An Analysis of Renewable Energy Within the United States and Washington, DC

Hannah Plazarin

ABSTRACT

This paper analyzes the renewable energy sector within the United States, particularly within Washington, DC. The paper begins with an overview of the renewable energy field and the advantages and disadvantages of a clean energy transition. This is followed by an examination of the impact of the Inflation Reduction Act, which was signed by former President Biden in 2022, in the country and in DC. The paper will examine DC's current sustainability-centered urban practices and legislation alongside its ranking as a green city. Economic analysis is performed for the areas with the most potential for improvement within DC: commercial and transportation sectors, environmental equity, consumer behavior, and enhanced storage capacities for renewable energy production. Lastly, recommendations are made for DC policymakers.

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HANNAH PLAZARIN is a Master of Public Policy student specializing in environmental policy. She will complete her MPP program in May 2025 with an additional graduate certificate in Environmental Resource Policy. With a strong passion for sustainability and environmental issues, she aims to drive impactful change through innovative policy solutions. Committed to addressing pressing environmental challenges, she is dedicated to creating a more sustainable future, ideally within the energy, natural resource, and waste management sectors.

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ENERGY: AN OVERVIEW

Renewable energy is defined by the United Nations as "energy derived from natural sources that are replenished at a higher rate than they are consumed" (2024). The most common sources include:

Solar: The largest-growing sector of renewable energy that generates electricity from the sun, even in cloudy weather. The cost of solar panels has decreased exponentially in the last decade, and solar panels have a lifespan of around 30 years.

Wind: The most generated source of renewable energy in the United States; harnesses energy through air-moving wind turbines.

Geothermal: Utilizes thermal energy from Earth's interior through reservoirs, but has high initial costs and is more intrusive to the environment than other forms of renewable energy.

Hydropower: Harnesses energy from moving water to generate electricity, and can be negatively impacted by climate-induced weather changes such as droughts.

Bioenergy: Produced from biomass, or organic materials including wood, charcoal, and manure, and used largely in developing countries. Burning biomass does create greenhouse gas emissions, including methane, but at lower levels than burning fossil fuels (United Nations 2024).

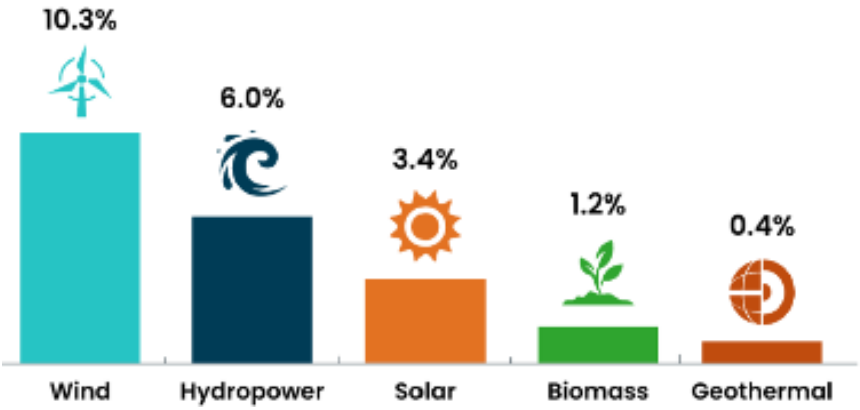
According to the United States Department of Energy (DOE), over 20 percent of all US electricity is generated via renewable energy, and the percentage is only expected to increase (DOE 2024). US renewable energy generation surpassed coal for the first time in history in 2022. While this is an astounding feat, there is still much room for growth to create a sustainable future in renewable energy. The US also saw a record-breaking 55 percent increase in solar energy installation in 2023 compared to 2022 (Bird 2024). Figure 1 shows 2022's breakdown of the United States' renewable energy production by fuel source.

