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Cleveland's Clean and Equitable Energy Future

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Prepared by Greenlink Analytics

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Acknowledgments

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Cleveland's Clean and Equitable Energy Future

Executive Summary

Founded in 1796, the city of Cleveland sits at the mouth of the Cuyahoga River on the southern shore of Lake Erie. This natural environment has played a critical role in Cleveland's development. Beginning in the early 19th century, with the completion of Ohio and Erie Canals, Cleveland became an important trade center due to its access to both the Great Lakes and the Atlantic Ocean. By the 1860s, Cleveland emerged as a hub of energy and manufacturing activity. This industrial past, combined with national and global trends around climate change, have dramatically shaped the climate challenges Cleveland faces.

On September 20th, 2018, the City of Cleveland became the first city in the state of Ohio to commit to powering itself with 100 percent clean energy. Building off of the City of Cleveland's Climate Action Plan (CAP), Mayor Frank G. Jackson announced his commitment and leadership to combat climate change by transitioning to 100 percent clean and renewable energy sources by 2050.

The development of a 100 percent plan aligns with the Mayor's vision of creating a green city on a blue lake. By increasing energy efficiency and by moving towards renewable and equitable energy sources, the City of Cleveland can make a major impact in reducing Cleveland's contribution to climate change, advancing energy equity, and avoiding significant health and environmental damages caused by dirty energy, all while creating jobs and boosting the local economy.

Cleveland's Clean and Equitable Energy Future is an action-oriented plan and framework the City can follow for successful implementation of this clean energy transition by 2050. This document outlines the opportunities and challenges the City will face in the coming years to run on 100 percent clean and equitable energy. In order to provide a clean energy future to a changing city, Cleveland's plan must pursue ambitious, yet achievable and realistic actions that are informed by community values and data.

In the creation of this Plan, the Mayor's Office of Sustainability teamed up with Cleveland Neighborhood Progress, Cleveland Foundation, Cray Consulting Group, The George Gund Foundation, and the United Black Fund of Greater Cleveland, to embark on a comprehensive planning and writing process. The process engaged local stakeholders including neighborhood representatives, non-governmental organizations, government, utilities, and business communities. A public, online survey was used to gather insights from over 550 Cleveland residents on their level of support for the 100 percent clean energy plan, their recommendations, and what public values should be incorporated throughout the plan. The top priorities that arose from community engagement were: ensuring that all residents receive the benefits of clean energy, protecting the environment, and creating local jobs. These values deeply resonate with several of the cross-cutting priorities set out by the CAP update in 2018: (1) social and racial equity, (2) good jobs, green jobs, (3) resilience to the impacts of climate change, and (4) local businesses taking climate action. *Cleveland's Clean and Equitable Energy Future* was built around these core public values to provide impactful, equitable, and economic pathways to transition the entire city to 100 percent clean energy by 2050.

