, fostering sustainability, and mitigating the adverse effects of global climate change.

This paper is structured as follows: Section two will outline the methodology employed in this comprehensive review. It will elucidate the research approach, including the identification and selection of relevant sources and data. Moreover, it will explain the criteria used to assess the effectiveness of climate change policies and initiatives, ensuring a rigorous evaluation. The section will also address the limitations and challenges encountered during the review process. In Section three, a comprehensive overview of climate change policies and initiatives implemented in the United States will be provided. This section will explore key legislative acts, regulations, executive orders, and their evolution over time. Additionally, it will examine the roles of federal, state, and local governments, as well as the involvement of different sectors and stakeholders in shaping climate change policies. Section four will focus on the evaluation of the effectiveness of climate change policies and initiatives in the United States. It will encompass the assessment of greenhouse gas emission reduction targets, the progress made in renewable energy adoption, the effectiveness of climate change adaptation strategies, the economic impact, and the success of international collaborations and agreements. In Section five, selected case studies will be analyzed in detail, providing nuanced insights into the outcomes, challenges, and lessons learned from specific climate change policies and initiatives. These case studies will offer valuable context and real-world examples to enhance the understanding of their effectiveness.

Section six will identify and discuss the factors influencing the effectiveness of climate change policies in the United States. It will examine political, economic, social, and technological factors that can shape and impact the success of these policies and initiatives. In Section seven, key findings and conclusions from the comprehensive review will be summarized, and policy recommendations will be presented. These recommendations will aim to enhance the effectiveness of climate change policies and initiatives in the United States, offering guidance for future decision-making and action. Finally, in the Conclusion (Section eight), a concise recapitulation of the main points discussed in the paper will be provided. It will emphasize the importance of ongoing evaluation and monitoring of climate change policies, while also underscoring the need for continued research and collaboration to address the multifaceted challenges posed by climate change.

This comprehensive review intends to offer valuable insights into the effectiveness of climate change policies and initiatives in the United States, fostering evidence-based decision

2. Methodology

2.1. Research Approach

The study used Google Scholar for its comprehensive review since it covers a wide range of academic publications, reports, and gray literature related to climate change policies. This approach involves conducting a comprehensive and structured analysis of existing literature, reports, policy documents, case studies, and empirical studies related to climate change policies and initiatives implemented in the United States. By using a systematic approach, this review aims to provide an objective and comprehensive assessment of the effectiveness of these policies and initiatives.

2.2. Identification and Selection of Relevant Sources and Data

To find a wide range of relevant studies, the following search phrases were utilized:

"Effectiveness of climate change policies in the US", "climate change policies in the United States", "adaptation measures climate change in the US.", “greenhouse gas regulations in the US", "renewable energy initiatives in the US", "energy efficiency programs in the US", and "climate resilience strategies in the US’’.

Using these search criteria, Google Scholar returned around 2,500 articles. This vast collection contains peer-reviewed journal papers, government reports, policy briefs, and other related literature published between 2000 and 2023.

2.3. The Guidelines for Article Selection

To guarantee a targeted and meaningful review, the following criteria were utilized when choosing publications:

- Relevance: Articles must specifically discuss climate change policies or activities in the United States.
- Emphasis on Effectiveness: Articles should assess the efficacy of certain policies or efforts, either quantitatively or subjectively.
- Publication Date: Only articles published during the last 20 years (2003–2023) were chosen to capture current methods and their implications.
- Source Type: The data's reliability and validity were ensured by prioritizing peer-reviewed articles, comprehensive government reports, and trustworthy policy briefs.
- Geographic Scope: The focus was solely on US-based policies and activities.
- Topic Diversity: To provide a comprehensive analysis, a variety of topics were included, including greenhouse gas restrictions, renewable energy, energy efficiency, and adaptation measures.

After using these criteria, 260 articles were selected for additional review. This decision was made after a thorough assessment of the effectiveness of individual policies and projects, which provided a wide view of the accomplishments and limitations in the United States context.

2.4. Selected Articles

A final group of 130 articles was selected from the shortlist for in-depth study. These papers provided the most complete appraisals and insights into many areas of US climate change policies. The studies examined the influence of renewable portfolio regulations on energy generation and fuel efficiency standards on emissions.

- The efficacy of regional carbon pricing schemes.
- Policy implementation problems between states.
- Considerations for equity in distributing climate policy benefits.

This thorough selection procedure guaranteed that the assessment was based on solid and relevant research, resulting in a comprehensive knowledge of the success of climate change policy in the United States.

2.5. Limitations and Challenges

During the review process, several limitations and challenges were encountered, including:

- Data Availability and Quality: The availability and quality of data vary across different policies and initiatives, making comparisons and generalizations challenging.
- Time Constraints: The time frame of the review may limit the inclusion of the most recent policy developments and their evaluation.
- Data Bias and Interpretation: Potential biases in the selected sources and the interpretation of their findings, as well as limitations in the methodologies used in the original studies.
- Complexity of Policy Interactions: The complexity of interactions and synergies between different policies and initiatives, which may influence their overall effectiveness.
- Evaluation Bias: The potential for evaluation bias due to the inclusion of studies or reports with specific perspectives or agendas.
- Scope and Generalizability: The review focuses specifically on climate change policies and initiatives in the United States and may not capture all relevant global or regional initiatives.

Despite these limitations and challenges, this comprehensive review aims to provide a robust evaluation of the effectiveness of climate change policies and initiatives in the United States, serving as a valuable resource for policymakers, researchers, and stakeholders in their efforts to address climate change.

3. Federal Policies and Initiatives

3.1. The Clean Air Act

The Clean Air Act (CAA) is a crucial environmental law in the United States aimed at regulating air pollution and safeguarding public health. It has played a significant role in addressing climate change by implementing policies to reduce greenhouse gas emissions and enhance air quality. Key initiatives under the CAA include the establishment of National Ambient Air Quality Standards (NAAQS), emissions standards for vehicles and engines, the Acid Rain Programme, and the Clean Power Plan (CPP) (Ruhl, 2010).

The NAAQS sets limits on harmful air pollutants to protect public health and is regularly updated. Emission standards for vehicles and engines have reduced pollutants from transportation sources, contributing to climate change mitigation. The Acid Rain Programme, through a cap-and-trade system, successfully reduced acid rain, improved air quality, and decreased greenhouse gas emissions. The CPP aimed to reduce carbon dioxide emissions from power plants but faced legal challenges and was replaced by the Affordable Clean Energy (ACE) Rule (LaCount et al., 2021).

The implementation of the Clean Air Act has led to significant progress in reducing air pollutants. EPA data shows a 74% decrease in emissions of various pollutants between 1970 and 2019. Air quality has improved across the country, although challenges remain in achieving compliance with NAAQS, particularly for ozone. The CAA has also contributed to greenhouse gas emission reductions by promoting fuel efficiency and reducing precursor pollutants (Davidson & Norbeck, 2012).

However, the Clean Air Act has limitations. There are regulatory gaps in addressing emerging pollutants and certain sectors like agriculture and transportation. Implementation challenges arise due to complex regulations, varying compliance requirements, and coordination issues among different agencies and government levels. The Act may need to be more adaptive to changing conditions and align with the latest scientific understanding and international agreements (Wadsack et al., 2018).

Future directions for the Clean Air Act involve strengthening renewable energy integration, setting more ambitious emission reduction targets, prioritizing environmental justice considerations, and improving interagency cooperation. Promoting and incentivizing renewable energy sources, establishing clear and enforceable emission reduction targets,

addressing environmental justice concerns, and enhancing collaboration among agencies are crucial for the Act's effectiveness.

Continual evaluation, adaptation, and innovation are essential to ensure the Clean Air Act remains effective in protecting public health and the environment amidst climate change challenges. By addressing its limitations and embracing future directions, the Act can make further progress in mitigating climate change and improving air quality.

3.2. The Clean Power Plan

The Clean Power Plan was a significant federal policy introduced in the United States in 2015 as part of the Obama administration's efforts to address climate change and reduce greenhouse gas emissions from power plants. The plan aimed to set state-specific carbon emission reduction targets and provide guidelines for states to develop their own strategies to achieve those targets. While the Clean Power Plan represented a crucial step towards cleaner and more sustainable energy production, it faced limitations and experienced subsequent changes under the subsequent administration (Ha & Grubert, 2023).

