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The U.S. Federal Strategies Supporting the Transition to Renewable Energy: A Study of Incentives, Legislation, and Institutional Initiatives

Hiba Ali Touama[1], Ahmed Hussein Shuheil[2]

Abstract

The United States plays a major role in global energy dynamics as a leading producer and consumer. The U.S. has advanced a several federal strategies to support the transition toward renewable energy. The strategies included legislative measures, financial incentives, institutional actions, and national programs to indorse the deployment of clean energy technologies. Although existing literature have addressed individual aspects of such U.S. efforts, limited attention was given to the way they operate collectively. This study aims to examine the U.S. legal and institutional frameworks, financial and tax incentives, and major national programs introduced to support the renewable energy sector. The study focuses on key legislative acts, including the Bipartisan Infrastructure Law, the Inflation Reduction Act, and the CHIPS and Science Act, as well as flagship initiatives. The study also provides a clear understanding of the federal actions coordination to achieve net-zero emissions and a carbon-free electricity by 2035.

Keywords: *U.S. Federal Strategy, Renewable Energy, Government Incentives, Environmental Legislation, Energy Security.*

Introduction

The renewable energy revolution came as a response to the increasing environmental and economic challenges and their direct impact on the global development (Jaafar & Nasser, 2023). Climate change reflections on the global security is the main driver of this transition toward renewable energy (Al-Hayali, 2024). These measures are expected to decrease the damage, which continues to threaten the eco-system and destroy potentials for sustainability (Hawraa & Mustafa, 2022). In light of climate change concerns, serious steps and policies that encourage a gradual shift toward low-carbon energy systems supported by renewable technologies have been globally adopted (Tawfiq, 2024). Among industry-driven nations, renewable energy is increasingly positioned as an essential part of economic stability (Maryam Ali & Jassim Mohammed, 2021). Consequently, clean energy occupies a central place in foreign policy planning and broader geopolitical interactions (Nahla & Ibrahim, 2021).

With the global population expected to reach 9.7 billion by 2050, the need to keep up with the increasing energy demand using reliable and sustainable sources is inevitable. Accordingly, international efforts have increased to support the advancement of renewable technologies that promise energy diversification and greater security, while also reducing the environmental and public health risks associated with conventional energy producing systems (Qadir et al., 2021). However, recent geopolitical instability, such as the Russia-Ukraine conflict, alongside the increasing frequency of climate-related disasters, has exposed the vulnerability of existing

[1] Department of International Studies, College of Political Science, University of Baghdad, Baghdad, 10071, Iraq, Email: heba.Ali2201@copolicy.uobaghdad.edu.iq, (Corresponding Author)
[2] Department of International Studies, College of Political Science, University of Baghdad, Baghdad, 10071, Iraq.

energy systems and emphasized the necessity of expediting the shift toward more sustainable and resilient models (Lulu, 2026; Okeke, 2025).

In light of these developments, renewable energy is increasingly being treated as a foundation for sustainable development. It has been credited with the potential to mitigate longstanding ecological issues while creating new economic opportunities (Kitakufe et al., 2024). Consequently, many governments have intensified their focus on reducing these emissions, formalizing their commitment through the United Nations Framework Convention on Climate Change. This international recognition reflects a growing consensus on the need for comprehensive strategies to combat climate change and promote sustainability (Divrik, 2025).

The availability of energy remains essential to meeting basic human needs and supporting economic activity. If challenges such as poverty and lack of access to energy are to be addressed, existing models of energy production and use will have to be reconsidered. These models often impose serious health and environmental costs, especially in low-income and vulnerable areas (Khalaf, 2019; Leffta, 2018). Therefore, coordinated international efforts will be needed, supported by innovation and long-term planning rooted in knowledge-sharing (Mushib, 2023b; Mahdi & Ghantab, 2019). Given that a significant share of emissions continues to come from the housing, transport, and industrial sectors, expanding renewable technologies in these areas is widely considered a necessary step toward achieving a more stable environmental balance (Mushib, 2023a).

As one of the world's largest energy producers and consumers, the United States is often looked to as a reference point in matters of global energy governance. For this reason, the U.S. federal strategy on renewable energy warrants close attention. In this study, the approaches adopted by the U.S. government to improve the renewable energy sector are examined to provide a broader understanding of local incentives, legislation, and institutional initiatives that shape the ongoing energy transition.