Social and racial equity

Good jobs, green jobs

Resilience to the impacts of climate change

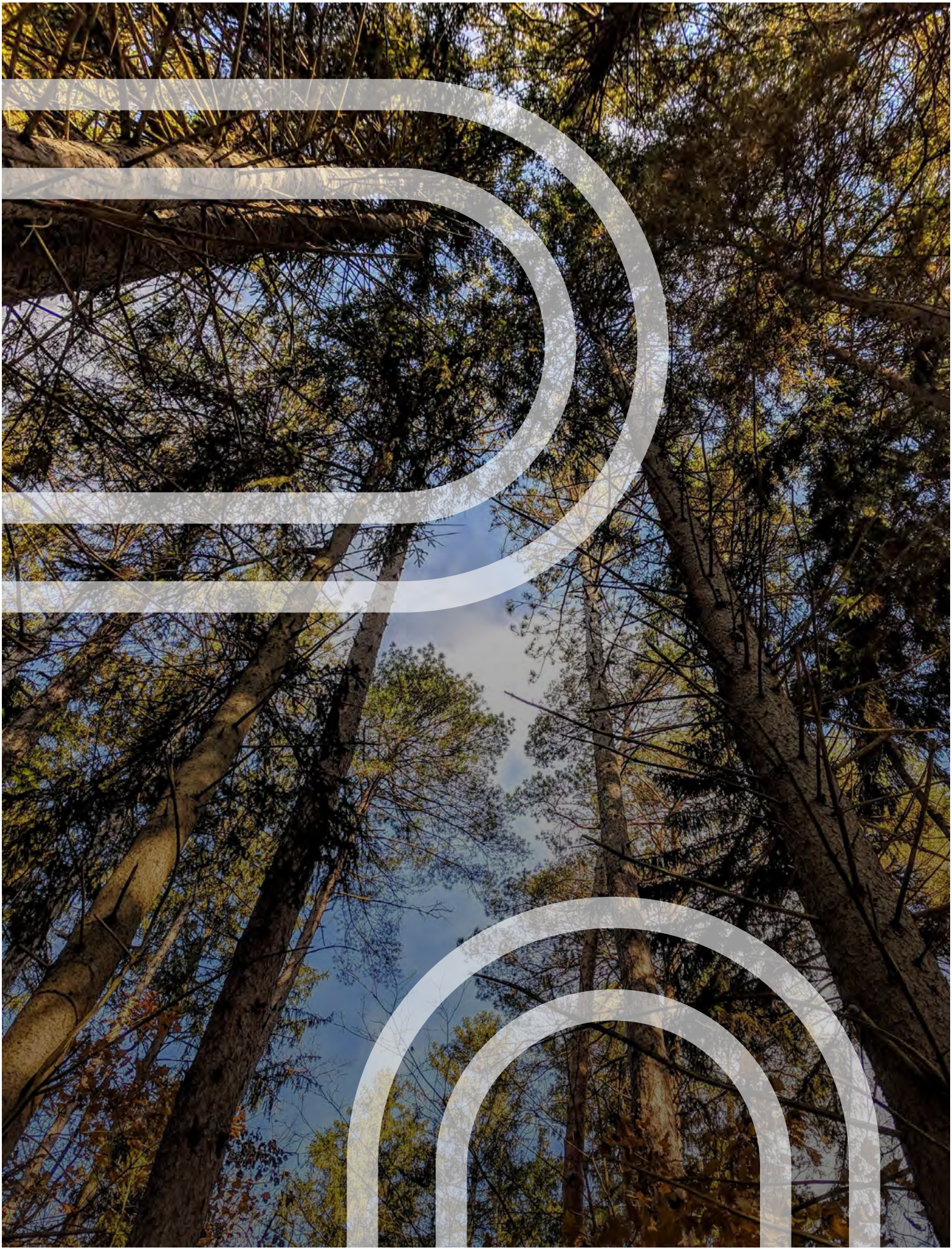
Local businesses taking climate action

The Mayor's Office of Sustainability and Core Partners also engaged Greenlink Analytics to provide a deep quantitative analysis of current and projected future energy use by the City of Cleveland and the Cleveland community. A sophisticated understanding of the energy landscape, rapidly decreasing renewables costs, innovative new technologies, market dynamics, and complex regulations greatly informed clean energy pathway modeling and development of this Plan. The modeling demonstrated there are multiple economic pathways for the city to achieve its 100 percent clean energy objectives, while also generating millions of dollars of public benefits to the Cleveland community, including utility bill savings for residents, the creation of green jobs, and public health benefits.

Based on modeled energy efficiency, solar, wind, storage, and transportation pathways, this document identifies feasible, impactful, and equitable policy and program actions in each of these sectors that the City of Cleveland can take to achieve 100 percent clean energy. Of those, the City has identified nine immediate actions it will commit to undertake, with another nine under consideration. Effective implementation of this Plan is key to achieving an equitable clean energy transition, with a particular focus on communities disproportionately impacted by climate change and energy inequities. Strong support of clean energy initiatives within the community and municipal government will determine the success of *Cleveland's Clean and Equitable Energy Future*. The City will also need to engage with Cleveland Public Power (CPP), FirstEnergy, the Public Utilities Commission of Ohio, and the Ohio State Legislature, to address systemic barriers to clean energy in Ohio and truly enable the expansion of clean energy opportunities and benefits across the state.

This Plan captures the hopes and priorities of many Cleveland residents - a cleaner, more sustainable, and equitable energy system that provides numerous benefits such as addressing systemic inequities; sustainable economic growth; improved risk management and resilience to climate change; healthier communities; and a more educated population prepared with the necessary tools and resources to take action at home, at work, and in their communities.

> *In 2018, Mayor Frank G. Jackson announced his commitment to combat climate change by transitioning to 100 percent clean and renewable energy sources by 2050.*



About *Cleveland's Clean and Equitable Energy Future*

"Over 15,000 people from across the community came together to help make tangible progress around renewable energy, local food, clean water, sustainable transportation, vibrant green space, and so much more."

While climate change is a global phenomenon, its harmful effects are felt locally. Many cities are intensifying their sustainability commitments and playing an important role in demonstrating shared energy priorities by transitioning towards clean and renewable energy. Cleveland has been at the forefront of these efforts. In 2009, Mayor Frank G. Jackson launched the Sustainable Cleveland 2019 initiative. Tied to the 50th anniversary of the Cuyahoga River catching fire for the last time, Sustainable Cleveland was designed to be a blueprint for reducing the city's carbon footprint, creating healthy and resilient neighborhoods, and fostering equitable economic development. During the initial ten years, over 15,000 people from across the community came together to help make tangible progress around renewable energy, local food, clean water, sustainable transportation, vibrant green space, and so much more. Based on the success of the initial ten years, Sustainable Cleveland is continuing beyond 2019 in order to:

- Build on the community-level momentum that was developed over the initial 10-year initiative;
- Organize collective, community-focused efforts to create healthier and resilient neighborhoods; and
- Identify how to use sustainable solutions to improve the quality of life for all residents.

At the heart of this progress and continuing efforts is the Cleveland Climate Action Plan (CAP). Launched in 2013 and updated in 2018, the CAP sets the course of action necessary to address the challenges associated with climate change in a contextually appropriate fashion. During the 2018 update process, the City of Cleveland Mayor's Office of Sustainability brought together a 90-member Climate Action Advisory Committee (CAAC) to help shape the CAP. Additionally, in order to align the CAP with community needs and ensure voices that are not traditionally part of the sustainability process were heard, the Mayor's Office of Sustainability coordinated twelve neighborhood-level community engagement sessions across the city. At these sessions, over 300 residents shared how they would like to see their neighborhoods improved.