The Clean Power Plan recognised the power sector as one of the largest sources of greenhouse gas emissions in the United States. By setting emission reduction goals for individual states, the plan aimed to drive a transition from coal-fired power plants to cleaner sources of energy, such as natural gas, renewables, and energy efficiency measures. This approach was designed to improve air quality, mitigate the impacts of climate change, and promote the growth of the renewable energy sector.

However, the Clean Power Plan faced several limitations and challenges. One major criticism was the perceived overreach of federal authority in setting state-specific emission reduction targets. Opponents argued that the plan infringed upon states' rights and imposed undue economic burdens on certain regions heavily reliant on coal for electricity generation. Legal battles ensued, leading to a stay from the Supreme Court and subsequent changes under the Trump administration (Ha & Grubert, 2023).

Under the Trump administration, the Clean Power Plan was repealed and replaced with the Affordable Clean Energy (ACE) rule in 2019. The ACE rule aimed to provide more flexibility to states in setting their emission reduction goals, allowing them to focus on efficiency improvements at individual power plants rather than pursuing broader renewable energy targets. Critics argued that the ACE rule lacked ambition and would slow down the transition to cleaner energy sources (Lu et al., 2016).

However, it is important to note that the ACE rule faced its own set of legal challenges and was never fully implemented. Additionally, several states and municipalities continued to pursue their own ambitious climate and clean energy goals, irrespective of federal policy changes. These local efforts highlight the importance of subnational action in addressing climate change and driving the transition to clean power.

Looking ahead, the future direction of federal policies and initiatives related to climate change remains uncertain and subject to political dynamics. With the change in administration in 2021, there has been a renewed focus on climate action and a commitment to re-establish the United States as a global leader in combating climate change. The Biden administration has set ambitious goals, including achieving a 100% clean energy economy and net-zero emissions by 2050 (Bailie et al., 2016).

To achieve these goals, the Biden administration has proposed the Clean Energy Standard, which aims to decarbonize the electricity sector by 2035. The plan includes significant investments in renewable energy, energy efficiency, and clean technologies. Additionally, the administration has prioritised rejoining international climate agreements and engaging in global efforts to limit global warming (Bailie et al., 2016).

However, the success of these initiatives depends on various factors, including political will, bipartisan cooperation, and public support. The transition to a clean energy future requires significant investments, technological advancements, and systemic changes across multiple sectors. Overcoming the challenges of resistance from certain industries, ensuring a just transition for affected communities, and addressing regional disparities will be crucial for effective climate policy implementation.

The Clean Power Plan represented an important step towards addressing climate change and reducing greenhouse gas emissions in the power sector. However, it faced limitations and subsequent changes under different administrations.

Continued efforts at the federal, state, and local levels are necessary to drive the transition to clean power and mitigate the impacts of climate change.

3.3. The Paris Agreement

The Paris Agreement is a landmark international treaty that was adopted in 2015 and aims to combat climate change by limiting global warming to well below 2 degrees Celsius above pre-industrial levels. The United States, under the Obama administration, played a crucial role in negotiating and joining the agreement. However, the agreement faced challenges and subsequent changes in federal policies under the Trump administration. Let's analyze the United States' federal policies and initiatives related to climate change, their limitations, and the future direction.

The United States' involvement in the Paris Agreement marked a significant shift in climate policy, signaling a commitment to global climate action. The agreement recognized the need for collective efforts to reduce greenhouse gas emissions and promote sustainable development. Under the Obama administration, the United States pledged to reduce its emissions by 26-28% below 2005 levels by 2025.

However, the Paris Agreement faced limitations in its implementation. One key limitation was the lack of binding enforcement mechanisms. The agreement relies on voluntary commitments from each participating country, known as Nationally Determined Contributions (NDCs), which outline their emission reduction targets and strategies. While the agreement sets a framework for global cooperation, the success of its implementation ultimately depends on the political will and domestic policies of individual countries.

In 2017, the Trump administration announced its intention to withdraw the United States from the Paris Agreement, citing concerns about the potential economic impact on American industries. The decision to withdraw drew criticism from the international community and many states, cities, businesses, and organizations within the United States, which reaffirmed their commitment to the agreement (Yu, 2018; Y. X. Zhang et al., 2017).

However, it is important to note that despite the federal policy shift, various subnational actors in the United States continued to pursue climate action. Numerous states, cities, and businesses set their own emission reduction targets, implemented renewable energy programs, and invested in clean technologies. This demonstrated the importance of subnational action in driving climate progress and mitigating the impacts of federal policy changes.

With the change in administration in 2021, the United States rejoined the Paris Agreement, reaffirming its commitment to global climate action. The Biden administration has set ambitious goals, including achieving a 50-52% reduction in greenhouse gas emissions below 2005 levels by 2030 and achieving a net-zero emissions economy by 2050 (Y. X. Zhang et al., 2017).

To support these goals, the Biden administration has proposed significant investments in clean energy, infrastructure, and research and development. The administration aims to prioritize renewable energy, energy efficiency, electric vehicles, and the decarbonization of the power sector. It also seeks to promote environmental justice and ensure a just transition for affected communities.

The future direction of federal policies and initiatives related to climate change in the United States will depend on various factors, including political dynamics, legislative support, and public engagement. Achieving the ambitious climate goals will require collaboration across sectors, bipartisan cooperation, and sustained investments in clean technologies and infrastructure.

However, challenges remain, including potential resistance from certain industries, regional disparities, and the need to address job losses and economic transitions in fossil fuel-dependent communities. Overcoming these challenges will be crucial for effective policy implementation and the successful transition to a low-carbon economy.

The Paris Agreement represents a significant global effort to address climate change, and the United States' involvement in the agreement has experienced fluctuations due to changes in federal policies. The future direction of federal policies and initiatives related to climate change will depend on political will, public support, and the ability to navigate challenges. Continued commitment to ambitious climate goals, collaboration with international partners, and subnational action will be key in achieving a sustainable and resilient future.

3.4. The Green New Deal

The Green New Deal (GND) is a policy proposal that originated in the United States but has gained global traction. It aims to tackle climate change and economic inequality simultaneously. The US version of the Green New Deal envisions a large-scale investment in clean energy infrastructure, job creation, and a shift to a low-carbon economy. The policy strives to achieve net-zero greenhouse gas emissions while creating well-paying jobs and ensuring a fair transition for workers in industries affected by the move away from fossil fuels (Galvin & Healy, 2020).

Although the specific details and initiatives of the Green New Deal can vary, there are common elements. These include promoting renewable energy sources, implementing energy-efficient technologies, expanding sustainable transportation, supporting sustainable agriculture, ensuring job creation and a just transition, addressing environmental justice concerns, and investing in reforestation and conservation efforts.

It is important to note that the Green New Deal is a proposal and has not been implemented comprehensively at the national level in the United States (Boyle et al., 2021). However, it has sparked debates and influenced climate policy discussions. Various aspects of the Green New Deal have been incorporated into legislative proposals and policy discussions at different levels of government (Mijin Cha et al., 2022).

Looking ahead, the Green New Deal offers an opportunity to shape future federal initiatives on climate change. Key future directions influenced by the Green New Deal include setting ambitious emissions reduction targets, investing in clean energy and infrastructure, prioritizing a just transition and equity, and reevaluating economic models to prioritize sustainability and social well-being (Allam et al., 2022).

As the urgency of the climate crisis becomes more apparent, bold and transformative action is necessary. Although the Green New Deal has not yet become federal policy, its influence is shaping the discourse and highlighting the need for a comprehensive approach to address climate change, economic inequality, and social justice. The future direction of federal initiatives is likely to be influenced by the principles and goals outlined in the Green New Deal as policymakers seek to accelerate the transition to a sustainable and resilient future.

4. State and Local Policies and Initiatives

4.1. Renewable portfolio standards

Renewable Portfolio Standards (RPS) serve as policy mechanisms aimed at fostering the adoption and advancement of renewable energy sources. Typically, these standards require utilities to procure a specified percentage of their electricity from renewable sources within a defined timeframe. Evaluating the effectiveness of RPS policies entails examining their impact on renewable energy deployment, economic aspects, and environmental advantages. The ensuing analysis provides insights into the efficacy of Renewable Portfolio Standards (Feldman & Levinson, 2023).

RPS policies have proven successful in driving the deployment of renewable energy. By establishing specific targets, these policies create a stable and predictable market demand for renewable energy, thereby incentivizing investments in renewable projects. Multiple studies have consistently indicated that states and countries with RPS policies experience significant increases in renewable energy capacity (Ali et al., 2021; Xin-gang et al., 2022; Zhou et al., 2022). The targets set by RPS policies act as catalysts for the growth of renewable industries, leading to a rise in job opportunities and technological advancements within the renewable energy sector.