Historical Context and Federal Strategic Direction in Renewable Energy

Few decades ago, the U.S. depended intensively on coal, oil, and natural gas to meet its energy needs. Concerns about air pollution, carbon emissions, and long-term ecological damage grew, gradually shifting the national conversation. By the early 2000s, new developments in technology and reductions in the cost of renewable systems made alternatives like solar, wind, and hydropower more accessible. The shift toward renewable energy gained momentum as awareness of environmental risks increased and as economic conditions made clean energy more viable (Fache et al., 2025; Zohuri, 2023).

The role of the U.S. in this global transition is shaped by its domestic capacity and its position on the world stage. The U.S. produces and consumes more energy than most countries, and it has the influence to affect international energy trends. At the same time, the U.S. is responsible for a large share of the global emissions. A successful transition could help reduce the risks associated with climate change, including strong storms, sea level rise, health hazards, and displacement caused by environmental stress (Koranyi, 2016).

The direction of federal energy policies has changed many times with the change in the political leadership. In 2009, during the Obama administration, energy reform became a part of the response to the financial crisis. The American Recovery and Reinvestment Act (ARRA) set aside more than $90 billion for clean energy and infrastructure projects (Tang, 2024). Support was extended to renewable power generation, including wind, geothermal, and small-scale

hydroelectric systems. Incentives were introduced through programs like Clean Renewable Energy Bonds and Qualified Energy Conservation Bonds to attract investments. Other provisions encouraged building upgrades and expanded tax benefits for electric vehicles and fuel-efficient technologies (Brass et al., 2009).

In 2013, the Obama administration unveiled the Climate Action Plan, which imposed limits on greenhouse gas emissions and enhanced the regulatory powers of the Environmental Protection Agency (EPA). By targeting energy efficiency in the built environment and transportation, the plan contributed to measurable declines in emissions (Gao, 2024). The 2015 decision to join the Paris Agreement further affirmed the country's commitment to international climate objectives. This momentum was reversed during the Trump administration, which withdrew from the agreement due to concerns about its economic and sovereignty implications (Weiss, 2021).

A major policy reversal occurred after the 2020 election. The Biden administration re-entered the Paris Agreement and introduced what has been described as the most ambitious climate policy agenda in U.S. history (TheWhiteHouse, 2021b). Legislative advances such as the CHIPS and Science Act, the Infrastructure Investment and Jobs Act, and the Inflation Reduction Act (IRA) marked a shift toward a long-term institutional commitment. These initiatives secured significant funding for clean energy development and laid the groundwork for systemic reform (Gao, 2024).

In support of global climate commitments, the United States has pledged, in coordination with other major emitters, to reduce greenhouse gas emissions substantially. Since the majority of national emissions stem from fossil fuel-based energy production, the expansion of renewable energy stands as a central pillar of the federal strategy (TheWhiteHouse, 2024). Key policy instruments include financial incentives, tax credits, Renewable Portfolio Standards (RPS), and significant investment in research and development (Xu, 2024).

The federal government has committed to achieving a fully clean electricity sector by 2035. Reaching this goal will require fundamental changes across the energy system. The Department of Energy (DOE) has introduced a ten-point action plan to support this transformation. The plan includes strengthening the reliability of existing clean energy infrastructure; increasing the deployment of mature technologies; advancing carbon management solutions; upgrading transmission and distribution networks; investing in communities historically dependent on fossil fuels; reforming grid planning and operational systems; enhancing system security; improving energy efficiency and demand-side flexibility; reinforcing domestic manufacturing and supply chains; and developing a skilled, inclusive workforce to ensure an equitable energy transition (IEA, 2024).

Renewable Energy Incentives in the United States

The United States has adopted a group of policies and incentives, coordinated among the federal government, state authorities, and electric utility companies to enforce the transition to renewable energy. These financial, regulatory, market-based, and legislative incentives serve as essential tools to stimulate investment in clean energy production and consumption. Listed is an overview of the key programs and incentives currently in place:

Federal Financial Incentives

The federal government provides a suite of direct financial incentives aimed at accelerating the deployment of renewable energy projects across the U.S. Among these is the Production Tax

Credit (PTC), which offers a per-kilowatt-hour credit for electricity generated from qualifying renewable sources. On the residential level, the Residential Energy Credit incentivizes homeowners to adopt solar energy technologies by offering income tax benefits for system installation. In addition, the Modified Accelerated Cost Recovery System (MACRS) facilitates rapid depreciation of renewable energy-related capital assets, thereby improving the financial attractiveness of such investments and boosting long-term project returns (IEA, 2022a).