Based on all of this feedback, the updated CAP outlined five focus areas – Green Building and Energy Efficiency; Clean Energy; Sustainable Transportation; Clean Water and Vibrant Green Space; and More Local Food, Less Waste – and four cross-cutting priorities – Social and Racial Equity; Good Jobs, Green Jobs; Climate Resilience; and Business Leadership. These focus areas and cross-cutting priorities incorporate multiple benefits and priorities, in addition to emission reductions remaining at the heart of the document. Nearly half of the actions in the updated CAP focus on energy efficiency and clean energy, reflecting this community-wide priority. The updated CAP Clean Energy focus area objectives, therefore, include a combination of renewable energy, fuel switching and re-use, and advanced technologies such as:

- Generate more solar energy locally;
- Improve access to affordable clean energy for residents and small organizations;
- Reduce commercial and industrial emissions with advanced technologies;
- Establish an offshore wind industry in Northeast Ohio;
- Use advanced technology to build a cleaner, safer, and smarter city;
- Support clean energy policy.

The updated CAP Green Building and Energy Efficiency focus area includes the following key objectives:

- Make more homes affordable, comfortable, healthy, and energy efficient;
- Prioritize energy efficiency for small and mid-size businesses;
- Support community hubs to be more efficient and resilient; and
- Promote new construction and major renovations that meet high green building standards.

Transitioning to clean energy is especially important for an older, industrialized city like Cleveland. The city is still heavily dependent on electricity generated from fossil fuels.[1] Cleveland's air quality, while improving in recent years, still produces higher than average asthma rates, in part due to burning fossil fuels. Despite Cleveland's total wealth increasing steadily since the Great Recession, incomes for low-income households have not kept pace.[2] While these trends are not unique to Cleveland, they are amplified in a legacy city where about half of all children are living in poverty. Importantly, low-income people and people of color, on average, spend a disproportionately large amount of their income on energy-related costs.[3]

Given these realities, the CAP established a series of aggressive emissions related goals, including achieving greenhouse gas emissions reduction goals of 40 percent by 2030 and 80 percent by 2050, and reaching a citywide goal of 100 percent of electricity demand from clean and renewable sources by 2050. With this second goal, Cleveland became the first city in the State of Ohio to commit to powering itself with 100 percent clean and renewable electricity. Currently, there are over 150 committed cities and towns across the U.S. and over 100 million people that now live in a place committed to 100 percent renewable energy targets with Cleveland residents being among them.

Having established that the community is firmly behind a long-term focus on clean energy, a clear next step has emerged: an actionable transition plan to 100 percent clean and renewable electricity demand that meets the CAP objectives while also fully integrating each of the cross-cutting priorities. For the purpose of *Cleveland's Clean and Equitable Energy Future* Plan, the definition of 'clean energy' has been limited to electricity derived from renewable fuel resources such as solar, wind, hydroelectric, geothermal, biogas, tidal, energy storage, and renewable energy credits (RECs), as well as energy efficiency and conservation related to electricity. Energy that is conserved and therefore that is not used in the first place remains the cleanest form of energy.

Currently, the City of Cleveland receives about 13 percent of electricity from renewable sources. There are a number of existing assets to work with to increase

this number, such as municipal aggregation, a municipal electric utility, offshore wind potential, vacant land for solar, and engaged stakeholders, among others. Even without this Plan, that 13 percent will continue to inch up over time because of current market and utility trends. However, getting to 100 percent and ensuring everyone experiences the benefits of clean energy will require intentionality, engagement, deep technical analysis, strong policy, and accountability.

This Plan serves as a roadmap for an actionable implementation of a 100 percent clean electricity or energy transition that benefits all, especially those suffering the worst energy inequities, and galvanizes coordinated action among all stakeholders such as local and state government, businesses and industry, utilities, neighborhood groups, educational institutions, and the nonprofit sector. This Plan provides:

- A practical, structured framework that is achievable based on the current regulatory context and conditions in Cleveland and the State of Ohio;
- A process to engage not only local stakeholders in Cleveland, but also other cities working on clean energy at other levels of government, including the state and federal level; and
- An equity focused approach that provides greater access to small business contracts and jobs in the growing clean energy and energy efficiency sectors.

As the City strives to achieve a 100 percent clean energy goal, success will not only be measured by the amount of greenhouse gas emissions saved, but also several other important metrics: equitable access to clean energy, the creation of new clean energy jobs and businesses, energy savings, and the broader impact of a thriving, new energy economy in Northeastern Ohio where all residents can access the economic and environmental benefits of clean energy.

13%

Currently, the City of Cleveland receives about 13% of electricity from renewable sources.

40%

The CAP update established a series of aggressive emissions related goals, including achieving greenhouse gas emissions reduction goals of 40% by 2030.

100%

Cleveland became the first city in the State of Ohio to commit to powering itself with 100% clean and renewable electricity.