RPS policies can yield positive economic impacts. They stimulate investment in renewable energy projects, which often necessitate a considerable workforce for construction, operation, and maintenance. Consequently, this can result in job creation and economic growth within the renewable energy sector. Additionally, RPS policies can decrease reliance on imported fossil fuels, enhancing energy security and mitigating price volatility associated with fossil fuels (Upton & Snyder, 2017). However, it is important to note that the cost of complying with RPS policies can vary depending on specific circumstances and the availability of renewable resources in each region.

RPS policies play a crucial role in curbing greenhouse gas emissions and combating climate change. By increasing the proportion of renewable energy in the electricity mix, RPS policies help displace carbon dioxide-emitting fossil fuel-based generation. Furthermore, promoting renewable energy sources through RPS policies contributes to reduced air pollution, improved public health, and decreased dependence on non-renewable resources.

While RPS policies have demonstrated effectiveness in promoting renewable energy, several challenges and limitations warrant consideration. Targets and compliance mechanisms of RPS policies vary across jurisdictions, leading to differing outcomes. In some instances, targets may be too conservative or lack enforcement mechanisms, thus limiting their impact. Additionally, the intermittent nature of certain renewable energy sources, such as solar and wind, presents challenges for grid integration and reliability, necessitating additional investments in energy storage and grid infrastructure (Mamkhezri et al., 2021).

RPS policies are often implemented alongside other complementary measures to maximize their effectiveness. These measures may include feed-in tariffs, tax incentives, grants, and research and development programs. By combining different policy instruments, governments can create an enabling environment for renewable energy development, address market barriers, and expedite the transition to a low-carbon economy (Xin-gang & Yu-qiao, 2021).

Some possible areas for improvement are as follows:

- Standardization and Harmonization: Greater standardization and harmonization of RPS policies across states can create a more cohesive and effective renewable energy market. This could include aligning target-setting methodologies and timeframes.
- Flexibility and Compliance Mechanisms: Providing flexibility in meeting RPS targets through mechanisms like tradable renewable energy credits (RECs) can facilitate compliance, encourage innovation, and reduce costs for utilities.
- Long-Term Planning and Stability: Establishing long-term RPS targets and providing policy stability can enhance investor confidence and attract sustained investment in renewable energy projects.
- Grid Modernization and Storage: Prioritizing grid upgrades, transmission infrastructure development, and energy storage systems can support the integration of renewable energy into the grid, ensuring reliability and maximizing the benefits of RPS policies.
- Equity Considerations: RPS policies should address equity concerns by ensuring that the benefits of renewable energy development are shared across communities, including low-income and marginalized populations.
- Support for Emerging Technologies: RPS policies could be expanded to include support for emerging technologies, such as tidal or geothermal energy, encouraging their development and market integration.
- Collaboration and Knowledge Sharing: States and localities can benefit from sharing best practices, lessons learned, and research findings related to RPS policies, fostering collaboration and accelerating renewable energy deployment.

Overall, Renewable Portfolio Standards have demonstrated their effectiveness in driving renewable energy deployment, stimulating economic growth, and delivering environmental benefits. However, the success of RPS policies depends on various factors, including policy design, regional characteristics, and the availability of renewable resources. To optimize their effectiveness, RPS policies should be accompanied by complementary measures and a long-term commitment to renewable energy development.

4.2. Carbon pricing programs

Carbon pricing programs in the United States play a crucial role in addressing the challenges posed by climate change. These programs aim to reduce greenhouse gas emissions by placing a financial cost on carbon dioxide and other greenhouse gas emissions. By implementing a price on carbon, policymakers aim to incentivize businesses and individuals to adopt cleaner and more sustainable practices, while also encouraging investment in renewable energy and low-carbon technologies. While the United States does not currently have a federal carbon pricing program, several states have taken the initiative to establish their own programs (Raymond, 2019).

One of the most prominent carbon pricing programs in the United States is the Regional Greenhouse Gas Initiative (RGGI). Established in 2009, RGGI is a cooperative effort among ten northeastern states: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont. RGGI employs a cap-and-trade system where participating states set a regional cap on carbon emissions from power plants. This cap is then reduced over time, creating a declining carbon budget. Power plants are required to hold allowances equal to their emissions, and these allowances can be bought, sold, or traded among participating entities. RGGI has successfully reduced carbon emissions from the power sector in the region while generating revenue for member states to invest in renewable energy and energy efficiency programs (Raymond, 2019).

Another notable carbon pricing initiative is the California cap-and-trade program. Established in 2012, this program covers a wide range of sectors, including power generation, transportation, and industry. Similar to RGGI, California's

cap-and-trade program sets a declining cap on greenhouse gas emissions and requires covered entities to hold allowances equal to their emissions. The program also allows entities to trade allowances, creating a market-based approach to reducing emissions. The revenue generated from the sale of allowances is invested in various climate-related initiatives, such as renewable energy projects, public transportation, and assistance to disadvantaged communities impacted by pollution (Raymond, 2019).

Apart from these regional initiatives, some individual states have implemented their own carbon pricing mechanisms. For example, Washington state passed a carbon fee initiative in 2018, which sought to establish a carbon tax on certain fossil fuels and use the revenue to invest in clean energy, water infrastructure, and forest conservation. However, this initiative did not receive enough support and was not implemented. Other states, such as Oregon and New York, have explored the possibility of implementing carbon pricing programs but have not yet taken concrete action (Raymond, 2019).

While progress has been made at the state level, the absence of a federal carbon pricing program in the United States remains a significant gap. A federal carbon pricing policy would provide a consistent and comprehensive approach to address climate change across the country. It could potentially include a carbon tax, cap-and-trade system, or a combination of both (see Table 1). However, the implementation of such a program at the federal level has been challenging due to political and ideological divisions (Hartmann et al., 2023).

Carbon pricing programs in the United States, such as the Regional Greenhouse Gas Initiative and California's cap-and-trade program, have demonstrated the effectiveness of market-based approaches to reducing greenhouse gas emissions. While these regional and state-level initiatives have made notable progress, a comprehensive and coordinated federal carbon pricing program remains a crucial step in addressing climate change on a national scale. Such a program would provide economic incentives for emission reductions, spur innovation in clean technologies, and contribute to the global effort to mitigate climate change (Raymond, 2019).

Table 1 Some state and local carbon pricing programs, policies, and initiatives related to climate change in the United States, along with their progress, limitations, and areas of improvement

Program	Policies/States	Progress	Limitations	Areas of improvement
Regional Greenhouse Gas Initiative (RGGI) (Friesen et al., 2022; Johnson, 2022)	Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, Vermont	RGGI has successfully reduced carbon dioxide emissions from the power sector by around 50% since 2005. It has generated revenue for member states and helped fund energy efficiency programs.	RGGI only covers power sector emissions, leaving out other sectors like transportation and industry. There is a need for broader sectoral coverage to achieve more comprehensive emissions reductions.	Expanding the program to include additional sectors, such as transportation and industry, would increase its impact. Additionally, exploring opportunities for RGGI to collaborate and potentially link with other regional programs can enhance its effectiveness.
California's Cap-and-Trade Program (Raymond, 2019)	California	California's cap-and-trade program has been successful in reducing emissions and providing a significant source of revenue for climate initiatives. It has achieved emissions reductions in covered sectors	Concerns have been raised regarding the program's complexity and potential cost impacts on consumers. Some argue that it may disproportionately affect low-income communities.	Addressing the concerns around program complexity, ensuring a fair and equitable transition for affected communities, and strengthening enforcement mechanisms can improve the effectiveness of

				California's cap-and-trade program.
Individual State Carbon Taxes (Hartmann et al., 2023)	Some states, such as Washington and Vermont, have considered or implemented state-level carbon taxes.	While there has been progress in initiating carbon tax discussions, actual implementation has been limited.	Implementation challenges often arise due to political opposition, concerns about economic impacts, and potential revenue distribution complexities.	Strengthening public engagement, addressing concerns about economic impacts, and exploring revenue distribution mechanisms can facilitate the implementation of effective state-level carbon taxes.
Transportation and Fuel Carbon Pricing Initiatives (Szasz, 2023)	Several states, including California, Oregon, and Washington, have implemented or are considering low-carbon fuel standards, fees on high-carbon fuels, and incentives for electric vehicles.	These initiatives have helped promote the adoption of electric vehicles, reduce carbon-intensive fuels, and encourage the development of cleaner transportation options.	Challenges include scaling up infrastructure, ensuring equitable access to clean transportation options, and addressing potential affordability issues for low-income communities.	Expanding charging infrastructure for electric vehicles, providing financial support for low-income individuals to access clean transportation, and incentivizing the adoption of sustainable transportation options can enhance the impact of these initiatives.
City-Level Initiatives (Carley et al., 2021)	Many cities, such as New York City and Boston, have implemented their own climate action plans, including emissions reduction targets and clean energy initiatives.	Cities have made significant strides in promoting renewable energy, improving energy efficiency, and implementing sustainable transportation initiatives.	Limited jurisdiction and resources can restrict the scope and impact of city-level initiatives. Coordinating efforts with state and federal programs can be challenging	Enhancing collaboration and coordination between cities, states, and federal governments can amplify the impact of city-level climate initiatives. Providing technical and financial support to cities can also facilitate their efforts in addressing climate change.

