A Comprehensive Economic Analysis of Renewable Energy in the United States

The SPRING Group

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2. Executive Summary

Over the past decade, grand progress has been experienced regarding the adaptation and implementation of renewable sources of energy. Concerns with unsustainable sources of energy have begun to become increasingly pressing issues, with organizations such as the United Nations or the International Renewable Energy Agency (IRENA) congregating to implement global policies to fight the climate crisis. Specifically, global dependency on fossil fuels has become a prominent source of criticism, as the burning of these sources of energy has contributed to 75% of global greenhouse gas emissions.[1] To combat current reliance on fossil fuels, numerous organizations have promoted a transition into renewable energy.

Global warming and greenhouse gas emissions are topics of importance to the SPRING Group. As an organization composed of students who are young adults, we have been exposed to both the fossil fuel crisis and the renewable energy transition of the 21st century. Especially as the next generation of global citizens who will be responsible for caring for the planet, our concern lies in the current policies that define our current relationship with our environment, and the future world we will have to live with.

As part of our continued goal to highlight youth viewpoints on issues of concern to them, SPRING seeks to bring the unique perspectives of students into global policies to implement more sources of renewable energy. This paper analyzes the economic implications of renewable energy, pulling from four U.S. domestic policies that involve the integration of renewable energy. It then offers a stakeholder analysis of how renewable energy integration may affect specific actors from a variety of scopes and then provides general economic analyses of the benefits and drawbacks of renewable energy.

[1] United Nations, n.d.

3. Background

Economic legislation targeting renewable energy has a lengthy history in the U.S., beginning more than a half-century ago with the Clean Air Act of 1970.[2] Since then, Congress has continued to invest in renewable energy, mostly in the form of tax credits.

From 2005 until 2015, the U.S. Federal Government spent $51.2 Billion on financial incentives for wind and solar energy, of which 89.5% came in the form of tax credits.[3] The other 10.5% is split between credit incentives ($1.3 billion) and grants for research and development ($4 billion).[4]

3.1 Energy Policy Act of 1992

The Energy Policy Act of 1992 reduced U.S. reliance on oil and improved air quality by focusing on both the supply and demand of energy.[5] The law introduced regulations to encourage the use of renewable energy, including a requirement for governments to acquire alternative fuel vehicles.[6]

The law also created a definition of alternative fuels that has since been used and amended by future laws on renewable energy, including the Energy Policy Act of 2005 and the Inflation Reduction Act of 2022. The definition encompassed a wide variety of fuels derived from biological materials, ranging from ethanol and other alcohols to less environmentally friendly options, such as natural gas and coal-derived liquid fuels.[7]

3.2 Energy Policy Act of 2005

The Energy Policy Act of 2005[8] created grant programs to promote renewable energy within the U.S., along with the development of new testing initiatives to further alternative fuels and the production of fuel-efficient vehicles.[9]

The law also amended regulations outlined in the Energy Policy Act of 1992 on fuel economy testing requirements at the federal and state levels.[10]

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[2] Department of Energy, n.d.
[3] Kirshenberg et al., 2018
[4] ibid
[5] Energy Policy Act of 1992
[6] Department of Energy, n.d.
[7] ibid
[8] Energy Policy Act of 2005
[9] Department of Energy, n.d.
[10] ibid

3.3 Clean Power Plan of 2015

The Clean Power Plan of 2015[11] was a set of regulations aimed at reducing carbon emissions by regulating existing power plants in the U.S., creating the nation's first standards for carbon pollution from electricity generation.

The regulations required that states establish standards of performance or other measures for fossil fuel-fired electric generating units to reduce carbon pollution.[12] These included an emission standards plan, which required power plants to meet emissions performance rates, and a state measures plan, which included renewable energy standards and programs to improve residential energy efficiency at a state level.[13]

The EPA further determined that the best system of emissions reduction would consist of three "building blocks" under the Clean Power Plan: (1) improving the heat rate of existing coal power plants to reduce carbon intensity, (2) increasing electricity generation from low-emitting power plants to replace generation from high-emitting plants, and (3) creating and using new renewable energy plants.[14]

In 2022, the Supreme Court ruled 6-3 in *West Virginia v. EPA* that the Clean Power Plan of 2015 (and similar efforts from the EPA) were unconstitutional because it was not given "clear congressional authorization" to adopt the Clean Power Plan.[15] Rulings like *West Virginia v. EPA* underscore the importance of congressional action in addressing and regulating clean energy within the U.S.