For qualifying facilities that began operation after December 31, 2021, PTC offers a corporate tax benefit of up to 1.5 cents per kilowatt-hour for electricity produced from sources such as landfill gas, open-loop biomass, municipal solid waste, and small-scale irrigation systems. A higher credit of up to 2.75 cents per kilowatt-hour applies to electricity produced from wind, closed-loop biomass, and geothermal energy. The credit remains available for a period of ten years following the start of service. For these larger projects, the tax credit begins at a lower rate, 0.3 or 0.55 cents per kilowatt-hour, depending on the energy source, but eligibility for the full credit is restored when the labor requirements are satisfied (EPA, 2024).

The ITC is a federal policy that provides a 30% tax credit for residential and commercial solar energy systems placed in service through 2032. Enacted under the Energy Policy Act of 2005 and extended by the IRA 2022, the ITC reduces tax liability by covering eligible expenses such as panels, inverters, mounting structures, installation, and permitting (SEIA, 2022).

The Residential Clean Energy Credit is a federal tax incentive designed to encourage homeowners to invest in renewable energy technologies (IRS, 2025). The MACRS is the primary depreciation method employed in the United States to facilitate capital cost recovery for businesses. This accelerated depreciation framework allows for higher deductions in the initial years of an asset's life, thereby improving cash flow and incentivizing capital investments (IEA, 2017).

Renewable Portfolio Standards (RPS)

Many states enforce Renewable Portfolio Standards that require utility companies to make some share of their electricity generated by renewable sources. While some states impose these standards as mandatory obligations, others adopt voluntary targets (IEA, 2022b). By 2015, 29 states and the District of Columbia had adopted mandatory RPS policies, while an additional eight states had established non-binding renewable energy goals. These programs have collectively driven the addition of over 46 gigawatts of non-hydro renewable capacity between 1998 and 2013, representing approximately 61% of total capacity additions during that period. While wind power has historically dominated RPS compliance, accounting for 78% of new additions, recent trends show growing contributions from solar, particularly in states that have introduced solar or distributed generation (DG) carve-outs. Many RPS programs are structured to allow flexibility and cost control through credit multipliers, tiered resource classes, and geographic eligibility rules. Compliance is typically tracked using Renewable Energy Certificates (RECs), which serve as tradable instruments verifying that electricity was generated from eligible renewable sources. These mechanisms enable utilities to meet targets efficiently, even when local generation is limited (EPA, 2015).

Renewable Energy Certificates (RECs)

RECs are financial instruments that represent one megawatt-hour of electricity generated from a renewable source. These certificates help utility companies meet legal obligations under state RPS policies and are also voluntarily purchased by companies seeking to improve their

environmental and reduce their carbon footprint. RECs are also known as "green certificates" or "clean energy credits" (IEA, 2022b). They are legally recognized instruments used in both compliance markets, where utilities meet Renewable Portfolio Standards, and voluntary markets, where organizations demonstrate environmental leadership. RECs are the only valid proof of renewable energy use under U.S. law, as confirmed by the EPA and various state agencies. Their ownership determines who can claim the environmental benefits of renewable electricity, while selling electricity without the RECs ("null power") forfeits the right to make green claims. Accredited tracking systems, such as Green-e® and PJM-GATS, help prevent double counting and ensure credibility (Mcfall et al., 2023).

Feed-in Tariffs (FITs)

Some states have implemented feed-in tariff schemes to incentivize renewable electricity generation by offering rates higher than those for conventional electricity. FITs system provides financial certainty for investors by making renewable energy projects more attractive and bankable (IEA, 2022b). FITs have been widely used to accelerate renewable energy deployment by offering long-term contracts at fixed or premium rates per kilowatt-hour, thereby reducing investment risk and encouraging private-sector participation. According to the National Renewable Energy Laboratory (NREL), effective FIT design includes technology-specific pricing, long-term price stability, and guaranteed grid access, which together enhance bankability and attract financing (Cox & Nrel, 2016).