While renewable energy production is continuing to increase, fossil fuels are still the leading source of energy in the United States and are depleting Earth's finite resources. Reliance on fossil fuels and non-sustainable energy practices leads to environmentally detrimental impacts and a loss of non-renewable resources for future generations. Burning fossil fuels is the primary cause of climate change, which creates severe consequences for the Earth's ecosystems alongside numerous other environmental issues and human health problems. Nonrenewable energy releases greenhouse gases, particularly carbon dioxide, methane, and nitrous oxide, which cause irreversible damage to the ozone layer

and, in turn, increase Earth's average temperature through global warming. This induces changes in weather patterns that create stronger storms, wildfires, floods, and rising sea levels, and it is detrimental to marine life on a global scale (Bird 2024).

Human health is affected globally by climate change because of increased sun exposure; proximity to extreme weather events such as hurricanes, wildfires, and tornadoes; stress relating to geographic displacement and more. Additionally, communities where fossil fuels are burned to produce electricity typically contain lower-income and vulnerable populations. These communities then experience higher risks of cancers, asthma, respiratory diseases, and other illnesses (University of California 2024). These are only some of the major crises caused by fossil fuels, and their impacts are substantial and perpetual. Switching to renewable energy is key to solving these issues and leads to a better, more sustainable future for all.

Figure 1: "Renewable Energy Pillar"



Source: U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy

ADVANTAGES OF RENEWABLE ENERGY TRANSITION

To decrease the damages from fossil fuels, a transition to renewable energy sources is necessary for human health, the environment, economic development, and longevity of resources. The Environmental Protection Agency (EPA) details environmental and economic benefits of using renewable energy. These benefits include generating energy that releases no greenhouse gases or air pollutants. Besides this reduction in pollution, clean energy can contribute to economic development through community infrastructure investments and new jobs in manufacturing, installation, and other fields (2024).

Diversifying the nation's energy supply with regenerative sources is vital to ensuring a stable and sustainable economy and avoiding reliance on a single

energy source as climate change continues to have unprecedented impacts on global weather. According to the Department of Energy, advantages of renewable energy include "enhanced reliability, security, and resilience of the power grid" alongside higher energy independence and expanded energy access for rural, coastal, or otherwise isolated communities (2024). Energy produced by a sustainable and regenerative process can help reduce inefficiencies and power blackouts in severe storms. This creates greater energy security across the nation and is important for rural and metropolitan areas alike when having the capability to produce and store energy locally.

Lastly, renewable energy regularly decreases utility bills for long-term savings, which typically outweigh the initial investment costs. Washington, DC's "Solar For All" program aims to reduce low-income households' energy bills 50 percent by 2032 by expanding residential solar energy installation (DCSEU 2025). This program, along with similar programs in other urban areas, credits residents for unused or extra electricity produced by net metering to allow residents to save more on utility bills. Furthermore, a cost-benefit analysis found that homes with solar power and battery storage can reduce their reliance on the power grid by 14 percent, compared to only 5 percent without battery storage (Applied Economics Clinic 2022). A household can save money and gain a reliable energy source when switching to renewable energy.

DISADVANTAGES OF RENEWABLE ENERGY TRANSITION

While the advantages of renewable energy outweigh the disadvantages by far, it is important to note some of the problems with wide-scale implementation. Transitioning to clean energy still relies on metals and minerals and largely ignores the "widespread social, economic, and political transformations that must also be factored into assessments of energy change" (Chipangamate and Nwaila 2024). Of the 30 required energy transition minerals and metals, around 50 percent are located on or near lands of Indigenous or low-income communities (Chipangamate and Nwaila 2024). The challenges of obtaining these crucial minerals stem largely from the United Nations Declaration on the Rights of Indigenous Peoples, which requires states to consult with Indigenous peoples to obtain their "free, prior, and informed consent" before implementing legislation (Owen et al. 2023). If there are no policies to ensure environmental protection of these lands and communities,Indigenous peoples have no reason to give their consent for mineral extraction.