3.4 Inflation Reduction Act of 2022

The Inflation Reduction Act created and expanded a number of financial incentives for renewable energy, providing $369 billion in funding for climate and clean energy provisions.[16][17] Most of the funding is directed towards a variety of tax credits for electric vehicles and renewable energy, including the Clean Vehicle Tax credit, Previously Owned Clean Vehicles Tax Credit, Qualified Commercial Clean Vehicles Tax Credit, Alternative Fuel Refueling Tax Credit, and Advanced Energy Project Credit.

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[11] Environmental Protection Agency, 2017
[12] ibid
[13] ibid
[14] ibid
[15] Soronen, 2022
[16] Inflation Reduction Act of 2022
[17] Mahajan et al., 2022

The law also features significant investments in U.S.-based manufacturing of renewable energy, increasing renewable energy production domestically.[18] Current projections suggest that the law is likely to reduce domestic carbon emissions by 42% from 2005 levels, compared to just 26% with frozen policies by 2030.[19] This investment has substantial economic and humanitarian impacts, creating an estimated 140 million jobs and saving 3,600 lives by 2030.[2021]

Importantly, the law came towards the end of the COVID-19 pandemic, which itself had substantial impacts on renewable energy investments. Disruptions to the global supply chain and the diverting of resources towards fighting the public health emergency led to a stall in renewable energy investments, with only 6% of stimulus spending directed towards carbon-cutting initiatives.[2223]

3.4 Regulation Portfolio Standards

Renewable Portfolio Standards and Clean Energy Standards are regulations for energy producers and providers to supply energy from low-carbon or renewable emission sources.[24] These standards can exist as either enforced requirements or unenforceable goals.

Renewable Portfolio Standards are in effect in 28 U.S. states and the District of Columbia, and 11 states have a Clean Energy Standard in place.[25] Of those, 17 states and the District of Columbia have a requirement or goal for 100% renewable or clean energy by 2050 or earlier.[26] A Renewable Fuel Standard also exists at the federal level for transportation fuels.[27]

States both with and without Renewable Portfolio Standards and Clean Energy Standards have increased their renewable energy electricity generation since Iowa became the first state to issue either standard in 1983,[28] largely due to federal

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[18] ibid
[19] Jenkins et al., 2022
[20] Mahajan et al., 2022
[21] ibid
[22] Johns Hopkins University, 2022
[23] Nahm et al., 2022
[24] Energy Information Administration, 2024
[25] Database of State Incentives for Renewables & Efficiency, 2023
[26] ibid
[27] Energy Information Administration, 2024
[28] Congressional Research Service, 2021

regulations and incentives (such as the Energy Policy Act, Clean Power Plan, and Inflation Reduction Act).

4. Stakeholder Analysis

Transitioning to renewable energy involvement takes place at all levels around the world, from international organizations to local ones, involving both governments and private firms. Each plays a particular role in driving policy, investing in innovation, and overcoming transition barriers.

4.1 Global Organizations

International bodies like the United Nations and the International Renewable Energy Agency (IRENA) have provided the basic frameworks necessary for international collaboration in renewable energy. Indeed, IRENA itself has been involved in the sharing of research, funding development projects, and setting ambitious global targets with its over 160 member states as a way of facilitating this transition toward sustainable energy. IRENA, in its 2023 report, has outlined a record 13.7 million jobs in the renewable energy sector of the world, with a host of economic growth tied to clean energy initiatives.[29]

The UN's Climate Change Conferences, such as COP28 and COP29, have increasingly focused on renewable energy as a pathway to reducing global emissions. These conferences call upon countries to commit to serious energy transitions in setting ambitious renewable energy targets, such as reaching net-zero emissions by 2050. The impacts of these efforts are witnessed through the rise of funding and policy commitments in developed and developing nations alike, with countries like Sweden and Costa Rica at the forefront of renewable energy adoption.[30]

4.2 U.S. Federal Government

The U.S. federal government works on setting national priorities and offering financial incentives for renewable energy projects. Federal agencies such as the Environmental Protection Agency and the Department of Energy are responsible for drafting policies, funding research, and ensuring that emissions standards are met. The EERE has been instrumental in funding innovative projects such as offshore wind farms and next-generation solar panels.[31]