Overall, some areas of improvement for state and local carbon pricing programs include harmonization and collaboration among jurisdictions, addressing equity concerns and ensuring a just transition, expanding the sectoral coverage of pricing programs, providing long-term policy certainty, and establishing robust monitoring and evaluation systems. It's important to note that the progress and limitations of these programs can evolve over time as they are implemented, and ongoing evaluation and adjustments are necessary to improve their effectiveness in addressing climate change.

4.3. Energy efficiency standards

Energy efficiency standards in the United States are a vital component of efforts to mitigate climate change. These standards aim to reduce energy consumption and promote the use of more efficient technologies and practices across various sectors, including buildings, appliances, transportation, and industrial processes. By improving energy efficiency, the United States can reduce greenhouse gas emissions, lower energy costs, enhance energy security, and create jobs in clean energy industries (Adua et al., 2021).

One of the key areas where energy efficiency standards have been implemented is in buildings. The U.S. Department of Energy (DOE) establishes energy codes and standards for residential and commercial buildings. These codes specify the minimum energy efficiency requirements for new construction and major renovations, including aspects such as insulation, lighting, HVAC systems, and appliances. The DOE periodically updates these standards to keep pace with technological advancements and to further improve energy efficiency. States and local jurisdictions often adopt these codes, sometimes with modifications, to ensure buildings in their regions meet the prescribed energy efficiency criteria (Obekpa & Alola, 2023).

Appliance and equipment standards are another important aspect of energy efficiency efforts in the United States. The DOE, in collaboration with other agencies, sets efficiency standards for a wide range of products, such as refrigerators, air conditioners, water heaters, televisions, and motors. These standards establish the maximum energy consumption or minimum efficiency levels that products must meet to be sold in the market. By setting these requirements, the DOE ensures that consumers have access to more energy-efficient options, which not only reduces energy consumption but also saves money on utility bills. Over the years, appliance and equipment standards have helped drive significant energy savings and emission reductions (Kellogg & Cumbre-Gibbs, 2023).

In the transportation sector, the Corporate Average Fuel Economy (CAFE) standards play a crucial role in improving energy efficiency. The National Highway Traffic Safety Administration (NHTSA) sets these standards, which regulate the average fuel economy of vehicles sold by automobile manufacturers. The standards are periodically updated to raise the average fuel efficiency of new cars, trucks, and SUVs. The latest standards aim to gradually increase average fuel economy to around 54.5 miles per gallon (MPG) for cars and light-duty trucks by 2025. However, it's worth noting that the federal government under different administrations may revise or adjust these standards, which can impact the long-term trajectory of energy efficiency improvements in the transportation sector (Zielinski et al., 2018).

Energy efficiency standards also exist for industrial processes and equipment. The DOE, in partnership with industry stakeholders, develops and promotes voluntary standards and guidelines for various industrial sectors. These standards cover areas such as motors, pumps, compressed air systems, and steam systems. By adopting more energy-efficient technologies and practices, industries can reduce energy waste, lower operating costs, and decrease their carbon footprint (Obekpa & Alola, 2023).

While energy efficiency standards have been effective in reducing energy consumption and greenhouse gas emissions, there are challenges to overcome. One challenge is ensuring compliance and enforcement, as not all products in the market meet the required efficiency standards. Stricter enforcement measures and robust testing and verification procedures are necessary to ensure that non-compliant products are identified and removed from the market.

Another challenge is keeping pace with rapidly evolving technology. As new innovations emerge, it is important for energy efficiency standards to adapt and reflect the latest technological advancements. Regular updates to standards and collaboration with industry experts are crucial to ensure that standards remain relevant, effective, and achievable (Adua et al., 2021).

Overall, energy efficiency standards in the United States are essential for combating climate change and promoting sustainable energy practices. These standards, implemented in buildings, appliances, transportation, and industrial processes, help reduce energy consumption, lower greenhouse gas emissions, and provide economic benefits. Continued efforts to strengthen and expand energy efficiency standards, along with robust enforcement mechanisms and collaboration between government and industry stakeholders, will be crucial in achieving long-term energy savings and significant reductions in carbon emissions.

4.4. Building codes and standards

Building codes and standards in the United States are increasingly incorporating provisions related to climate change and sustainability. Efforts to address climate change through building codes have seen progress in recent years, but there are still limitations and areas for improvement. Here's an analysis of the state of building codes and standards in the United States concerning climate change:

Many states have adopted more stringent energy efficiency requirements in their building codes. This includes provisions for insulation, windows, lighting, and HVAC systems to reduce energy consumption and greenhouse gas emissions. Some states, such as California and New York, have implemented ambitious energy codes that go beyond the national standards. Several jurisdictions have incorporated requirements for renewable energy systems in building codes. This includes mandates for solar panels or other forms of onsite renewable energy generation in new

constructions. For example, California's Title 24 Energy Code requires solar photovoltaic systems in new residential buildings. Building codes are increasingly addressing resilience and adaptation to climate change impacts. This includes measures such as enhanced structural design to withstand extreme weather events, flood-resistant construction techniques, and requirements for stormwater management (Kellogg & Cumbre-Gibbs, 2023).

Building codes have some limitations despite their advancement. Building codes vary across states and jurisdictions, leading to inconsistencies in the level of climate-related requirements. This lack of uniformity can create challenges and hinder progress in addressing climate change at a national level. While progress has been made, the adoption and enforcement of more stringent climate-related building codes are not universal. Some states and jurisdictions have been slower to implement such codes due to various reasons, including cost concerns and political resistance. Building codes primarily focus on new construction, but the majority of the building stock consists of existing buildings. Retrofitting these structures to meet higher energy efficiency and climate resilience standards can be challenging, as it requires significant investments and coordination (Kellogg & Cumbre-Gibbs, 2023).

There are some necessary areas for improvement to consider.

- Uniformity and Consistency: Efforts should be made to promote uniformity and consistency in building codes related to climate change across states and jurisdictions. This could involve adopting model codes at the national level or encouraging states to harmonize their codes with best practices.
- Strengthening Energy Efficiency Standards: There is room for improvement in the stringency of energy efficiency standards across the board. Increasing the requirements for insulation, high-performance windows, efficient lighting, and HVAC systems can significantly reduce energy consumption and carbon emissions.
- Expanded Scope: Building codes can expand their focus beyond energy efficiency to include broader sustainability considerations. This could involve incorporating provisions for water efficiency, material selection, indoor air quality, and lifecycle assessment of buildings.
- Incentives and Support: Governments can provide incentives, grants, or financial support to encourage compliance with climate-related building codes. This can help offset the cost of implementing higher standards, especially for retrofits of existing buildings.
- Education and Training: Building professionals and code officials should receive adequate education and training on climate-related building codes to ensure effective implementation and enforcement.

Overall, progress has been made in integrating climate change considerations into building codes and standards in the United States. However, addressing limitations and focusing on areas of improvement, such as uniformity, stronger energy efficiency standards, expanded scope, incentives, and education, will be crucial to accelerating the adoption of climate-friendly building practices across the country.

5. Private Sector Initiatives

The term "private environmental governance" (PEG) refers to the performance of traditionally governmental duties by private organisations, such as the provision of public goods and the mitigation of undesirable externalities. PEG programmes that aim to reduce climate change have grown quickly in the past ten years and have been the focus of research across many disciplines (Vandenbergh & Johnson, 2021).