Support for Biofuels and Alternative Vehicle Fuels

Federal and state-level policies collectively support the growth of the biofuel industry through a range of regulatory and financial mechanisms. One of the central tools is the establishment of mandatory annual production quotas by the Environmental Protection Agency (EPA), which ensures a baseline level of biofuel integration into the national energy mix. To further stimulate production, financial incentives are extended to manufacturers, agricultural producers, and biofuel refiners, to further encourage investment throughout the supply chain. At the state level, policy frameworks promote sustainable transportation alternatives, aiming to reduce reliance on fossil fuels and foster the adoption of lower-emission fuel sources (IEA, 2022b).

Research and Development (R&D) Funding

The U.S. Department of Energy (DOE) allocates annual budgets to support research and development in renewable energy technologies, in partnership with universities, research institutions, and the private sector. These investments focus on next-generation technologies, system efficiency improvements, and cost reductions. In addition to these core programs, U.S. renewable energy policy relies on a variety of regulatory and market-based tools that help accelerate the energy transition. Among the most significant is Net Metering, a mechanism that allows residential solar system owners to sell excess electricity back to the grid, encouraging decentralized generation and consumer participation. Carbon pricing is also used to help cut emissions. Tools like carbon taxes and cap-and-trade systems make renewable energy projects more cost-effective. In addition, clean energy producers can earn extra income by selling renewable RECs in the market (Sharma, 2024a). Public awareness campaigns further promote sustainable energy consumption and clean energy adoption (Sharma, 2024b).

Tax incentives and green bonds played key roles in advancing clean energy, though they operate in different ways. Tax incentives are one of the government's main tools to support clean energy development by reducing costs for producers and investors (Sapar & Kusuma, 2025). On the

other hand, green bonds serve as a way to raise capital for larger-scale clean infrastructure. Issued by governments or private companies, green bonds generate funds specifically for projects that cut emissions and improve energy use. Green bonds often support efforts in sectors like sustainable buildings, transport, agriculture, and waste management (Hughes-Cromwick et al., 2025).

Federal-Led Programs Accelerating Renewable Energy Deployment

The U.S. federal government has implemented a diverse range of programs aimed at supporting the national transition to renewable energy. These programs deliver financial incentives, technical support, and policy guidance across sectors. Each initiative targets a specific domain of clean energy advancement (Karaeva et al., 2023).

Green Power Partnership (GPP)

The GPP is one of the cornerstone voluntary programs supporting the country's clean energy transition. The program incentivizes institutions, public and private, to procure electricity from renewable sources and report their usage in relation to overall consumption. Since its inception, the GPP has played a central role in mainstreaming voluntary green electricity purchasing and standardizing associated reporting practices. According to the 2025 update, the GPP expanded its eligibility to include some nuclear energy projects to support a shift toward carbon-free, though non-renewable, technologies in select voluntary procurement programs. While the inclusion of nuclear power has raised definitional questions, the GPP maintains that such additions are clearly distinguished and carefully regulated. In addition, a new pilot initiative has been launched to acknowledge green power purchases used to address Scope 3, Category 11 emissions, those linked to the electricity consumption of sold products (EPA, 2025). Finally, the EPA has retired the Green Power Communities initiative to reallocat resources to expand guidance and toolkits that can more effectively support local governments in their renewable energy goals (EPA, 2025).

AgSTAR Program

The AgSTAR Program is also a key federal initiative promoting the deployment of anaerobic digestion (AD) systems on farms. The program supports the conversion of livestock waste and other organic feedstocks into renewable biogas, thereby reducing methane emissions and contributing to sustainable energy generation in rural and agricultural settings.The program functions primarily through outreach, education, and technical support, targeting farmers, developers, and policy stakeholders. By consolidating technical best practices and policy-relevant considerations, AgSTAR aligns well with federal goals to decarbonize the agricultural sector, improve manure management, and promote circular bioeconomy models. It also enhances the bankability of projects by offering insights into financial planning and market opportunities, especially in light of incentive programs like the Low Carbon Fuel Standard (LCFS) and Renewable Fuel Standard (RFS). In recent literature, the AgSTAR framework has been positioned as a model for replicable methane mitigation initiatives. Studies suggest that supporting AD deployment at small to mid-sized farms, especially through co-digestion with food waste, can scale biogas production while preserving economic viability in less concentrated agricultural regions (EPA, 2020).