Additionally, technologies for renewable energy production require more raw materials than are used in traditional non-renewable energy systems (Chipangamate and Nwaila 2024). While these materials are necessary, it is important to obtain them in a way that is conscientious to the areas from which

they originate and ensure efficient mineral utilization without detrimental environmental and societal effects.

The US will also have to increase electrical long-term storage for renewable energy, which still lacks the wattage needed to store a fully-renewable energy supply. To maintain the demand for energy, it is crucial to have an energy reserve, which means building and updating the necessary infrastructure to avoid power outages. This is especially imperative to commercial buildings like hospitals and public service stations that require specific energy standards. Moreover, renewable energy is dependent on weather conditions and is prone to variability, which is why investing in long-term storage capacities is critical for renewable energy production.

Furthermore, within the US, elections and extreme partisanship dissuade or otherwise change the existing energy policies when new legislators come into office. Even though over half of the public supports renewable energy, there is still a divide along partisan lines. A poll by the University of Maryland and The Washington Post saw that 65 percent of Americans support tax credits to install solar panels, and 54 percent support expanding tax credits to manufacture solar panels and wind turbines (Room et al.2023). The severe political divide between policymakers is cause for concern when discussing current and future projections for a clean energy transition. It is increasingly important to elect officials who purposefully move towards a cleaner, more sustainable future and who listen to the priorities of the people.

Lastly, other obstacles that remain for this transition include rising interest rates, permitting challenges, and supply chain issues (Bird 2024). While there are many challenges in the transition period to fully clean energy, it is important to note the lasting impact on the environment and society.

THE INFLATION REDUCTION ACT

Renewable energy in the US has grown substantially over the last few decades, especially in the past year. The Inflation Reduction Act, which was signed by President Biden in 2022, created one of the US's largest investments in energy security and climate mitigation practices thus far (US Department of the Treasury 2024). This policy has directed significant investments into disadvantaged communities and tax credits for clean energy investments. According to the US Department of the Treasury:

> "Before the IRA passed in August 2022, an average of $2 billion per month of clean electricity investment was announced in areas eligible for the Energy Community Bonus and $2.5 billion per month throughout the rest of the U.S

> . . . After the IRA passed, those numbers ballooned to nearly $4.5 billion per month and $3.5 billion in the rest of the US" (2024).

Disadvantaged communities that are historically reliant on fossil fuels for wages, employment, and tax revenue are eligible for the Energy Community Bonus. Before the IRA, "68% of announced investments in clean technologies were in counties with median incomes below the US aggregate median income" (US Dept of the Treasury 2024). After this policy was passed, the number rose to 75 percent.

This policy was critical to investing in clean energy practices in those communities that were previously neglected. The IRA alone invested over "$60 billion in critical clean energy, climate and electrification measures in disadvantaged communities" (Lewis et al. 2022). The IRA also increases the number of clean energy-related jobs in these neighborhoods and decreases the average energy bill of residents who use renewable energy. President Biden launched the Justice40 Initiative to further advance environmental justice and clean energy practices within these marginalized communities (White House 2024).

The Biden Administration projected that deploying clean energy willcut electricity rates by as much as 9 percent by 2030, thanks to both the Inflation Reduction Act and Bipartisan Infrastructure Law. The IRA provides tax credits for residential rooftop solar, geothermal, or battery storage installation up to 30 percent of the cost, which translates to roughly $400 annual savings per household (The White House 2024).

The Biden Administration's goal was 100 percent carbon pollution-free electricity, otherwise known as a net-zero electric grid, by 2035 with complete elimination of fossil fuels. By 2030, the target is that 80 percent of all energy will be renewable, even though 79 percent of total US energy production in 2021 still came from fossil fuel sources (Mai 2023). However, by 2025, solar energy production in the US is expected to increase by 75 percent and wind by 11 percent (DOE 2024). The newly-appointed Trump Administration has revoked much of the Biden Administration's goals for renewable energy, however, and does not share the same values regarding clean energy. This creates severe uncertainty on the future of the Inflation Reduction Act.