The US government in 2022, launched actions and commitments directed at addressing the climate crisis domestically and globally, including new initiatives to support developing countries, catalyze investment, and accelerate clean energy transition. In order to combat the climate crisis, some of these include enhancing global climate resilience, speeding up global climate action, catalysing investment at the scale necessary, and involving all of society (Falkner, 2017).

The U.S. in cooperation with Caribbean and Latin American countries continues to support climate adaptation, resilience, and energy security, as well as the promotion of trade and investment in clean energy and the enhancement of education and workforce development programs. This collaboration addresses the climate crisis 2030 (The White House, 2022).

Thus, it is crucial to concentrate on private rather than public governance because bottom-up private sector initiatives have the advantage of avoiding polarisation and can thus fill in any gaps in existing government climate laws, policies, and programmes while also enhancing existing government action. However, the fact that private sector initiatives are influenced by social and market pressures rather than direct electoral pressures makes them vulnerable to unfavourable outcomes when those pressures conflict with the public interest. The magnitude of the private governance

prospects may also be missed by both private and public policymakers in the absence of a top-down, methodical analysis, which could result in an ineffective distribution of resources. When it comes to money, the private sector is assisting with funding climate adaptation, and the United Nations Development Programme (UNDP) has made increasing private sector funding of adaptation efforts a priority (Padilla & Hudson, 2019).

The private sector's initiatives could be the key to promoting climate action within the political aisle, especially among Republicans and conservatives. Understanding climate change mitigation efforts by the private sector boosted support for lowering carbon emissions across the political spectrum. When conservative and mild readers saw private solutions as practicable and successful, their support for lower carbon emissions increased more. However, caution on tempering concern about climate change issues has been expressed.

5.1. Role of the private sector in addressing climate change

The private sector in the United States of America has been active in the climate change revolution recently. Some specific roles of the private sector in addressing climate change issues in the United States are:

- Setting and achieving voluntary emissions reduction targets: Many private sector actors have committed to reducing their greenhouse gas emissions in line with the goals of the Paris Agreement, either individually or as part of coalitions such as We Are Still In (The White House, 2022). Some examples of companies that have set ambitious targets include Microsoft, which aims to be carbon negative by 2030, and Walmart, which aims to achieve zero emissions across its global operations by 2040.
- Investing in clean energy and low-carbon technologies: The private sector has been a major driver of innovation and deployment of renewable energy sources, energy efficiency measures, electric vehicles, carbon capture and storage, and other solutions that can help mitigate climate change. For instance, Google has been matching its global electricity consumption with 100% renewable energy since 2017, and Tesla has been leading the market for electric cars and batteries (Ansah & Sorooshian, 2019).
- Supporting climate resilience and adaptation: The private sector has also been involved in enhancing the capacity of communities and ecosystems to cope with the impacts of climate change, such as extreme weather events, sea level rise, droughts, and wildfires. For example, Starbucks has been working with coffee farmers to improve their practices and livelihoods in the face of changing climate conditions (Ansah & Sorooshian, 2019).
- Advocating for climate action and policy: The private sector has also played a role in influencing public opinion and decision-making on climate change issues, both domestically and internationally. For example, Apple has been vocal in supporting the U.S. re-joining the Paris Agreement, and Amazon has been lobbying for a federal carbon tax. Additionally, some private sector actors have joined forces with civil society and government partners to advance climate action initiatives, such as the Renewable Energy in Latin America and the Caribbean (RELAC) initiative and the 100,000 Strong in the Americas Climate Initiative (100K CLIMA) (Syropoulos & Markowitz, 2022).

The private sector is stepping up where many federal governments are falling short because it is in their own self-interest, and it is an opportunity to create an emotional connection to values-based customers. Many companies now incorporate climate-action and sustainability goals in their affairs. Though, putting a system that allows for accomplishing a fully decarbonized economy is proving enormously difficult, there would still be some form of global carbon tax or regulatory regime.

5.2. Corporate social responsibility programs

Corporate social responsibility has, so far, focused on integrating economic, environmental, social, and governance concerns into the business operations, affairs, and interactions of companies and their stakeholders (United Nations, 2023). Below are some corporate social responsibility programs, with respect to improving climate change in the United States, that have been considered in recent times. Some of these programs are also currently ongoing.

- Carbon neutrality and net zero emissions: Many corporations have committed to reducing their greenhouse gas emissions to zero or below by a certain date, either by improving their energy efficiency, switching to renewable sources, investing in carbon capture and storage, or offsetting their emissions through nature-based solutions or carbon credits. For example, Microsoft has pledged to be carbon negative by 2030 and remove all its historical emissions by 2050, while Walmart has set a goal of achieving zero emissions across its global operations by 2040 (Velasco Vizcaíno et al., 2021).
- Climate risk disclosure and reporting: Many corporations have voluntarily disclosed and reported their climate-related risks and opportunities to their stakeholders, following frameworks such as the Task Force on Climate-related Financial Disclosures (TCFD) or the Carbon Disclosure Project (CDP). These disclosures help

corporations to assess their exposure to physical, transition, and liability risks from climate change, as well as to identify potential solutions and strategies to mitigate them (Bose & Hossain, 2022).

- Climate advocacy and policy: Many corporations have also engaged in advocacy and policy efforts to support climate action and regulation at various levels of government, either individually or as part of coalitions or initiatives. These efforts aim to influence public opinion and decision-making on climate change issues, as well as to demonstrate corporate leadership and commitment. For example, Amazon has been lobbying for a federal carbon tax and has joined the Climate Leadership Council, a bipartisan group of business and civic leaders that advocates for a carbon dividend plan (Mendoza-Vasconez et al., 2022).
- Climate resilience and adaptation: Many corporations have also implemented programs and projects to enhance their own resilience and adaptation to the impacts of climate change, as well as to support their suppliers, customers, communities, and ecosystems in coping with these impacts. These programs and projects may involve improving infrastructure design and maintenance, developing contingency plans and emergency response systems, diversifying supply chains and markets, investing in insurance and risk management solutions, or providing technical assistance and capacity building. For example, Starbucks has been working with coffee farmers to improve their practices and livelihoods in the face of changing climate conditions (Feldmeyer et al., 2019).

5.3. Sustainable business practices

Setting and achieving science-based emissions reduction targets: Many businesses have committed to align their greenhouse gas emissions with the goals of the Paris Agreement, which aim to limit global warming to well below 2°C, preferably to 1.5°C, compared to pre-industrial levels. These targets are based on the best available science and require businesses to reduce their emissions across their entire value chains. For example, Microsoft has pledged to be carbon negative by 2030 and remove all its historical emissions by 2050 (Lathabhavan, 2022).

Investing in renewable energy and energy efficiency: Many businesses have invested in renewable energy sources, such as solar, wind, and hydro, to power their operations and reduce their dependence on fossil fuels. Some businesses have also joined initiatives such as RE100, which aims to bring together companies committed to 100% renewable electricity. Additionally, many businesses have implemented energy efficiency measures, such as LED lighting, smart thermostats, and green buildings, to lower their energy consumption and costs. For example, Google has been matching its global electricity consumption with 100% renewable energy since 2017.

Developing and adopting low-carbon technologies and solutions: Many businesses have been innovating and deploying low-carbon technologies and solutions that can help mitigate climate change and create new markets and opportunities. These technologies and solutions may include electric vehicles, batteries, carbon capture and storage, bioplastics, plant-based proteins, and circular economy models (W. Zhang et al., 2022).

Engaging with stakeholders and advocating for climate action: Many businesses have been engaging with their stakeholders, such as customers, employees, suppliers, investors, regulators, and communities, to raise awareness and mobilize action on climate change issues. Some businesses have also been advocating for climate action and policy at various levels of government, either individually or as part of coalitions or initiatives. These efforts aim to influence public opinion and decision-making on climate change issues, as well as to demonstrate corporate leadership and commitment (Gillis et al., 2021).

5.4. Clean energy investments

Clean energy investments are necessary to help the environment through preservation. A number of some possible investments in clean energy initiatives are outlined below.

- Tax credits and incentives for renewable energy and battery storage: A significant $370 billion investment was made to tackle the climate crisis as part of the US's 2022 Inflation Reduction Act. By 2030, houses, companies, and communities can all use clean energy thanks to tax credits and other incentives provided by the Inflation Reduction Act. These tax credits and incentives are expected to leverage roughly $1.7 trillion in new private investment in clean energy manufacturing and deployment.
- Research and development for clean energy innovation: The US Department of Energy (DOE) supports research and development for a wide range of clean energy technologies, such as solar, wind, hydro, geothermal, nuclear, hydrogen, carbon capture and storage, and biofuels. The DOE also funds national laboratories, universities, and private sector partners to advance scientific discovery and technological innovation in clean energy. For example, the DOE announced $128 million in funding for 75 research projects on solar energy in 2020 (Laird, 2011).