EQUITY IS A CRITICAL OBJECTIVE OF THIS PLAN

Equity is a critical component of Cleveland's overall sustainability efforts. During the 2018 CAP update, the Mayor's Office of Sustainability, reflecting the overall priorities of Mayor Jackson, embedded racial equity as an intentional priority in the planning process. This effort began by defining specific equity goals which included structuring the CAP to:

- Promote the creation of employment and small business and entrepreneurial opportunities with potential to lift up and empower communities;
- Mitigate environmental factors leading to health disparities, such as barriers to active lifestyles and transportation, pollution exposure, and disparate access to greenspace and other natural resources;
- Promote investments in housing energy efficiency that will make them safer, more comfortable, and affordable; and in community infrastructure that enhances the ability to respond to climate change, pedestrian and bike safety, and other elements of resilience;
- Include communities of color and under-represented populations in the CAP process, from defining priorities at the neighborhood level to implementation via the Cleveland Climate Action Fund; and
- Serve as a foundation to guide decision-makers through the process of recognizing inequities, the conditions under which they thrive, and the possible solutions and environments that would mitigate negative effects and enhance positive results.[4]

To support the activation of these goals, all members of the Climate Action Advisory Committee (CAAC) participated in the Racial Equity Institute's training program. Based on this training, as well as what was learned through the twelve community meetings, the Mayor's Office of Sustainability developed a Racial Equity Toolkit. This Toolkit consists of a series of simple questions designed to evaluate how impactful specific actions could be at addressing equity. These questions included:

- Have communities of color been engaged and does the proposed objective align with existing neighborhood priorities?
- How do we track the outcome we are looking for and can the data be disaggregated to illuminate disparity?
- Who will benefit and who will be burdened by this action?
- Do the proposed objectives support communities of color and low income populations through workforce development and economic opportunity?
- Is the language we are using easily understood and accessible?[5]

Every action or goal in the CAP was evaluated using this tool, and if it did not support the broader equity objectives it was deprioritized. To continue the efforts begun with the CAP, this Plan works to ensure that a transition to 100 percent clean energy can have substantial equity benefits within the Cleveland context.

ENERGY EQUITY

A key climate equity metric for Cleveland residents is "utility burden," which refers to the percentage of income households use to pay utility bills, including electricity, gas, and water. Nationally, energy bills for electricity and gas represent about 3.6 percent of the average household's income. Households are considered in high energy burden if they spend over 6 percent of their income on energy bills, and in severe energy burden if they spend over 10 percent. Across the city, Cleveland has a high average energy burden of 6.6 percent as of 2019, which is significantly higher than the national average.

More than 100,000 Cleveland households live in high energy burden (above 6 percent) and over 40,000 households live in severe energy burden (above 10 percent). Furthermore, when Cleveland's energy burden is mapped neighborhood by neighborhood in the Greenlink Equity Map (GEM) platform, data shows that energy burdens are unequally distributed through the city **(Figure 1-1)**. Residents in the eastern parts of the city disproportionately carry high and severe energy burdens. Of the census tracts in Cleveland, almost 75 percent of them are highly energy burdened (exceeding 6 percent), the vast majority of which are communities of color.[6]

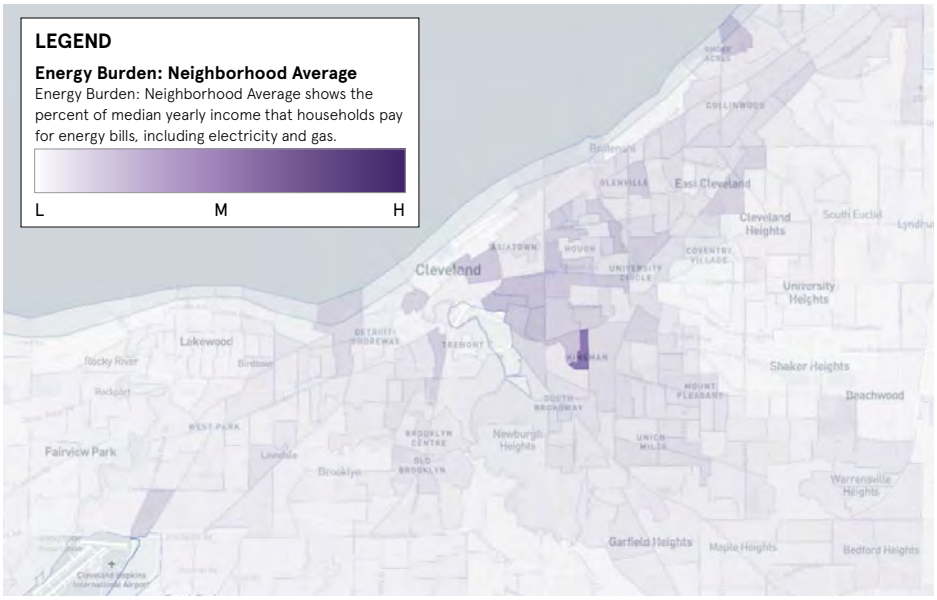


Figure 1-1. High energy burdens are unequally distributed across Cuyahoga County. Source: Greenlink Equity Map (GEM). GEM is an online mapping platform designed to help cities visualize equity-related issues and how burdens are spread across neighborhoods. The GEM platform provides equity indicators at a neighborhood level to assist cities in understanding the current situation of their communities, providing critical data resources to build strong city-community partnerships, and building more equitable climate solutions.

Cleveland's top 20 most energy burdened census tracts have an energy burden around 19.2 percent.