As of June 2024, the EPA's AgSTAR Program reports the operation of approximately 400 manure-based anaerobic digestion (AD) systems across the US. These systems are predominantly located on dairy farms (343 systems), followed by hog (50), poultry (8), and beef

operations (9), with some facilities processing manure from multiple livestock types. The widespread implementation of AD systems reflects a significant federal effort to mitigate methane emissions and support renewable energy production within the agricultural sector. In 2023 alone, these systems collectively avoided 14.8 million metric tons of CO_2 equivalent emissions, while generating approximately 3.29 million megawatt-hours of renewable energy, underscoring their environmental and energy contributions. A steady upward trend in AD adoption is evident, with annual increases in operational projects from 270 in 2020 to 400 by mid-2024 (EPA, 2024).

RE–Power America's Lands Initiative

The RE–Powering America's Lands Initiative, led by the U.S. Environmental Protection Agency's Office of Land and Emergency Management, represents a strategic federal effort to facilitate renewable energy development on formerly contaminated lands, landfills, and mine sites. By aligning energy redevelopment projects with local community visions, the initiative transforms underutilized or environmentally compromised sites into productive assets for clean energy generation. As of October 2022, the program had tracked 502 renewable energy installations across 47 states and territories, collectively contributing more than 2.4 gigawatts (GW) of installed capacity. These projects yield a variety of community-level benefits, including reduced electricity costs, job creation, and new streams of tax revenue. Notable examples include the 6.5 MW solar installation at French's Landfill in New Jersey, projected to save Brick Township approximately $13 million in energy costs over 15 years, and the 2.0 MW Greenfield Solar Farm in Massachusetts, which created around 50 local construction jobs and delivered substantial municipal savings (EPA, 2023b).

The program operates through three core goals: (1) providing technical and programmatic assistance to expedite clean energy deployment; (2) promoting policy frameworks and best practices that support renewable energy use on contaminated lands; and (3) leveraging partnerships and federal funding to scale impact. The initiative maintains a strong collaborative relationship with the NREL and has developed tools such as a national mapping database of over 190,000 potentially contaminated sites, helping stakeholders identify viable locations for energy redevelopment (EPA, 2023b).

Landfill Methane Outreach Program (LMOP)

LMOP is a voluntary initiative that promotes the capture and beneficial use of landfill gas (LFG) to reduce methane emissions and support renewable energy generation. As landfills are the third-largest source of anthropogenic methane emissions in the U.S., LMOP plays a critical role in managing greenhouse gases while simultaneously unlocking economic opportunities from waste-derived biogas. LMOP works closely with local governments, landfill operators, developers, and energy users to facilitate the development of LFG energy projects that capture methane generated through the anaerobic decomposition of organic waste in municipal solid waste landfills and convert it into usable energy in the form of electricity, thermal power, or renewable natural gas (RNG). As of 2021, over 550 LFG energy projects were operational across 48 states and one territory, collectively reducing an estimated 107 million metric tons of CO_2-equivalent emissions annually. Approximately 70% of which generate electricity, 17% support direct thermal use, and 13% produce RNG (EPA, 2024).

Combined Heat and Power Partnership (CHP Partnership)

Established by the U.S. Environmental Protection Agency (EPA), the Combined Heat and Power Partnership (CHP Partnership) is a longstanding federal initiative that promotes the use of highly efficient cogeneration systems to advance energy savings and emissions reduction goals. In 2011, the program published its landmark report highlighting the opportunities for CHP deployment at wastewater treatment facilities (WWTFs) (EPA, 2011). The report underscored not only the environmental and operational benefits of on-site energy production, but also the economic feasibility of CHP systems, particularly for large treatment plants with steady thermal loads and access to digester gas. Building on this foundation, the 2019 report on CHP in the multifamily housing sector expanded the program's scope into residential energy resilience. It documented 395 operational multifamily CHP systems nationwide, with a majority located in the Northeastern United States. These systems were estimated to reduce over 430,000 tons of CO_2-equivalent emissions annually, while providing reliable electricity and thermal energy to residents, an especially critical advantage during grid outages or extreme weather events (LLC, 2019).