The US must continue to educate the public and provide incentives and subsidies to encourage residents to make this change to meet their goals. This will prove challenging in rural US communities, which tend to hold more conservative beliefs regarding clean energy as compared to urban areas such as Washington, DC Rural areas also have larger agricultural industries that rely on fossil fuel consumption. To change energy consumption, clear messaging

about the industrial energy transition, including its climate benefits, potential for new jobs and job training, and financial incentives, is critical.

RENEWABLE ENERGY IN THE NATION'S CAPITAL

Washington, DC is one of the nation's leaders in sustainability, but there is still room for improvement. According to the US Energy Information Administration (EIA), in 2022, Washington, DC consumed less electricity than all but four states because of its small geographical size, even with one of the highest population densities compared to other American urban areas. It also ranks as the 13th highest in the nation for per capita electricity consumption when compared to other states. (US EIA 2024). Solar energy and biomass are the main renewable resources for electricity within the District and generated around 76 percent of all energy in 2022 (US EIA 2024). 2022 saw DC obtaining energy through 59 percent solar, 24 percent nonrenewable natural gas, and 17 percent biomass generation. Additionally, there is not currently any commercial wind, hydroelectric, or geothermal power development within the District. While geographical challenges do not allow DC to generate every type of renewable energy, especially hydroelectric and geothermal power,DC could consider investing in offshore wind power in conjunction with surrounding states and their adjacent bodies of water (US EIA 2024).

The commercial sector accounts for about 71 percent of all electricity sales in DC because of its large volume of government buildings, museums, and universities. The federal government is its largest natural gas customer (US EIA 2024). The residential sector is the second largest natural gas consumer in DC, and nearly half of all households use this depletable resource. The third largest natural gas consumer is the transportation sector, particularly personal transportation. Table 3 below shows a breakdown of greenhouse gas emission produced per sector in DC in 2015.

When compared to the US 's average per capita GHG emissions of 20.7 tons of Carbon Dioxide Equivalent (tCO2e) per person, DC ranks below higher-emitting cities like Baltimore and Chicago at 11 tCO2e. However, it produces more than Boston, Seattle, and other West Coast cities (Department of Energy and Environment 2018).

While DC is overall more sustainable than comparable urban cities on the East Coast, it still has room for improvement in terms of emissions and overall energy consumption.

WASHINGTON, DC'S SUSTAINABILITY RANKING

Washington, DC is on track to be one of the most sustainable urban areas within the US and rivals many major West Coast cities. A study by the Consumer News and Business Channel (CNBC) ranked the top ten greenest US cities for homebuyers based on five criteria: sustainability, policy and infrastructure, energy, environment, and affordability (Fernandez 2024). Washington, DC was ranked second behind Portland, Oregon, with the following eight cities, besides New York City, located on the West Coast. The report discussed DC's ranking as "highest for the environment, in the top three for sustainability, and in the top five for energy." (Fernandez 2024).

DC was also ranked second on EPA's 2022 list for US metropolitan areas with the most Energy Star certified buildings (Goines 2023). Washington, DC, second only behind Los Angeles, hosts 555 Energy Star-certified buildings, which utilize energy-saving practices that cost less to operate and produce far fewer pollutants than other buildings. It is especially important for DC to revitalize commercial and government buildings that are not energy efficient, as they produce the highest number of pollutants. Buildings with this certification saved building owners almost $180 million in utility costs and prevented nearly 517,000 tons of greenhouse gas emissions in 2022 (Goines 2023).