Energy burden concerns are not separate from issues of poverty; Cleveland's top twenty most energy burdened census tracts have an energy burden around 19.2 percent and an average income of $12,000. According to a study by the American Council for an Energy-Efficient Economy (ACEEE) and the Energy Efficiency for All (EEFA) coalition, Cleveland ranks very high in energy cost burden for low-income and underserved communities.[7]

High energy burdens and the resulting financial constraints can affect an individual's quality of life and potentially put them in difficult or dangerous situations, especially if residents end up forgoing food, medical care, or heating and air conditioning to save on bills - situations reported by more than 30 percent of the U.S. population.[8] These burdens can also cause increased levels of stress or health concerns, especially for elderly people and infants. The importance of addressing utility burden has become increasingly clear in light of the evidence that difficulty paying their utility bills is the most common reason that people use short-term loan products, which could result in bad credit, high debt, and an overall decrease in financial health in a community as people struggle to pay.[9]

Viewing clean energy with an equity focus can put into perspective some of the mental and physical health conditions that adversely affect urban communities and households generally carrying the highest energy burden. For example, shorter life spans and physical health challenges from poor air quality, unclean drinking water, and obesity all have the potential to be combated in part by developing clean energy infrastructure.[10]

The Cleveland-Akron-Canton metropolitan area ranked **11th of 204** other metropolitan areas surveyed in the U.S. for annual high particulate pollution.

Historically, Cleveland residents have endured oppressive tactics such as redlining and neighborhood disinvestment leading to the decline of urban communities. These and other structural and systemic challenges like low wages, the wealth gap, financing barriers,[11] poor housing quality,[12] and higher costs for energy efficient equipment for local retailers,[13] cause low-income communities and communities of color to face higher barriers to accessing opportunities to alleviate high utility burdens.[14, 15] In the American Lung Association's 2020 State of the Air Report, the Cleveland-Akron-Canton metropolitan area ranked 11th of 204 other metropolitan areas surveyed in the U.S. for annual high particulate pollution.[16]

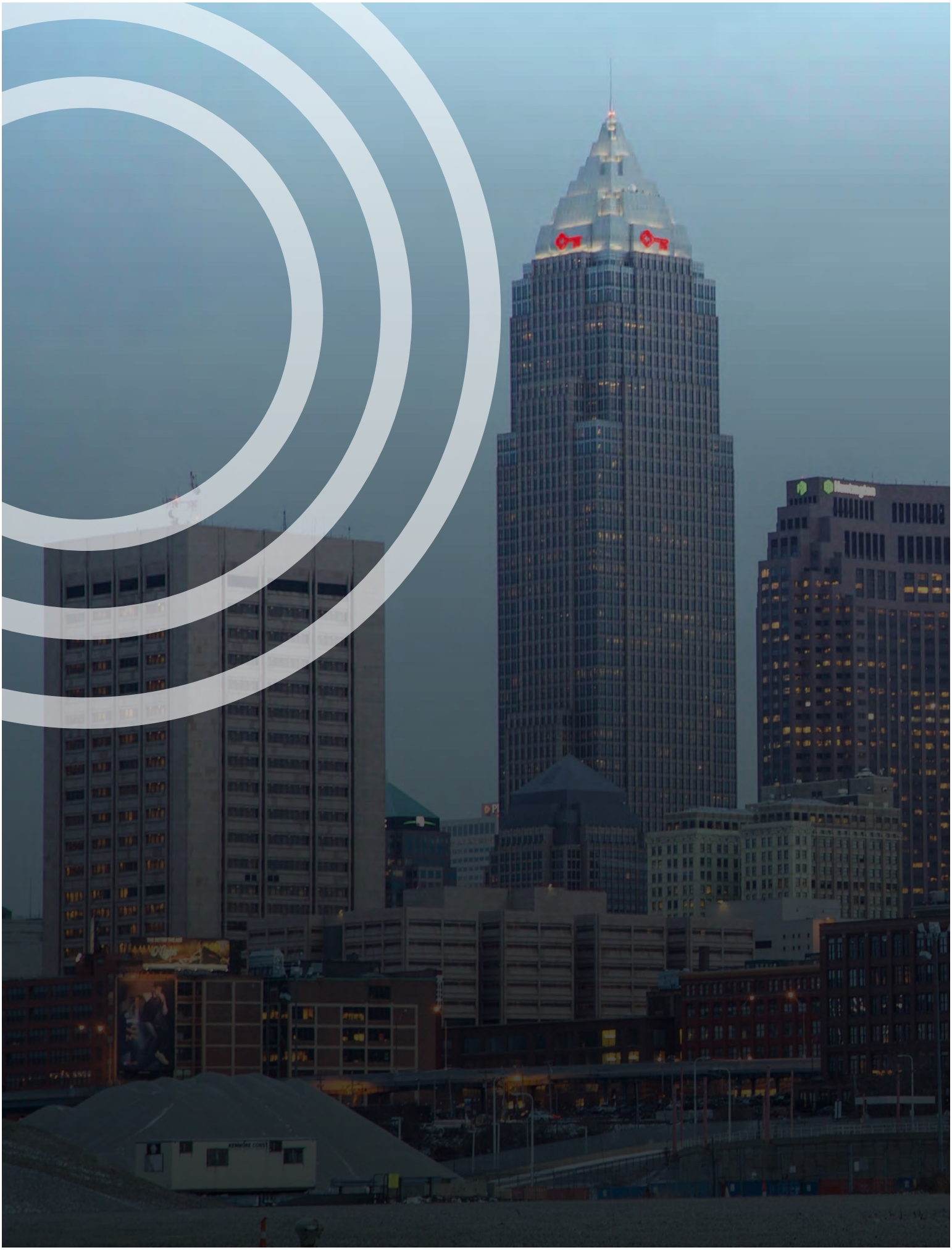
Alone, each of these disparities represent significant burdens. Taken together, these disparities and equity gaps present a challenge and a call to action to increase equitable outcomes through clean energy access. Increasing energy efficiency and use of clean energy on-site could reduce energy burden for families and improve the quality of life in these communities. This model is supported by other cities committed to 100 percent renewable energy and looking at how they're ensuring an equitable clean energy transition. In 2014, Burlington, Vermont became the first U.S. city to be powered by 100 percent renewable energy. Eager to do more,