- Investment in clean energy infrastructure and grid modernization: The US needs to upgrade its aging and vulnerable electricity infrastructure and grid to accommodate the increasing penetration of renewable energy sources and distributed energy resources. This requires investment in transmission and distribution lines, smart grid technologies, microgrids, energy storage systems, electric vehicle charging stations, and cybersecurity measures. For example, the Biden administration has proposed $100 billion for grid modernization and resilience as part of its American Jobs Plan (In et al., 2022).
- Partnership and cooperation with other countries on clean energy: The US is also investing in clean energy cooperation and collaboration with other countries, especially those that are major emitters of greenhouse gases or have significant renewable energy potential. This includes providing financial and technical assistance, sharing best practices and lessons learned, supporting multilateral initiatives and platforms, and engaging in bilateral and regional dialogues and agreements. For example, the US re-joined the Paris Agreement on climate change in 2021 and hosted the Leaders' Summit on Climate with 40 world leaders (Paramati et al., 2017).

5.5. Evaluation of the effectiveness of private sector initiatives

So far, these initiatives employed are still in process, and effectiveness will be measured on par with the climate-action goals that the US President Biden announced in 2021.

No definite solutions have been ruled as entirely effective but the sustainable business practices, clean energy initiatives, corporate social responsibility programs, and other general contributions by the private sector have been large contributors to moving closer to achieving these goals.

5.6. Discussion of Challenges Facing the Implementation and Effectiveness of Climate Change Policies and Initiatives in the United States

The multidimensional nature of climate change necessitates the examination of a range of social, economic, ethical, and political concerns to develop effective response strategies. As it pertains to this chapter, we recognize certain challenges that are distinctively associated with climate change and must be accounted for in the formulation of the nation's response strategies. There are a multitude of obstacles impeding the development of tenacity to climate change at the local, regional, and national levels, including complications in decision-making, insufficient resources, institutional limitations, and variations in risk perception, cultural values, and beliefs. The chapter highlights some of the obstacles posed by climate change that must be considered in shaping the nation's response strategies.

The comprehension of costs and benefits related to different courses of action is deficient: The decisions made with regards to actions that are aimed at limiting or adapting to climate change have qualities that make the analysis of such actions incredibly difficult. For example:

The expenses associated with constraining or accommodating to climate change are widely acknowledged to be more definite. However, divergent presumptions, including the rate at which recent technologies are innovated and implemented into the market, could potentially result in considerably distinct inferences concerning the expenses of such measures.

Actions aimed at mitigating the risks associated with climate change incur immediate costs, however, the benefits they bring will be evident elsewhere, impacting the future generations. The United States is significantly impacted by climate change, especially in low-lying island nations and other regions. This underscores the urgency of taking action to alleviate the effects of climate change in these areas. Even within the country, the immediate beneficiaries of short-term measures to reduce climate change risks are future generations who will be spared from severe consequences in the coming decades and beyond. Economists and other stakeholders have raised issues about the usefulness of conventional discounting techniques in assessing public benefits, particularly in the context of climate change, which necessitates balancing trade-offs across multiple generations.

Consideration must be given to collateral costs and benefits. The interdependence among Earth's physical systems, such as the atmosphere, oceans, land surface, and freshwater, along with the ecological and human social systems, holds great significance. Modifying one system can have ripple effects on others, and endeavors aimed at mitigating or adapting to climate change can lead to unforeseen outcomes, both advantageous and disadvantageous. The enhancement of freshwater efficiency to increase a community's resilience to climate change can also assist in addressing natural variations in water supply. The challenges in predicting multiple interactions pose difficulties in assessing the incidental costs and benefits when evaluating the costs and benefits of climate change response measures.

Multiple sources have noted that the initiation and sustainability of adaptation efforts face a significant obstacle due to the insufficiency of resources for various stakeholders (BM et al., 2014; Carmin et al., 2012; De Bremond et al., 2014; Edmondson & Levy, 2013; Keener et al., 2012) which hinders the progress of climate adaptation planning, implementation, and evaluation. The shortage of financial resources and personnel to effectively identify, implement, monitor, and sustain adaptation efforts is widespread, with limited funding available from resource managers, municipalities, states, and regional councils of governments. The availability of funding is often in the form of a one-time injection of capital as opposed to a continuous revenue stream, exemplified by initiatives like the American Recovery and Reinvestment Act and the Partnership for Sustainable Communities program, which are jointly administered by HUD, DOT, and EPA. The lack of comprehensive, coordinated, and sustained multi-year funding continues to be an obstacle to stakeholders' ability to advance climate adaptation planning, implementation, and evaluation, as observed by various sources ("Alaska Native Villages: Limited Progress Has Been Made on Relocating Villages Threatened by Flooding and Erosion," 2011; Brunner & Nordgren, 2012; Garfin et al., 2013) The absence of additional funding is a significant barrier to adaptation activity, given the prevailing budgetary constraints and competing priorities, as noted by various sources (Staudinger et al., 2012).

According to multiple sources (Pourmokhtarian et al., 2022; Water, Food, Energy Clim. Nexus, 2016; Lofgren and Gronewold, 2012), decision-making fragmentation hampers the effectiveness of climate change adaptation. Various government agencies and companies often bear responsibility for managing specific resources, with diverse regulations and incentives shaping their management and utilization. The lack of coordination among federal, private, and non-governmental entities, along with the fragmentation of responsibilities, poses obstacles to climate change adaptation. Additionally, the proliferation of redundant and sometimes conflicting adaptation data, tools, and resources serves as an additional barrier, as noted by various sources. Fragmentation in jurisdictional control also represents a significant challenge in enhancing the resilience of systems that span jurisdictional boundaries, such as transportation systems and ecosystems. Stakeholders often feel overwhelmed by the abundance and complexity of available information due to fragmentation in research efforts and data production from the physical and social sciences, as well as the policy environment, as observed by various sources (Scarth, 2013).

Preparing for the impacts of climate change requires a multifaceted approach that involves adaptable systems and approaches like adaptive management (C., 2006, Kai N. Lee. Compass and Gyroscope—Integrating Science and Politics for the Environment. Washington, DC: Island Press, 1993, ISBN 1-55963-197-X (cloth), 1-55963-198-8 (pbk.), 243 pp., $24.95 (cloth 1996); Nelson, Adger, and Brown, 2007; Mann et al., 2008). However, many existing institutional structures lack the flexibility necessary for effective responses to a dynamic and changing climate. For example, current regulations and laws often have rigid frameworks or are based on principles that assume a non-changing climate, which can impede the use of flexible strategies required for climate change preparedness. This includes the absence of clear legal mandates to consider climate conditions and impacts on decision-making processes. Barriers to current adaptation efforts can also arise from past decisions, institutions, or infrastructure (Carpenter and Brock, 2012; Bozeman, Bozeman, and Theis, 2020). Restrictive management procedures within systems such as biodiversity conservation and emergency management can further hinder progress in adaptation activities.

In addition to institutional limitations, the dearth of political guidance can pose a substantial obstacle to furthering resilience-building methodologies (Shea, 2003; Zou, Zhang, and Cheng, 2021). The presence of resolute political leadership and advocates for adaptation are often regarded as pivotal factors that contribute to the triumph of many adaptation endeavors. The nonexistence of sturdy political guidance and established political frameworks can hinder progress. Furthermore, adaptation processes and policies that are executed through Executive Orders by one administration, but not integrated into legislation, can be annulled by subsequent administrations (Peterson, McKinstry, and Dernbach, 2008). Additionally, despite the mounting potency and certitude of scientific evidence pertaining to climate change, public surveys indicate a noteworthy level of political polarization concerning climate change.

Divergent perceptions of risk, cultures, and values present formidable challenges to the pursuit of climate action. Owing to disparities in individual and collective cultures, values, and experiences, there exist divergent views on the hazards associated with the impacts of climate change (Kahan et al., 2011; Leiserowitz, 2006; Verweij et al., 2006). These discrepancies may result in polarization and stalemate when making decisions regarding preparing for long-term climate variability and change. While some prioritize climate adaptation and mitigation, others do not (Adger et al., 2009; Kahan et al., 2011; Renn, 2011). It is crucial to transcend this gridlock and cultivate collaborative and inclusive processes for implementing climate adaptation. At present, the lack of familiarity with integrating local knowledge and needs with traditional scientific information hampers adaptation efforts and capacity building in many regions of the nation. Cultural taboos, resistance to change, and psychological impediments further impede climate action.