In 2022, DC "was selected as one of 11 global cities featured in a virtual exhibit on cities' climate action as part of the United Nations Climate Change Conference of Parties" because of its sustainability goals (Sustainable DC 2022). Additionally, the Arcadis Sustainable Cities Index 2022 ranks global urban areas based on "planet," "people," and "profit" pillars. While cities like Oslo, Stockholm, and Tokyo ranked in the top three, Washington, DC ranked twentieth globally, a significant accomplishment.The only US cities that ranked above DCwere Seattle, in seventh place;, San Francisco, in ninth place; Los Angeles, in fourteenth place; and New York, in fifteenth place (Arcadis 2022).

Washington, DC is making waves in the clean energy sector on both a domestic and a global scale. The city is on track to meet its ambitious sustainable goals of carbon neutrality and 100 percent reliance on clean energy within the next two decades (DOEE, 2018).

Washington, DC's government proposal for renewable energy, Clean Energy DC, outlines progressive standards for reducing emissions, alongside the current Sustainable DC 2.0 Plan, and funding opportunities including grants and subsidies. The goal of the Sustainable DC 2.0 Planvis "to make the District the healthiest, greenest, and most livable city in the nation by 2032" (DOEE 2018). The plan is broken into action plans for governance, equity, climate, education, health, transportation and more (Sustainable DC 2018). The priority of the

Clean Energy DC legislation is to reduce greenhouse gas emissions and overall energy use 50 percent by 2032 and to increase renewable energy use to 50 percent.

Other programs, such as the DC Sustainable Energy Utility (DCSEU), offer additional assistance for home energy efficiency and electrification. DC also hosts an Affordable Home Electrification Program to help lower-income households electrify home heating and water systems to minimize reliance on natural gases (DCSEU 2022).

Furthermore, Washington, DC introduced Council Bill 25-119 for the Healthy Homes and Residential Electrification Amendment Act of 2023 (Council of the District of Columbia 2024). This bill was passed by D.C in May 2024, and will cover all installation costs for low- and moderate-income households and retrofit for electrical appliances. It would also prohibit the DC Housing Authority from installing appliances that utilize fossil fuel combustion in the future. This would provide necessary funding for lower-income households to switch to energy-efficient appliances which would, in turn, decrease their monthly utility payments (Council of the District of Columbia 2024).

IRA'S IMPACT IN WASHINGTON, DC

The Inflation Reduction Act directs all funding to State Energy Offices, but because Washington, DC is a federal district entity, it is directed by the District Department of Energy & Environment, or DOEE (DC Sustainable Energy Utility 2022). The IRA for Washington, DC has proven to lower energy costs through rebates, tax credits, and grants (White House 2024). Tax credits would cover 30 percent of the costs of solar panel installation, household storage updates,and community projects, and it would cover an additional 20 percent for affordable housing properties and 10 percent for low-income community projects. Additionally, funding is expected to save the average new DC homeowner $162 annually, or 11 percent. For the tens of thousands of DC residents living in affordable housing units, the IRA's Neighborhood Access and Equity Grant Program will support the transition to clean energy and electrification by further lowering the costs for these renters. The DOEE plans to use one of the program's rebates to transition affordable housing units from gas-powered appliances to electric ones as well (White House 2024).

The IRA was also projected to expand the job market and provide more economic opportunities for residents. In 2021, 14,244 workers in DC were employed in clean energy jobs (White House 2024). The IRA was set to expand clean energy opportunities and, because of tax credits' impact on renewable energy demand, create a projected upward shift in the supply of clean energy

providers to account for this growth.

DC's estimated 79,814 small businesses account for 98.2 percent of all businesses in the District. IRA tax credits allow commercial buildings to receive $5 per square foot for energy-efficient improvements to lower their utility bills and up to 30 percent coverage of the cost of solar panel installation for small businesses. This will assist small businesses in implementing much-needed renewable energy improvements for their buildings in the District (White House 2024).