In 2021, the EPA issued an updated Fuel and Carbon Dioxide Emissions Savings Methodology for CHP systems. This document provided a standardized framework for calculating the emissions reductions and energy savings achieved by CHP installations. These results are based on national fuel averages and grid efficiency data from EPA's eGRID database. The 2021 methodology has since served as the basis for tools like the CHP Energy and Emissions Savings Calculator (CEESC), used by developers, facility managers, and policymakers to evaluate project feasibility and report emissions benefits (EPA, 2021).

In addition to its technical and sectoral efforts, the CHP Partnership has also supported regulatory innovation to reduce institutional barriers to project deployment. One major area of progress has been the streamlining of air permitting processes for CHP systems. Traditionally, obtaining air permits posed delays and high compliance burdens, particularly for smaller installations. In response, several states, most notably Connecticut, New Jersey, and Texas, developed Permits by Rule (PBR) and General Permits (GP) as alternatives to conventional site-specific air permits. These frameworks provide standardized, pre-approved conditions for eligible CHP systems, simplifying the approval process while maintaining compliance with air quality standards (EPA, 2014). While each state adapted the model differently, all relied on rigorous air quality modeling to set emission thresholds, stack height requirements, and system size limits. New Jersey developed separate general permits for engines and turbines, tied to its broader target of achieving 1,500 MW of CHP capacity. Texas introduced PBR and standard permits, supported by legislative action and collaboration with industry stakeholders (EPA, 2014).

Energy Star Program

The ENERGY STAR Program is a voluntary labelling and certification program launched in 1992 to identify and promote energy-efficient products, buildings, and practices. The ENERGY STAR label now appears across more than 80,000 product models, spanning 75 residential and commercial categories, and is recognized by nearly 90% of the American households. Its influence extends across the residential, commercial, and industrial sectors. To date, more than 2.7 million ENERGY STAR certified homes and apartments have been built, including 190,000 in 2023 alone, representing more than 12% of new U.S. housing stock (EPA, 2023).

The program's cumulative impact is substantial. In 2020 alone, its emissions reductions accounted for more than 5% of total U.S. GHG emissions, with additional air pollutant

reductions valued at $7–17 billion in public health benefits (EPA, 2023a). ENERGY STAR continues to evolve through initiatives such as the NextGen certification for electric homes, expanded product categories, and updated performance criteria. These efforts are now reinforced by federal incentives under the Inflation Reduction Act, which ties energy-efficient home tax credits to ENERGY STAR certification standards (EPA, 2023a).

National Climate Commitments and Sectoral Strategies

National climate goals in the U.S. are pursued through a collection of sectoral strategies that reflect the legal and institutional structure of federal governance. The following section outlines the broader climate commitments and the plans targeting specific areas such as energy, transport, and industry, and offer a view of climate actions coordinated across different sectors:

U.S. Nationally Determined Contribution (NDC)

The U.S. has introduced what is known as the Fair Share Nationally Determined Contribution (NDC) as part of its climate vision for 2035 (Natalie et al., 2024). The NDC came up a range of policies and initiatives that place renewable energy at the center of a just transition to a low-carbon economy. The NDC outlines a transformative overhaul of the national energy system that aims to decarbonize key sectors and promote sustainability by advancing the development of carbon-free hydrogen and supporting carbon capture technologies that adhere to rigorous environmental standards. The NDC also focuses on expanding the use of zero-emission vehicles while modernizing electric vehicle charging infrastructure. In the transportation sector, the NDC promotes the adoption of low-carbon renewable fuels for maritime and aviation industries. To reduce building emissions, the NDC calls for improved energy efficiency through the use of electric heating and cooking technologies, alongside the adoption of sustainable building codes (UNFCCC, 2021).

America's Strategy to Secure the Supply Chain

America's Strategy to Secure the Supply Chain strategy was lunched by the department of energy in 2022 to tackle the growing challenges in the clean energy sector. The strategy focuses on building supply chains that are not only diverse and resilient but also environmentally sustainable. At its core, the strategy envisions a clean energy economy that stimulates growth and enhances public health. For achieving these goals, the strategy uses a range of implementation tools, including grants, loans, tax incentives, support for foreign direct investment, and workforce training programs tailored to emerging industries (Igogo, 2022).