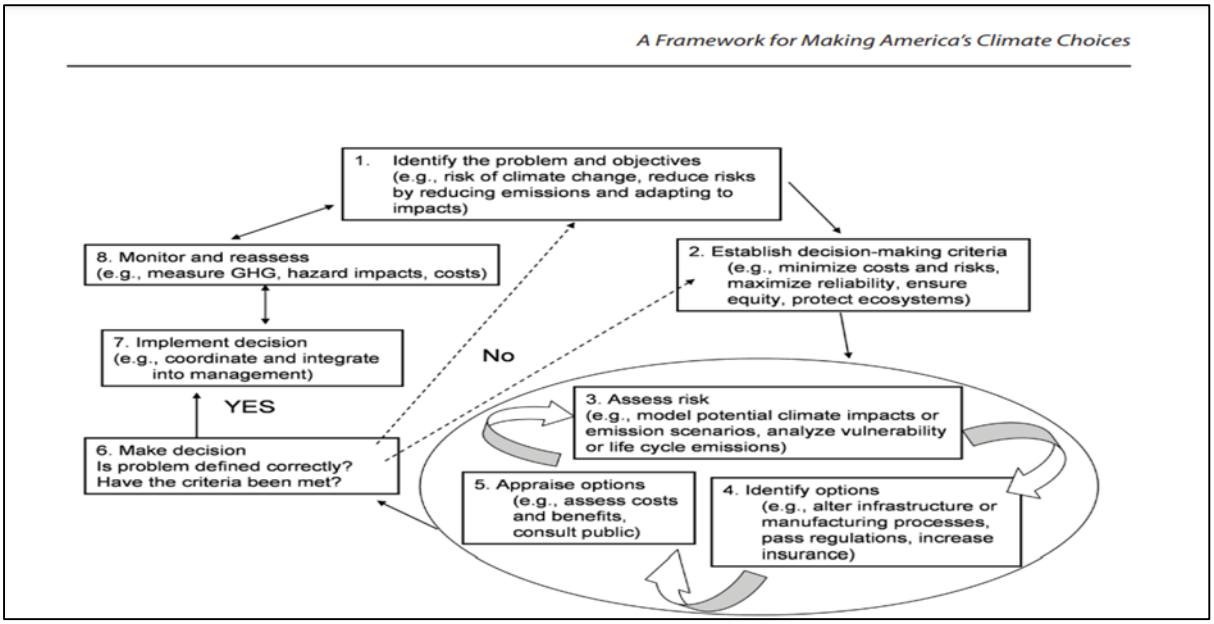
There are various factors that hinder the public's understanding of climate change, resulting in obstacles and complexities. A comprehensive grasp of climate change is of paramount importance to curb greenhouse gas emissions and advance adaptation, as it serves as the foundation for devising policies that align with public sentiment. Even scientific experts encounter difficulties in fully comprehending climate change primarily due to the voluminous data and intricate mathematical models involved. Individuals with limited exposure in analyzing quantitative data and time constraints may resort to dubious sources for information. Firsthand experiences have a profound impact on one's perception of their immediate surroundings, which can lead to misconceptions about climate change. Discriminating long-term changes from natural variability is a challenging task without sustained and systematic measurement, and assessments pertaining to various phenomena are often heavily influenced by salient and recent extreme events.

People employ various cognitive frameworks to comprehend complex phenomena, but some of these prevailing models used to understand climate change do not align with scientific knowledge. For instance, there is a notable confusion among a significant number of individuals who mistake greenhouse gases (GHGs) for other types of air pollutants, such as sulfur or nitrogen oxides, which disperse rapidly when emissions are reduced. Furthermore, even individuals with higher education, including many science undergraduates, tend to underestimate the necessary reductions in CO2 emissions to systematically stabilize atmospheric concentrations. Many people rely on secondary sources of information, with the media being the most common one. Unfortunately, some of these sources can be influenced by organized campaigns that oppose policies aimed at limiting CO2 emissions, thus perpetuating beliefs about climate change that lack solid scientific evidence. In the United States, media coverage often creates confusion by presenting climate change as a subject of serious scientific debate, despite its wide acceptance within the research community. The increasing polarization of public beliefs about climate change in the United States is influenced by these factors, often aligning with political ideologies. Public understanding of climate change is significant as it influences decision-making at all levels of society, from individual actions to national policies. Therefore, it is crucial to identify and address the factors that hinder public understanding of climate change. Enhancing science communication and education are essential for disseminating accurate information about climate change to the public. Additionally, reducing political polarization and countering disinformation campaigns will play a crucial role in enhancing public understanding of climate change.

Identification of Opportunities to Improve the Effectiveness of Climate Change Policies and Initiatives.

Throughout history, humans have often approached environmental changes in an ad hoc manner, responding to situations as they arise. However, contemporary methodologies and approaches have been developed to allow decision-makers to systematically analyze complex problems. One such approach is the precautionary principle, which prioritizes the prevention of potentially severe or irreversible environmental damage, even in the presence of significant scientific uncertainties. On the other hand, the "staying the course" approach involves refraining from acting until the need for it is firmly established and the consequences are well understood. Additionally, tools like cost-benefit analysis and related instruments are commonly used to assess the potential outcomes of taking or not acting, using a common metric often expressed in terms of monetary values discounted to present-day equivalents.

In the context of climate change, it is crucial to employ risk management strategies through the framework of "adaptive governance." This approach emphasizes the importance of fostering effective collaboration among institutions and stakeholders involved in climate change response, facilitating the exchange of information among decision-makers across different levels and sectors, regularly reviewing and adjusting decisions based on new information, and designing policies that can adapt to changing circumstances while maintaining long-term effectiveness. The significance of adaptive governance in addressing climate change is evident in Figure 1, which highlights its pivotal role in navigating and managing environmental challenges. By implementing these methods and strategies, policymakers can systematically and efficiently address complex environmental issues, thereby ensuring a sustainable future for generations to come.



SOURCE: Adapted from R. I. Willows and R. K. Connell, Climate Adaptation: Risk, Uncertainty, and Decision Making, UKCIP Technical Report (Oxford, UK: UK Climate Impacts Programme, 2003).

Figure 1 A depiction of the stages involved in an iterative risk management approach to tackle climate change

The objective of this inquiry is to furnish a thorough comprehension of the pivotal elements that necessitate consideration when devising strategies to tackle the issue of climate change. Moreover, its aim is to accentuate the significance of conducting recurring assessments to guarantee the triumphant execution and realization of climate-related pursuits such as:

The objective of addressing the pressing and urgent issue of climate change is to proactively anticipate and mitigate the associated hazards. A crucial and fundamental benefit that is sought in the combat against climate change is the potential for risk reduction. This objective can be accomplished by reducing the likelihood of adverse events occurring, as well as by diminishing vulnerability to such events, ideally achieving both objectives. Evaluating the potential reduction in risk, despite being a daunting task, is a crucial factor in the decision-making process in this domain. However, it is vital to recognize that in certain scenarios, response options may decrease some risks while concurrently increasing others, necessitating trade-offs. For instance, promoting the use of air conditioning to adapt to higher summer temperatures may undermine efforts to limit climate change if the additional electricity required is generated by sources that emit greenhouse gases. Nevertheless, in some cases, an option may offer complementary risk reduction benefits.

Due to the uncertainties and subjective judgments involved in assessing various risks related to climate change, some analysts have developed methodologies that integrate the perspectives of multiple experts. While certain response options may effectively reduce risks, others may inadvertently escalate them, necessitating the consideration of trade-offs among different risk factors. Actions that may not directly mitigate risks in the present can create opportunities for future options that have the potential to significantly reduce risks. However, it is imperative to recognize that certain options may restrict or constrain future possibilities for risk reduction. Although the field of risk analysis furnishes valuable guidance for estimating the potential for risk reduction, the complexity, and uncertainties inherent in decision-making regarding climate change require the utilization of approaches that synthesize the judgments of numerous experts.