Burlington leaders have committed to becoming a Net Zero Energy city by 2030. In order to address both equity and energy, Burlington Electric offers incentives to help low-income customers switch to heat pumps to heat and cool their homes. The City Council has also approved a recommendation to weatherize all rental properties making property owners responsible for insulating homes properly and sealing leaks which reduces energy burden and overall usage for low-income residents.[17]

The actions Cleveland takes to achieve its 100 percent clean energy target will directly affect the benefits and are at the core of the city's economic activity. This Plan illustrates how a transition to clean energy can advance energy equity, address climate concerns, create thousands of good green jobs, amplify small business participation in building a clean energy infrastructure, and make Cleveland a healthier, more resilient community.

Cleveland's Clean and Equitable Energy Future is a roadmap for the implementation of 100 percent clean energy transition that benefits all residents. To fully develop the Plan, the City of Cleveland:

- Secured grant funding for plan development;
- Assembled a Core Team including Cleveland Neighborhood Progress, Cleveland Foundation, Cray Consulting Group, Greenlink Analytics, The George Gund Foundation, and the United Black Fund of Greater Cleveland;
- Conducted community engagement to use the top priorities of the community to inform the Plan;
- Analyzed clean energy pathways to understand the city's current energy usage and potential pathways to achieve the 100 percent goal;
- Evaluated clean energy policy and program actions that support clean energy pathways; and
- Identified specific commitments for clean energy implementation.



Cleveland's Electricity Landscape

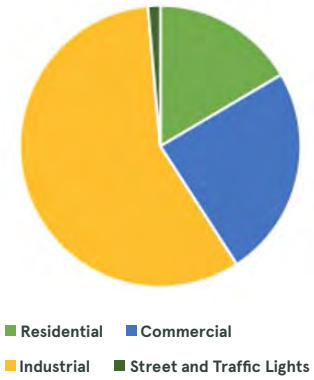


Figure 2-1:
Cleveland's electricity consumption by sector

To better understand how Cleveland will achieve its ambitious 100 percent clean energy goal, it is critical to first understand Cleveland's current electricity landscape. In 2018, Cleveland used about 6.4 million MWh of electricity, a little over 4 percent of the demand for the entire State of Ohio.[18] Cleveland's largest electricity consumers are industry and manufacturing, which use about 60 percent of electricity in the city. Commercial buildings make up another 23 percent of the total, followed by residential homes, which use roughly 16 percent of electricity in the city.[19] Finally, street and traffic lights account for the final 1 percent of electricity demand in Cleveland. If no new actions on clean energy or energy efficiency are taken, electricity use in Cleveland is expected to increase over 20 percent to 7.7 million MWh per year by 2050.[20] As a point of comparison, this 1.3 million MWh increase would be the equivalent of more than doubling the consumption from households in Cleveland. This substantial increase highlights the pressing need for action on Cleveland's CAP goals related to 100 percent clean energy, not just by the City but also by numerous Cleveland stakeholders including industry, businesses, utilities, and residents.

REGULATORY ENVIRONMENT

When evaluating clean energy options, such as solar, wind, hydroelectric, geothermal, biogas, tidal, energy storage, renewable energy credits (RECs), and energy efficiency, Cleveland starts by considering the electric utilities that service Cleveland and their regulatory structures. Cleveland's electricity is delivered by Cleveland Public Power (CPP) and the Cleveland Electric Illuminating Company (Illuminating Company or 'CEI'). CPP is a municipally owned public power utility and the Illuminating Company is a subsidiary of FirstEnergy, one of the country's largest publicly-traded investor-owned utility holding companies. Approximately 25 percent of the city's overall energy load (annual MWh consumption) across all sectors is served by CPP, and 75 percent by the Illuminating Company. Approximately 40 percent of the residential and commercial sector load is each served by CPP, and 60 percent by the Illuminating Company, respectively. The Illuminating Company serves approximately 85 percent of the industrial sector load, compared to 15 percent by CPP, which accounts for the larger overall consumption from the Illuminating Company.[21]

Both CPP and the Illuminating Company distribute electricity to their customers from electricity generated within PJM Interconnection LLC's (PJM) territory. PJM is a regional transmission organization (RTO), and operator of

the largest wholesale electricity market in the country, covering part or all of 13 states and Washington, DC.[22] PJM is subject to rules and regulations issued by the Federal Energy Regulatory Commission (FERC), an independent arm of the U.S. Department of Energy. Ohio operates in a deregulated environment, whereby customers of investor-owned utilities such as CEI, have a choice of where their energy supply comes from. In addition to short and long term supply contracts, the balance of power supplied to Cleveland to match demand ultimately comes from generators bidding to sell their power in PJM, in block or "day ahead" markets.