Lastly, the IRA will provide discounts to consumers of $7,500 for new electric vehicles and $4,000 for used electric vehicles. This will help decrease the amount of pollution resulting from personal transportation and help lower- and middle-class residents make the switch to more energy-efficient modes of transportation. (US Department of the Treasury 2024).

The IRA, alongside other legislation, is set to significantly help the District meet its goal of carbon neutrality by 2045 (DOEE 2018).

ECONOMIC ANALYSIS OF RENEWABLE ENERGY PRACTICES IN DC

Although DC is progressing towards its renewable energy goals, there is still room for growth and improved efficiency. The areas encompassing the largest potential for growth are, specifically, the commercial and transportation sectors.

Commercial Sector

DC's commercial sector holds the greatest potential for growth.. Even with the high number of Energy Star Certified buildings, in 2021,the commercial sector consumed 57.7 percent of all energy in the District at 80.7 trillion British thermal units (BTU). BTU is a conversion of the physical amount of energy consumed, produced, exported, or imported, and one BTU is about equal to the energy released by burning one match (EIA 2023). The United States consumed 33.41 quadrillion BTU of natural gas, 35.85 quadrillion BTU of petroleum, and 9.85 quadrillion BTU of coal in 2022 alone (EIA 2023). The residential sector in DC consumed less than half the energy of the commercial sector in 202[?], consuming 25.4 percent, or 35.6 trillion BTU, of all DC's energy. The transportation sector consumed 12.7 percent of all energy and 17.8 billion BTU.

Because the federal government is the largest natural gas consumer in DC, there is a vast need for energy efficiency upgrades in federal buildings. This is especially critical following a report by the Government Accountability

Office indicating that federal buildings are underutilized due to the increase of telework (Marroni 2023). In 2023, seventeen of the twenty-four CFO federal agencies used, on average, 25 percent or less of building capacity, and other agency buildings used only 39-49 percent of building capacity (Marroni 2023). The federal government owns over 500 million square feet of office space, which costs billions annually. The agencies prioritizing teleworking over in-office standards should be consolidated to not only save taxpayers' money but to decrease the energy waste from underutilization. The GAO study only considered federal buildings,not other commercial buildings that are struggling with the same issues (Marroni 2023).

Post-pandemic office work has seen a rise in teleworking, which is expected to increase. DC companies and organizations need to rethink their current leases and organizational structure and combine with other agency buildings suffering from the same capacity underutilization. This will significantly decrease the energy being consumed, as buildings at less than half capacity are still using roughly the same amount of electricity and utilities as those at full capacity. (Marroni 2023).

The District has a 100 percent Renewable Portfolio Standard goal that requires energy companies to provide all energy from renewable resources by 2032 (DOEE 2023). If all commercial buildings over 10,000 square feet were to meet 50th percentile criteria for their ENERGY STAR score, a measurement software that analyzes individual buildings' emission and energy consumption, citywide energy consumption could be reduced by over 20 percent, or 1.05 million tons of greenhouse gas each year (Berkeley Lab 2019). Conventional energy retrofits for current buildings can save up to 30-40 percent alone without renewable energy power (DOEE 2023). These savings are only set to increase when utilizing lower-cost clean energy sources.

Transportation Sector

Public transportation is already more sustainable than personal vehicles, and the Washington Metropolitan Area Transit Authority (WMATA) has many initiatives to use more green energy in DC transportation. The DC Metro alone consumes equivalent energy to 70 percent of an average US coal-fired power plant on an annual basis, and energy costs are the largest non-personnel operating expense (WMATA 2024). WMATA introduced its first Energy Action Plan to reduce energy consumption and prioritize sustainability in 2017 to continue through 2025; however, it has a long way to go to achieve its goal. Table 4 displays the current Energy Action Plan's estimations. WMATA estimated that their energy revitalization plan would avoid 160,000 metric tons of CO2 emissions between 2017 and 2025.