Strengthening American Leadership in Clean Cars and Trucks

As part of its broader climate agenda, the United States is steering its transportation future toward zero-emission technologies. At the heart of this strategy is an ambitious goal: by 2030, half of all new cars and trucks sold should be clean vehicles. This vision encompasses a diverse mix of battery-electric, plug-in hybrid, and hydrogen fuel cell models. But technology alone won't drive the shift, robust regulatory standards and widespread electric charging infrastructure are critical pillars of this transition. To ensure sustainability and competitiveness, the plan also fuels innovation and investment across the domestic automotive manufacturing sector, which lay the groundwork for long-term leadership in clean mobility (Presidential Documents, 2012) .

Federal Sustainability Plan

Framed as a cornerstone of the Biden Administration's climate vision, this federal sustainability plan stands as one of the boldest national commitments to environmental leadership. It charts a clear path forward: by 2030, the federal government aims to run entirely on carbon-free electricity, with at least half of that sourced from 24/7 clean power. By 2035, every vehicle in the federal fleet is expected to be zero-emission. Buildings, too, are set to transform, with a goal of reaching net-zero emissions by 2045 and halving building-related emissions by 2032. The strategy extends its reach to procurement, targeting net-zero emissions across all federal purchasing by 2050 (TheWhiteHouse, 2021a).

Landmark Legislation Advancing U.S. Renewable Energy

The United States has enacted a series of landmark federal laws that form the legal foundation for its clean energy transition. These laws span multiple domains, including infrastructure, domestic manufacturing, and innovation promotion. The most significant of these laws is covered in this section:

Bipartisan Infrastructure Law (BIL)

The passage of the BIL in 2021 marked a transformative moment in U.S. clean energy policy (Donohoo-Vallett et al., 2023). With more than $62 billion directed to the Department of Energy, the law seeks to catalyse domestic manufacturing of clean technologies, improve national energy efficiency, and secure a sustainable, resilient energy future. Among its key investments, $7 billion was earmarked to bolster the battery supply chain, crucial for electric vehicles and storage technologies, while $1.5 billion supports the scale-up of clean hydrogen production. To strengthen the power system's reliability, the BIL allocated $11 billion to enhance grid resilience against climate and cyber threats, alongside $3 billion to modernise the grid through smart technologies that facilitate decentralised renewable integration. Additionally, the law reinforces existing infrastructure, dedicating $6 billion to sustaining nuclear power operations and $700 million to enhancing hydropower efficiency (2023).

CHIPS and Science Act

Although primarily enacted to revitalise the U.S. semiconductor industry, the CHIPS and Science Act of 2022 holds substantial implications for the renewable energy landscape. By fostering domestic innovation and reducing dependence on foreign technology, the Act indirectly fortifies the broader clean energy transition. It provides $52.7 billion in funding, including $39 billion in manufacturing incentives and $13.7 billion for research and development, laying the groundwork for a technologically sovereign future. A 25% tax credit further incentivises capital investments in semiconductor and related equipment manufacturing. Noteworthy investments include Micron's $40 billion commitment to domestic memory chip production and a $4.2 billion collaboration between Qualcomm and GlobalFoundries to expand facilities in New York. While not explicitly a climate policy, the CHIPS Act complements federal energy strategies by securing critical components of the renewable technology supply chain and reinforcing U.S. leadership in clean-tech innovation(USMissionKorea, 2022) .

Inflation Reduction Act (IRA)

The Inflation Reduction Act (IRA), passed in 2022, stands as the most sweeping federal initiative ever enacted to confront climate change in the United States. Its reach extends across the full energy value chain, from upstream raw material sourcing to downstream consumer incentives, positioning it as a cornerstone of the nation's decarbonization strategy (Bistline et al., 2023)

(USDepartmentoftheTreasury, 2022). With an unprecedented $369 billion allocated to clean energy investments, the Act sets an ambitious goal of cutting greenhouse gas emissions by 40% by 2030 relative to 2005 levels. It incentivizes industrial sectors to adopt low-carbon technologies, supports transportation electrification through tax credits for clean vehicles and charging stations, and drives building decarbonization via energy efficiency upgrades and low-emission appliances. In parallel, the Act dedicates $21 billion to advancing climate-smart agriculture and forest conservation, and an additional $5 billion to wildfire mitigation and community climate resilience. Importantly, the IRA promotes domestic manufacturing of clean energy technologies and charges the U.S. Department of the Treasury with ensuring that tax credit administration aligns with principles of environmental justice. By embedding equity at its core, the Act aims to ensure that the economic, health, and environmental benefits of the clean energy transition are equitably distributed, especially among historically underserved communities(USDepartmentoftheTreasury, 2022) .