In addition to this complex set of market relationships, there are also regulators and legislators to consider. Cleveland Public Power, as a municipal electric utility, is regulated by the City of Cleveland's codified charter, City Council and City administration. This allows CPP greater flexibility in program design, rates, and generation decisions, compared to the Illuminating Company which is regulated by the Public Utilities Commission of Ohio (PUCO). The five PUCO Commissioners are governor appointees that oversee utility service providers, including electricity and natural gas, and "ensure that all residential, business, and industrial utility consumers have adequate, safe, and reliable utility services at a fair price while facilitating an environment that provides competitive choices."[23]

The Ohio Legislature and Office of the Governor also have broad authority in establishing and enforcing the energy policies of the State of Ohio. The legislature has the ability to provide incentives, create market rules, and require expanded clean energy portfolios, which the governor can choose to sign into law. As a result, the hourly make-up of the City's electricity mix is guided by a combination of day-to-day PJM market forces following FERC rules at rates overseen by PUCO, the City of Cleveland's long-term supply portfolios and efficiency incentives as provided through state legislation, and the City of Cleveland's ordinances and resolutions. Other agencies and organizations play smaller but very important roles, too, such as the Ohio and U.S. Environmental Protection Agencies, focused on public health outcomes, and a myriad of regional and local energy programs and policies.

In particular, state policies and regulations enacted in the past decade have increased the difficulty of achieving Cleveland's goal. Ohio has taken steps to subsidize coal, eliminate supportive policies like renewable portfolio standards and energy efficiency standards, and made it significantly more difficult for wind projects to be developed. These steps, frequently done with the support of major electricity companies in the state, have increased the barriers to clean energy access for Cleveland residents and businesses.

While there are numerous stakeholders over a wide range of jurisdictions and geographies, achieving the 100 percent goal will require moving all of them, from single buildings up to multistate regions, to a more efficient

delivery of energy services and to a completely clean electricity supply. An entire industry needs to be turned. Delaying action allows the investment of tens of billions of dollars into ways of doing things that fail to address equity challenges, the climate crisis, or provide meaningful job growth. The status quo is unsustainable, ineffective, and unfair. The fastest way towards a clean energy future requires strong commitments to community engagement and local partnerships, improved financial and regulatory energy efficiency and renewable energy policies from the state level, and supportive federal clean energy programs. Moving to the energy system necessitated by climate change, called for by justice, and envisioned for a prosperous society will be a critical ongoing challenge over the next several decades.

STRONG ENERGY FOUNDATION

The City of Cleveland is committed to advancing energy efficiency and renewable energy programs by collaborating with public, private, and institutional leaders to develop energy efficiency, wind, solar, and other clean energy capabilities. These collective actions will enable the City to achieve its 100 percent goal. Fortunately, Cleveland is already building on a strong energy foundation.

Cleveland has already made initial progress towards its 100 percent clean energy goal. Cleveland's carbon footprint was calculated in 2018, and the city has seen a 7 percent decrease in carbon emissions from its 2010 baseline emissions. The major contributors to the reduction in carbon emissions relevant to this Plan, were the decreased electricity emissions from a cleaner electric grid, as well as lower overall electricity consumption. CPP's energy portfolio now includes 21 percent from renewable and advanced energy sources, and Cleveland's overall electricity portfolio includes 13 percent from a combination of renewable resources and REC purchases, as of 2018. Over the course of the past decade, Cleveland households have made steady progress towards becoming more efficient electricity users, reducing consumption by an average of 8 percent per household. This stands in contrast to Ohio as a whole, which saw household consumption decline, but only by 1.6 percent over the same period.

From an overall emissions reduction perspective, there was also a reduction in natural gas use in buildings in 2018 compared to 2010, as well as a reduction in industrial and process emissions due to fuel switching from coal to natural gas by large emitters, and reuse of industrial process by-products such as flare gas. The reductions in electricity were somewhat offset by increased emissions from on-road vehicles and industrial activity from economic recovery since the 2008-2009 recession. However, 2018 saw a significant reduction in industrial emissions compared to 2017 and lower overall emissions despite an increase in economic activity, thereby pointing towards a decoupling trend of emissions reductions despite increased economic activity.

CITY INITIATIVES

These emissions reductions have been supported by deliberate efforts by the City of Cleveland as well as through partnerships with various community stakeholders, to be more efficient in energy use across the community. In 2012, the City of Cleveland joined the Cleveland 2030 District, a coalition of building owners, service professionals, and community stakeholders working to transform the built environment of the city through large-scale reductions in energy use, water use, and greenhouse gas (GHG) emissions. Also in 2012, Cleveland demonstrated leadership by joining the U.S. Department of Energy's Better Buildings Challenge, which supports building owners by providing technical assistance and proven solutions for energy efficiency. As part of the Challenge, the City of Cleveland committed to reducing its municipal facilities' building energy usage by 20 percent by 2022, using a 2010 baseline. In 2013, Cleveland adopted a Sustainable Municipal Building Policy to efficiently manage energy, water, waste, and stormwater at City facilities. The policy requires that green building practices are incorporated into the siting, design, construction, remodeling, repair, maintenance, operation, and deconstruction of all City facilities.