The Inflation Reduction Act of 2022 is the largest investment in renewable energy to come out of Congress to date. The law provides $369 billion for climate and energy

[29] IRENA, 2023
[30] Climate Council, 2022
[31] US Department of Energy, n.d.

provisions that are aimed at cutting U.S. carbon emissions by 42% by 2030 compared with 2005 levels.[32] It extends tax credits to electric vehicles, wind farms, solar installations, and domestic clean energy manufacturing. Analysts estimate that these investments will create more than 5 million jobs by 2032 while increasing U.S. competitiveness at least tenfold in the global energy market.[33]

4.3 State-Level Governments

State governments are pivotal in implementing renewable energy standards and incentivizing local projects. Renewable Portfolio Standards (RPS), which require utilities to source a specific percentage of their energy from renewables, are active in 28 states and Washington, D.C. States like California and New York have been especially aggressive, committing to 100% clean energy by 2045 and 2050, respectively.[3435]

Besides the RPS, most states offer incentives such as grants, tax credits, and low-interest loans for projects on clean energy. For example, the Self-Generation Incentive Program in California provides rebates for energy storage systems, which thereby allows the integration of solar and wind energies.[36] These kinds of programs at the state level promote emission reduction and create more than a thousand new jobs in the renewable energy sector.

4.4 Economic Sector: Job Displacement and Growth

While the transition to renewable energy has created millions of jobs, it also threatens workers who depend on more traditional industries. In 2024 alone, clean energy employed over 3.4 million Americans-manufacturing, installing, and operating.[37] Yet economic insecurity plagues regions reliant on fossil fuels, from Appalachia to oil country, where mine closures and declining production have ravaged local economies.[38]

For example, Boone County in West Virginia lost half of its general fund revenue from 2015 through 2019 as coal mines closed.[39] Federal programs, like the POWER Initiative, provide matching grants for worker retraining and economic diversification strategies

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[32] US Department of Energy, 2022
[33] BlueGreen Alliance, n.d.
[34] California Energy Commission, n.d.
[35] Hu, 2024
[36] California Public Utilities Commission, n.d.
[37] E2, 2024
[38] Blonz et. al., 2023
[39] Hidgon, 2020

focusing on local business development.[40] The International Energy Agency estimates that globally, while 14 million new jobs will be created in renewable energy by 2030, about 5 million fossil fuel jobs could be lost, and comprehensive workforce transition programs are urgently needed.[41]

4.5 Private Sector Companies

Private companies represent the leading means of innovation and investment in renewable energy. Major corporations such as Tesla, Siemens, and General Electric have thus invested hugely in renewable technologies ranging from solar panels to wind turbines. The Inflation Reduction Act has further incentivized private investment, hence over $215 billion worth of clean energy manufacturing projects in a year from the passage of the act.[42]

Meanwhile, the critical role of startups and smaller companies is undeniably vital in this sector. For instance, energy storage and grid integration companies provide a means of making wind and solar reliably meet the demand for energy, and are, therefore, indispensable.[43] So, by driving clean energy adoption, the private sector is meanwhile opening up high-wage jobs in engineering, manufacturing, and installation.

4.6 Tax Credits and Private Sector Incentives

Tax credits have indeed been one of the most effective tools in the adoption of renewable energy. The Investment Tax Credit, which allows for a 30% deduction for the costs associated with solar energy systems, has been the cornerstone of U.S. renewable energy policy since its inception.[44] Similarly, the Production Tax Credit provides per-kilowatt-hour incentives for wind energy projects.[45]

The Inflation Reduction Act expanded these credits, extending them through 2025 and introducing new credits for technologies like energy storage and carbon capture.[46] These incentives have made renewable energy projects more affordable for companies

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[40] ARC, 2023
[41] Cozzi, 2021
[42] US Department of Energy, 2024
[43] John, Wildeman, 2024
[44] US Department of Energy, 2022
[45] Holland & Knight, 2024
[46] US Department of the Treasury, 2023

and consumers alike.[47] According to the Solar Energy Industries Association, the ITC alone has helped solar deployment grow by over 10,000% since its inception.[48]

[47] Worland, 2024
[48] SEIA, 2019

5. Benefits of Renewable Energy

5.1 Job Creation

New policies passed to generate more sources of renewable energy open up hundreds of job opportunities. Today, within the United States, there are over 8 million jobs in the clean energy sector; globally, there were 12.7 million jobs in the clean energy sector in 2021, with clean energy implying renewable sources of energy.[4950] Specifically, multiple layers contribute to job creation in the renewables sector.