Assessing the efficacy of each measure in mitigating climate change risks is an imperative undertaking. Addressing climate change necessitates consideration of the technical, economic, and political factors at play. Additionally, the dearth of information available to determine the feasibility of tidal energy technologies is noteworthy. In situations where an alternative offers considerable risk reduction but entails high costs and uncertain efficacy, it may be judicious to conduct further research or pilot testing to alleviate uncertainties linked to its implementation. Evaluating both feasibility and efficacy is also pivotal when evaluating policy instruments. To appraise the effectiveness of diverse policy approaches, it is advantageous to scrutinize a plethora of information sources. This encompasses perusing pertinent literature, scrutinizing experiences of local and state governments, examining initiatives in foreign nations, and assessing analogous programs executed by the United States federal government. Studies such as the Regional

Greenhouse Gas Initiative, the European Union's emissions trading system, and the acid rain cap-and-trade program under the Clean Air Act endow valuable insights and benchmarks to evaluate the efficacy of cap-and-trade programs in actual-world contexts.

In the context of resource constraints, policymakers must consider both cost and cost-effectiveness while assessing response alternatives. The analysis of cost-effectiveness signifies that various options have the potential to achieve comparable levels of risk reduction. In such cases, decision-makers tend to opt for alternatives with lower costs, assuming similar potential effectiveness. Conversely, cost-benefit analysis endeavors to identify the optimal risk mitigation strategy that balances expenses with societal advantages. The effectiveness of cost-benefit and cost-effectiveness evaluations is constrained within the scope of climate-related decisions. The complexities of the interconnected systems, uncertainties in future costs and benefits, and the long-term impacts of climate change pose challenges to these evaluation approaches. The consideration of cost and cost-effectiveness should be balanced with other factors like environmental impacts, social equity, and long-term sustainability when making decisions related to climate change. Some alternatives may incur disproportionate costs compared to their potential risk reduction, rendering them impractical, particularly if they lead to widespread business closures or other unfavorable economic impacts. As such, cost considerations should be viewed as one element of the overall "feasibility" criterion.

On the contrary, certain alternatives may be vindicated by their favorable economic returns or incidental benefits, even in the absence of their climate-related merits. To effectively tackle climate hazards, it is of utmost importance to consider the incidental costs and benefits associated with every potential approach. It is crucial to understand that certain decisions made to alleviate climate-induced hazards may have the potential to negatively impact other national priorities, such as ecosystem services, human health, and national security. As an illustration, the utilization of nuclear energy can elevate the hazards linked with nuclear proliferation, while allocating more agricultural land for bio-fuels production may imperil ecological systems and food security. Conversely, certain policies intended to mitigate or adapt to climate change may generate significant co-benefits. For instance, enhancing energy efficiency to cut down on greenhouse gas emissions can also pacify emissions of conventional pollutants. Alleviating greenhouse gas emissions in the transportation sector can lessen the country's reliance on petroleum, mitigating vulnerability to volatile oil prices and supply disruptions. In addition to reducing carbon emissions, the adoption of soil and forest management techniques can also have secondary benefits, such as curbing nutrient runoff, soil erosion, and the depletion of habitats. However, policymakers must evaluate the potential co-benefits of various alternatives when making a choice among alternative approaches for mitigating climate hazards.

Equitable and just considerations hold utmost importance in the assessment of public policy alternatives for climate change. The allocation of responsibilities between developed and developing nations is a matter of global apprehension, along with the aspect of inter-generational equity. Domestically, the distributive effects of climate change measures and emissions reduction policies are being deliberated, particularly in relation to their impact on households with low incomes. These households, consuming less energy and contributing proportionally less to emissions, are more susceptible to energy price fluctuations. Their limited disposable income constrains their capability to invest in energy-conservation measures. Low-income households are anticipated to experience a greater impact from climate change compared to other socioeconomic groups.

When considering climate choices in the United States, it is essential to factor in the international aspect. Solely reducing U.S. emissions is insufficient to avert the dangers of hazardous climate change. For a consistent approach, equivalent actions need to be taken by all significant emitters. Therefore, when assessing response alternatives nationally, it is crucial to incorporate the potential impact of American climate policies on other nations' actions. To reduce greenhouse gas emissions in the United States, policymakers should focus on research and development initiatives that consider the global perspective, especially in clean energy technology. These initiatives possess the potential to notably diminish overall climate risk, an outcome that surpasses measures that concentrate solely on U.S. emissions.

To mitigate the uncertainty surrounding technological advancements, societal changes, and the impacts of climate change, it is advisable to pursue response options that demonstrate resilience to a variety of potential future scenarios. Employing a risk management strategy of hedging by pursuing multiple response options can help ensure a robust and flexible approach when confronted with uncertainty regarding future outcomes. This can be illustrated by investing in diverse new energy technologies to meet future demands and challenges.

Ensuring resilience can be attained by designing infrastructure for transportation, water, and utilities that can endure diverse weather extremes, including heavy precipitation, flooding, and prolonged dry spells. Strengthening general adaptive capacity is crucial through the implementation of early warning systems and disaster response preparations. The efficacy of potential policy measures is contingent upon a range of factors, including their extent, rigor, and

classification. For example, an auto fuel efficiency standard that is too weak may be cost-effective and politically feasible but may not effectively reduce climate-related risks. Conversely, an excessively stringent standard may be expensive, raise equity concerns, and encounter implementation challenges. Therefore, attaining equilibrium is imperative for the successful implementation of efficacious and proficient measures to alleviate and adapt to climate change.

In the process of decision-making, multiple criteria are considered, and their respective significance is evaluated, which may vary among decision-makers, while coping with uncertainties is also a crucial element of this process. Although the ranking of different response actions based on criteria can provide valuable insights, it may not always result in a definitive preferred course of action or strategy. Nevertheless, it establishes a basis for decision-makers to form sound judgments and engage in well-constructed debates. The decision sciences provide several techniques to aid decision-makers in assessing choices and making trade-offs. These tactics promote a more structured and thorough approach to decision-making.

6. Conclusion

This comprehensive review has shed light on the effectiveness of climate change policies and initiatives in the United States. Through an examination of various strategies and actions taken at the federal, state, and local levels, we have assessed their impact on mitigating greenhouse gas emissions, promoting renewable energy adoption, and building resilience to climate impacts.

Overall, the findings indicate a mixed picture of progress and challenges. While the United States has made significant strides in implementing climate change policies and initiatives, there are areas where improvements are needed. The review highlighted the importance of robust and comprehensive policies that address multiple aspects of climate change, including mitigation, adaptation, and transition to a low-carbon economy.

One of the key observations from this review is the significant role played by subnational actors, such as states, cities, and businesses, in driving climate action. In the absence of strong federal leadership during certain periods, these entities have stepped up to fill the gap and demonstrate ambitious commitments towards reducing emissions and adopting sustainable practices. This bottom-up approach has shown promise and should be further encouraged and supported.

Furthermore, the review underscores the necessity of international collaboration to address the global nature of climate change. While the focus of this paper has been on the United States, it is crucial to recognize that climate change is a shared challenge requiring collective efforts. Engaging in international agreements and partnerships, such as the Paris Agreement, will be instrumental in achieving meaningful and long-lasting solutions.

Future Outlook

Looking ahead, several key considerations emerge for the future of climate change policies and initiatives in the United States. First and foremost, sustained political will and leadership are essential for implementing effective and ambitious climate action. Consistent and long-term commitment at all levels of government is crucial to drive transformative change.

Additionally, there is a need for enhanced coordination and collaboration among different stakeholders, including government agencies, businesses, civil society organizations, and communities. By fostering partnerships and leveraging diverse expertise, innovative solutions can be developed and implemented more effectively.

Technological advancements and scientific research will continue to play a vital role in shaping climate change policies. Investments in renewable energy, energy efficiency, and clean technologies should be prioritized to facilitate the transition to a low-carbon economy. Continued support for research and development in these areas will be necessary to unlock new opportunities and drive sustainable growth.

Furthermore, addressing climate justice and equity must be at the forefront of climate change policies. Vulnerable communities, including low-income populations and marginalized groups, often bear the brunt of climate impacts. Ensuring that policies are inclusive, equitable, and prioritize the needs of these communities will be crucial in building resilience and achieving climate justice.

In conclusion, while there have been notable achievements in climate change policies and initiatives in the United States, the urgency and scale of the challenge require further action. By building on the lessons learned from the past and

embracing a collaborative, inclusive, and forward-looking approach, the United States can contribute significantly to global efforts to mitigate climate change and secure a sustainable future for generations to come.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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