The WMATA is slowly transitioning to a 100 percent emission-free bus system by 2045, in line with the Sustainable DC 2.0 Plan. Around 40 percent of WMATA's 1,600-bus fleet consists of hybrid-electric buses and contributes to the Energy Action Plan estimates above (WMATA 2024).

The plan is a great start for the WMATA, but there is room for concern regarding its lack of specific standards for using more renewable energy beyond buses. The Action Plan states that the WMATA will "pursue opportunities for renewable energy and work with utilities to take advantage of rebates to maximize efficiency investments" without fully stating what it is planning for and which opportunities to pursue (WMATA 2024). The WMATA currently has a 25-year contract with TotalEnergies to create solar carports, or covered metro stations or parking areas, for a total of 11 acres of solar panels. This would generate approximately 10 megawatts of electrical capacity, equivalent to power generation for at least 1,100 homes annually (WMATA 2023). Because the plan creates no cost for Metro and all the electricity it generates will be delivered to local residential and commercial consumers, this is a great example of how to incorporate renewable energy in the transportation sector.

Overall, green energy in the DC transportation sector is improving but still has a long way to go to be fully energy-efficient. The best way to start is to incorporate solar energy into all metro stations for internal lighting, find ways to utilize efficient renewable energy to power the metro systems, and create infrastructure to house backup solar storage.

Environmental Equity

While the IRA is working towards environmental equity within the United States, there is always concern regarding how sustainable transitions impact lower-income communities. DC is working towards bridging this equity gap, especially with the Healthy Homes and Residential Electrification Amendment Act of 2023 that was passed May 2024.

The Office of the People's Counsel of DC conducted a feasibility study regarding solar potential in DC wards called "The Future of Solar Study for the District of Columbia." The study's findings "reveal the differences in solar potential on a ward level and the suitability of particular options for generating solar power across the wards" (McCoy 2020). This study showed that the wards with the greatest potential for private rooftop installations were 2, 3, 5, and 6, which are also the highest-income wards of the District. Large building rooftops and parking lot canopies were best for Wards 5, 6, 7, and 8, largely due to high numbers of commercial and industrial buildings. The study found that the 2032 DC goal of 100 percent renewable energy is feasible, but the development and installation of new rooftop and parking canopy solar systems are critical to

reach this goal (McCoy 2020).

The data provided by this study highlighted that while the price of solar electricity is currently slightly higher than prices generated by fossil fuels, the rapid decrease in solar panel pricing should soon show a generous price decrease well below that of fossil fuels. (McCoy 2020). This is a classic model of supply-and-demand projections: as supply increases to meet new demand, the price will shift. According to Our World in Data, solar panel costs have decreased by 90 percent in the last decade, and solar power is one of the cheapest electricity sources worldwide. The cost has fallen by roughly 20 percent each time the global cumulative capacity has doubled. This shows that solar energy will continue to become more affordable and widely utilized (Ritchie 2024).

The recent Solar for All Program that was announced in April 2024 is expected to expand solar benefits to 19,000 additional low- or moderate-income households within the District. The program received an award from the Department of Energy for "excellence in equitable community solar development" (DOEE 2024). This is ecritical to ensure environmental equity, especially in Wards 7 and 8, which have the lowest median incomes of the District and are relying more on fossil fuel energy production. Negative externalities, like pollutants and unupgraded energy systems, are largely prevalent in lower-income and marginalized communities. (Nelson, et al. 2024).

Overall, DC is working hard to ensure environmental equity in its renewable energy implementation plan. With the multitude of funding programs, including those from the IRA, the biggest challenge to service these wards will be to disseminate information regarding the opportunities that exist. It is important to focus on communal outreach to affordable housing landlords, parking lot owners, and all homeowners, especially in Wards 7 and 8. This outreach should educate residents on these credits, grants, and programs to implement renewable energy.