Manufacturing parts to ship and implement in localized regions requires a strong workforce in the manufacturing sector. Skilled workers are required to streamline the manufacturing process and produce the parts necessary to generate clean energy, such as wind turbine or solar panel parts.[51] That's why, since 2022, there have been 20,000 new jobs from over 500 clean-power-related manufacturing facilities, with 80,000 new jobs expected from facilities being developed.[52] Recently, over 100,000 manufacturing jobs in the clean energy industry have been announced following the passing of the Inflation Reduction Act.[53]

Furthermore, after parts for clean-energy infrastructure are manufactured, more individuals must be employed to install the infrastructure.[54] Economic growth is not only a result of the manufacturing jobs needed to create infrastructure but also the individuals employed to implement infrastructure in their designated areas. The employment needed to construct such projects almost doubled the national construction-job growth to 4.5%, adding almost 90,000 energy jobs to the construction sector.[55]

Additionally, once renewable energy has been fully implemented, more people are required to take long-term permanent jobs to maintain and operate the infrastructure; these jobs are oftentimes stable and of high-paying positions that provide more opportunities to hired workers.[56]

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[49] US Department of Energy, 2024
[50] University of Pennsylvania, 2024
[51] Jack Miller, n.d.
[52] Phil Sgro, 2024
[53] E2, 2024
[54] Jack Miller, n.d.
[55] US Department of Energy, 2024
[56] Jack Miller, n.d.

Overall, the number of possible jobs created from clean-energy policy implementations would be grand. If, by 2025, the United States were to have reduced emissions to net zero, then there could be an extra 2.3 million net jobs created by 2035.[57] Moreover, the Inflation Reduction Act, a national policy to reduce greenhouse gas emissions, led to an employment boom in green energy, adding over 313,000 new jobs to the sector.[58]

5.2 Market Fluctuation Preventability

Fossil fuels are one of the key drivers of market fluctuations. From 2021-2023, fossil fuels contributed to the historic peak in inflation, reaching 9.1% inflation in the middle of 2022, of which a third was from fossil fuels.[59] This volatility regarding fossil fuels prices was found to be a threat to macroeconomic price stability.[60] Because various markets and sectors are incredibly reliant on fossil fuels, when fossil fuel companies choose to raise and lower production, thus setting new levels of demand, the market becomes extremely unstable.[61]

Renewable energy, on the other hand, provides a solution to market instability from fossil fuels. Researchers from South Korea found that sources of clean energy aren't affected by parameters that affect the traditional stock market like fossil fuels would, which makes it a comparably more resilient source of energy.[62] This is because a transition into clean energy would also transition the economy to become reliant on the electricity sector, which is highly regulated and has historically provided stable energy prices.[63]

5.3 Sustainability

Regarding sustainability, renewable sources of energy provide more benefits for the environment and the general earth. Fossil fuels are one of the largest sources of greenhouse gas emissions because when burned, they release carbon dioxide into the atmosphere which traps the sun's heat and exacerbates warming.[64] That's why fossil fuels make up 75% of total global greenhouse gas emissions and almost 90% of total

[57] Saha et. al., 2022
[58] Marcacci, 2024
[59] Karlsson, Melodia, 2023
[60] ibid
[61] 350, 2022
[62] Rodgers, 2024
[63] Keating, 2022
[64] United Nations, n.d.

carbon dioxide emissions, and explains why the Earth is recorded as warming faster than any point in recorded history.[65]

On the other hand, renewables provide a more sustainable alternative to fossil fuels. Because renewable energy is naturally replenished, cost-efficient, and has a low environmental impact, it is generally considered to be a sustainable source of energy.[66] Specifically, because renewable energy is derived from sustainable sources of energy such as sun, wind, or water, it doesn't carry the weighty environmental implications that fossil fuels do.[67] Therefore, a transition to renewable energy would open up opportunities to experience long-term sustainability regarding the environment, slowing down the warming of the climate.