Innovation Pathways and Strategic Blueprints for Future Clean Energy

In addition to federal legislation, the United States has launched several executive initiatives and national plans aimed at accelerating the transition to clean energy from multiple dimensions including innovation, battery development, and industrial decarbonization:

Energy Earthshots Initiative

The U.S. Department of Energy's Energy Earthshots Initiative, launched in 2021, embodies a bold vision for accelerating breakthroughs in clean energy innovation. Designed to drive down the costs of transformative technologies, the initiative targets key bottlenecks across energy production, storage, and consumption, laying the groundwork for a zero-emission economy. Each "shot" within the program sets a clear and measurable target: the Hydrogen Shot aims to reduce the cost of clean hydrogen by 80%, reaching $1 per kilogram within a decade. The Long Duration Storage Shot seeks a 90% cost reduction for energy storage systems lasting over 10 hours, while the Carbon Negative Shot aspires to make carbon dioxide removal and permanent storage achievable at under $100 per metric ton. Other ambitious goals include slashing the cost of Enhanced Geothermal Systems by 90% to $45 per megawatt-hour by 2035 and cutting Floating Offshore Wind energy costs by over 70% within the same timeframe. Additionally, the Affordable Home Energy Shot focuses on social equity, aiming to halve the cost of home energy upgrades and reduce utility bills by more than 20% for low-income households. Together, these Earthshots signal a strategic push toward scalable, affordable, and equitable clean energy solutions (Granholm, 2021) .

National Blueprint for Lithium-Based Batteries (2021–2030)

The National Blueprint for Lithium-Based Batteries (2021–2030), released by the U.S. Department of Energy in 2021, presents a comprehensive strategic framework to position the United States as a global leader in battery innovation and supply chain resilience. With lithium-based technologies at the heart of the clean energy transition, powering everything from electric vehicles to grid storage, the blueprint prioritizes the creation of a secure, sustainable, and competitive domestic battery ecosystem. Central to the roadmap is the effort to secure reliable access to raw materials while minimizing dependence on geopolitically sensitive minerals such as cobalt and nickel. It also emphasizes the development and commercialization of next-generation battery technologies, particularly solid-state systems that promise higher performance and safety. Equally important is the scaling of domestic manufacturing capacity for

battery cells, electrodes, and integrated packs. Finally, the blueprint ties technological progress to ethical imperatives, encouraging electric vehicle adoption alongside robust labour protections and environmental safeguards (DOE, 2022).

U.S. Industrial Decarbonization Roadmap

Industrial decarbonization has become a focal point of U.S. climate strategy, particularly in sectors that are notoriously difficult to abate. The roadmap centres on reducing emissions in key industries, chemicals, iron and steel, cement, and petroleum refining, that together account for 51% of industrial CO_2 emissions and 15% of total U.S. emissions across the economy. Tackling these sectors requires a layered approach: electrification is set to replace conventional thermal processes; biofuels and low-carbon hydrogen are being scaled to substitute fossil-based inputs; and sweeping improvements in industrial energy efficiency are being pursued. At its foundation, the strategy relies on deep investments in research and innovation to enable the structural shifts needed to reach net-zero emissions across U.S. industry by 2050 (DOE, 2022).

Conclusion

This study demonstrates that the U.S. federal strategies support the renewable energy sector has evolved beyond being a purely technical agenda. Instead, it now constitutes a central pathway for reorganizing the nation's economic and productive structures. The integration of clean energy policies with industrial sovereignty, strategic autonomy, and supply chain resilience signals an implicit redefinition of energy's role within the U.S. national security framework. The findings suggest that the clean energy transition is being utilized as a strategic lever to rebalance federal-state relations through the equitable distribution of investments, local manufacturing programs, and co-financing mechanisms, a dimension that has been underexplored in existing literature. The American experience further reveals the rise of an "industrial logic" within climate policy, where environmental discourse is increasingly framed within the priorities of competitiveness and technology-driven growth. Therefore, the U.S. strategy is not only a strong response to the urgent need for energy transition but also shows a broader change in how the views the link between energy and power. Such change could strongly affect future ways of governing, both in the U.S. and globally, especially in the context of climate change and the global move toward a green economy.

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Declaration of Competing Interest

There is no conflict of interest to disclose.

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