Consumer Response

There is minor, but still present, cause for concern when considering the behavioral economics of renewable energy transitioning within DC. Because there is no federal carbon tax, the second-best option is to increase the prices of fossil fuel-consuming appliances and energy sources to shift consumer behavior towards cleaner energy (Sanin et al. 2016).

The Inter-American Development Bank published a report discussing behavioral economics and the impact of energy efficiency regulations. It stated that "if energy efficiency increases the value that consumers get from a given amount of energy, it will enhance the value of that energy for initial levels of use" (Sanin et al. 2016). If renewable energy prices are high, an increase in

energy efficiency will increase the demand for this form of energy.

This brings into question DC residents' present bias regarding renewable energy. Will they wait for renewable energy to possibly become cheaper in the future, holding out on implementing it now in case there are more subsidies down the road? It is difficult to tell. This means policymakers must inform residents and property owners of the uncertain supply of future subsidies to help initiate action now. Policymakers can stress the deadline, if one, for these subsidies and grants or explain that funds will be allocated on a first-come, first-served basis. This could compel residents and property owners to act faster than they would if left to their own devices.

Recommendations for Washington, DC Policymakers

As analyzed above, the areas in DC with the most potential for energy-efficient growth are the commercial and transportation sectors, and expanding long-term storage capacities for renewable sources will support the city in its goals. Legislators should prioritize making better use of federal buildings and incorporating more solar energy into these buildings to reduce energy waste. Additionally, the WMATA should focus on incorporating more solar energy into its structures, which it has started with the construction of its solar carports. Additionally, the goal for carbon neutral buses is a great starting point, especially because almost half of the bus-fleet is already electrified. However, with its estimated 1 million annual rides and amount of energy consumed every day, the WMATA should prioritize revolutionizing and electrifying more potential areas than it already has. Furthermore, to ensure that environmental equity remains a priority for DC's Sustainability Plan, DC policymakers and legislators should prioritize disseminating information including how the IRA and other DC-specific grants and subsidies will eventually run out. The current incentives and funding opportunities available, it is important to advocate the decreased initial costs and financing options available in order to save money in the long run and pay the least amount up front. It is also important to advocate for the benefits of investing in renewable energy in terms of long- and short-term utility savings, environmental impacts, and other community advantages,with a specific focus on lower-income wards like 7 and 8.

Lastly, a top priority should be expanding the long-term storage capabilities to incorporate fully renewable energy power. Stabilizing the grid without fossil fuels will provide a more sustainable method of energy consumption that will also reduce carbon emissions. This will reduce the potential for energy disruptions by creating a cache to ensure efficient and reliable power alongside achieving net-zero carbon emission goals. In addition, it would lower energy costs for residential and commercial buildings in long-term savings.

Washington, DC is on its way to being the greenest city in America and, hopefully in the next decade, a top ten city globally. By prioritizing the focus areas listed above, DC can surely meet and exceed its carbon neutrality and energy goals.

CONCLUSION

While both the US as a whole and Washington, DC are working towards a more sustainable future, DC is leaps and bounds ahead of most of the US. The Inflation Reduction Act has proven to be a significant policy in the form of renewable energy implementation across the country and is projected to help DC reach its goals of carbon neutrality, alongside the many other grants, subsidies, and tax incentives the District offers.

By examining the economic approaches to areas that need more attention for efficient renewable energy implementation, one can see that DC is on the right track but still has a way to go. The commercial sector has the most potential for growth in energy efficiency, and legislators should take a hard look at combining federal underutilized facilities and implementing rooftop solar energy. The transportation sector should finalize plans for renewable energy incorporation and make a thorough action plan for the Metro system. DC should prioritize disseminating information to ensure consumers can make informed decisions based on the abundance of resources available to them and ensure environmental equity across all wards.

Washington, DC will continue to be an example of prioritizing environmentally sustainable practices in the energy sector. The next few years will determine if DC can reach their carbon neutrality goals and optimize efficiency in the commercial and transportation sectors alongside prioritizing economic neutrality.

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