In the long term, concerns regarding the climate also have lasting impacts on national and global economies. If the planet continues to heat, countries may be more vulnerable to natural disasters, extreme weather trends, and warmer temperatures that affect all sectors of the economy.[68] Specifically, due to hurricanes and wildfires, climate change has cost North America $415 billion in repair costs.[69] Furthermore, the implications of climate change have the potential to ruin large-scale infrastructure, negatively affecting workforce productivity, global economies, and global supply chains.[70]

5.4 Cost Reductions

Fossil fuels are notoriously expensive. Over the last decade, the price of fossil fuels has increased from 13-20%, with electricity prices also increasing globally.[71] With increased gas demand and a depletion in natural resources to extract fossil fuels from, these prices have continued to rise for years.[72] This has resulted in oil and gas shocks, not only making numerous economies more volatile but also inflating prices for consumers and lowering their quality of life.[73]

On the other hand, the cost of renewable energy has been getting increasingly cheaper for both consumers and the economy. When considering new cost-saving infrastructure improvements for technologies like solar or wind energy, renewable energy has the

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[65] ibid
[66] United Nations, n.d.
[67] United Nations, n.d.
[68] Cho, 2019
[69] ibid
[70] ibid
[71] Jaller-Makarewicz, 2021
[72] ibid
[73] Kelly, 2024

potential to save trillions of dollars from production alone, not including the long-term costs it could save the environment.[74] Historically, solar energy prices were predicted to fall 2.6% during the 2010s, but they fell by 15% during that period, showing the true cost-effectiveness of renewable energy, solar specifically.[75] In 2022, renewable sources of energy were found to be the cheapest form of power, with 2021 investments saving the global economy $55 billion in energy costs.[76]

[74] Wood, 2021
[75] ibid
[76] United Nations, 2022

6. Drawbacks of Renewable Energy

6.1 Job Displacement

As the renewable energy industry continues to develop, workers in the fossil fuel industry are at risk of being left behind. In the case of the closing of the Contra Costa Country, California, Marathon Oil Refinery in 2020, surveys found that the post-layoff unemployment rate of the Marathon Workers was 22.5%. Furthermore, the post-layoff workers who had found jobs experienced a ~24% cut in pay.[77] The U.S. Government must ensure a fair transition for fossil fuel industry-heavy regions and industry workers throughout the shift to renewable energy infrastructure. As of 2019, there are 1.7 million U.S. workers in the fossil fuel industry through extraction, support, and utility roles.[78] In U.S. regions such as Slope County, North Dakota, and Reagan County, Texas, jobs in the fossil fuel industry account for almost half of the employment.[79] Moreover, the government may have to direct fossil-fuel workers study from the University of Pittsburgh found in the 15 biggest fossil-fuel extraction regions, less than 1.5% of fossil-fuel workers are likely to switch to clean energy jobs.[80]

Along with affecting individuals, the transition involves high costs for local and federal governments. The fossil fuel industry contributes largely to local governments through taxes. As employment in these industries has trended downward, public funding plunged. In Boone County, West Virginia, general fund revenue was cut in half from 2015 to 2019 due to coal mine closures.[81] Furthermore, the federal government will seek to alleviate the burden of job loss from these workers. Methods such as retraining and education for these workers to direct them to the renewable energy industry would aid in developing a large workforce, yet it is costly. Facilitating the transition for fossil fuel workers to the renewable industry could approximately cost $2300 per worker annually.[82] Overall, a transition that allows clean energy to flourish could cost an estimated $23 billion annually until 2030.[83]

The costs of transitioning to clean energy infrastructure extend past the U.S. borders. A paper provided by the Reserve Bank of Australia used data from the following countries: Australia, Austria, Canada, Denmark, Estonia, Finland, France, Germany, Hungary,

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[77] Parks and Baran, 2023
[78] Tomer et al., 2021
[79] ibid
[80] Monahan, 2023
[81] Environmental Defense Fund, 2020
[82] Aklin and Urpelainen, 2022
[83] ibid

Netherlands, Norway, Portugal, Spain, and Sweden. On average, workers displaced from energy-intensive industries tended to experience earning losses 7 percentage points higher than workers in other industries six years post-displacement.[84] Moreover, the International Energy Agency (IEA) predicts that miners will suffer disproportionately during a transition.[85] The IEA estimates that 1.4 million jobs could be lost by 2030, primarily in Asia.

6.2 Initial Investment

Although the prices of solar and wind energy have been trending downwards, they still require substantial initial investments on larger scales. Renewable energy projects require much more initial capital financing than utilizing fossil fuels.[86] In 2022, U.S. construction costs for solar and wind power were $1,588 and $1,451 per kW capacity respectively on average. Meanwhile, the costs for natural gas per kW of capacity averaged $820.[87] Solar construction costs had risen due to a 13% construction cost increase of crystalline silicon tracking panels.[88] In developing countries and regions with insubstantial financial resources, this can act as a barrier preventing the installation of clean energy infrastructures.[89]

Investments in renewable energy projects can also be impeded by fossil fuel lobbyists. In 2020, fossil fuel industry lobbyists spent $139 million on political donations and $111 million in lobbying. In return, the industry received a combined $30 billion of federal relief and subsidies in 2020.[90] In 2022, the industry spent approximately $124.4 million lobbying the U.S. federal government.[91] A major lobbying entity is the American Petroleum Institute (API), which opposed provisions of the Inflation Reduction Act which instated a methane emission tax.[92] Many other corporations in the fossil fuel industry conflict with policies developed to move away from traditional energy sources to cleaner energy.[93] Lobbying from the fossil fuel industry has been shown to disincentivize the U.S. federal government from pursuing a hard-line stance concerning the transition to renewable energy.

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[84] Barreto et al., 2024
[85] Bandura and Bonin, 2024
[86] Aydos et al., 2022
[87] U.S. Energy Information Administration, 2024
[88] ibid
[89] Qosja, 2024
[90] House Committee on Oversight and Reform, 2021
[91] Sayki and Cloutier, 2023
[92] LobbyMap, 2024
[93] InfluenceMap, 2016

6.3 Infrastructure Integration

To effectively utilize renewable energy sources such as solar or wind power, the government must overcome challenges in grid integration and energy storage for renewable sources. Among technical issues, appropriate technologies are required to convert direct current power into usable alternating current power.[94] Additionally, some regions may not produce adequate energy to meet their demand, and energy production may surpass demand in others. Therefore, we must implement viable storage and grid systems. Connecting renewable energy sources to power grids is currently costly and inefficient. Moreover, we must expand transmission line networks by at least 25% in the next decade to distribute renewable power.[95] In regards to storing excess energy, we lack effective standardized systems. We must consider the costs and minerals required to develop battery systems, which obstructs us from progressing quickly in renewable infrastructure implementation. Attempting to mitigate these issues, the US Department of Energy (DOE) has engaged in private R&D partnerships to advance grid and energy storage expansion.[96]

[94] Pacific Northwest National Laboratory, 2024
[95] Haar, 2023
[96] ibid

7. Summary

The transition towards renewable energy should not only be thought of as a dire necessity in terms of the environment, but more as an enabling moment to reconceptualize economies, energy structures, and international cooperation. As this paper illustrates, the movement away from fossil fuels is fraught with difficulties regarding job displacement, high upfront costs, and challenges with infrastructure integration. However, the benefits of jobs, economic stability, and sustainability over the long term outweigh obstacles when well managed.

These include, but are not limited to, landmark policies like the Energy Policy Acts of 1992 and 2005 and the Inflation Reduction Act of 2022. These should be supported by specific, targeted interventions that will address the obvious gaps in current efforts: workforce transition programs in fossil fuel-dependent regions, investment in advanced grid technologies, and support for developing nations.

From the UN and IRENA to private sector innovators and state governments, the stakeholders must act with precision at warp speed. Long-term incentives that ensure sustained investment in renewable technologies, rather than temporary fixes, are what policymakers should focus on. The private sector, spurred by tax credits and market demand, needs to lead from the front in scaling up innovation solutions like energy storage and modernization of grids.

The bridge renewable energy needs to cross for ambition to meet execution involves the non-isolated rethinking of energy systems, as policy and technology solutions that can mutually solve social equity, economic resilience, and climate imperatives. Achieving this vision will demand bold, decisive actions that will set the stage for a cleaner, more sustainable, inclusive global energy landscape.