Within this framework, the City has made tangible investments to move toward its 100 percent clean energy goal. These investments include a mix of policy and programmatic efforts that have been completed or are currently underway and have been factored into the analysis. These align with best practices or efforts that have proven successful in other similarly situated cities, including:

- *Hiring a full-time energy manager* – The City hired its first full-time energy manager in 2007, and has tasked this position with supporting broad-based efforts to make City operations more energy efficient, conduct community-based analyses, and support efforts to reduce emissions across the region. Recently, these efforts were expanded as the City added an Energy Analyst to create increased ability to perform this work.

- *Tracking and publishing energy usage* – The City has invested in energy tracking software which allows it to assess usage at City facilities, track overall trends, identify opportunities for improvement, and regularly report on progress and savings. This reporting is best encapsulated in annual reports to the Mayor's Cabinet, annual submissions to the Department of Energy's Better Buildings Challenge portfolio, and the Sustainable Cleveland Municipal Operations (SC-MAP) GHG inventory updates.

- *Updating and publishing GHG inventories* – The City also updates community-level GHG data on an annual basis. This data is disseminated through multiple channels including the Sustainable Cleveland dashboard of indicators, Carbon Disclosure Project (CDP) annual report, and to the Global Covenant of Mayors (GCoM).

Approximately **90% of streetlights** have been upgraded and the City is beginning an assessment of energy savings related to the project.

The City required community choice aggregation bidders to provide **100 percent of energy** through clean sources.

- *Establishing an alternative portfolio standard for Cleveland Public Power (CPP)* – As the owner of a municipal utility, the City has an ability to drive clean energy at the utility level. In 2008, the City established an alternative portfolio standard for CPP with targets of having 15 percent of energy from renewable sources by 2015, 20 percent by 2020, and 25 percent by 2025. Currently, CPP has achieved approximately 21 percent.

- *Installing LED streetlights* – In 2019, the City launched an effort to upgrade its over 61,000 streetlights to LED technology under the City's SafeSmartCLE banner. This program was designed to reduce energy usage, improve lighting conditions across the city, and serve as a platform to build additional smart cities solutions on. As of February 12, 2021, approximately 90 percent of streetlights have been upgraded and the City is beginning an assessment of energy savings related to the project.

- *Utilizing community choice aggregation to increase clean energy resources* – Since not all customers are served by CPP, the City also has the ability to engage in community choice aggregation on behalf of residential and small commercial CEI customers. In the most recent iteration, the City required bidders to provide 100 percent of energy through clean sources. As a result, an additional 41,000 residential and small commercial customers are receiving clean energy.

- *Creating a voluntary energy efficiency program for government and commercial enterprises* – Cleveland has a 2030 District affiliate that includes more than 60 million square feet of properties in two districts covering Downtown Cleveland and University Circle. The District has adopted energy and water related goals that are aligned with the CAP and its broader objectives.

- *Funding energy efficiency and conservation programs* – CPP, as well as the City's water and sewer utilities, provide funding support to energy efficiency and conservation programs through direct funding mechanisms to CHN Housing Partners, a local non-profit that provides comprehensive support services to low income residents in Northeast Ohio.

- *Purchasing renewable energy credits (RECs)* – As the City looks to implement clean energy strategies, it has, due to a variety of regulatory and market forces, utilized RECs as a part of its overall strategy. The City has purchased a limited amount of RECs to support a LEED certification project, added to the City's EPA voluntary green power partnership requirements, and has also included RECs in its base bid for municipal electricity supply procurement. While RECs are necessary to support Cleveland's effort to achieve its clean energy goals, they are not ideal due to outsourcing environmental and economic benefits associated with clean energy investments.

COMMUNITY INITIATIVES

In addition to the municipal government, community driven efforts are helping achieve an equitable clean energy transition. Based on the CAP development process and community engagement for this project, it is clear Cleveland's stakeholders care deeply for their city and the health of their communities. Organizations such as the Cleveland 2030 District, Council of Smaller Enterprises (COSE/GCP), Emerald Cities, CHN Housing Partners, Enterprise Green Communities, Cuyahoga Metropolitan Housing Authority (CMHA), Cuyahoga County, and health and higher educational institutions (such as the Cleveland Clinic, University Hospitals, Metro Health, Cleveland State University, Case Western Reserve University, and Tri-C) have made significant inroads with their energy efficiency and clean energy implementation goals. This has also been exhibited by the many grassroots and nonprofit organizations and government entities that have been created or galvanized to address issues that affect Cleveland neighborhoods such as lead poisoning, air quality, and public transportation inequities.

Informed and committed residents and community groups are coming together to change the energy landscape across the city. Resident-owned solar is one of the strategies for building a generational legacy and work is happening around this issue in Cleveland. In the Hough neighborhood, there is emerging activity around the creation of a community solar project, which would be Cleveland's first resident-owned community solar garden. Through this approach, neighbors in the community will be owners of the solar array, bringing financial opportunities to the neighborhood to build a safe, economically stable, and beautiful community. Neighbors could also see discounts on their monthly bills thanks to the benefits of virtual net metering. Through local small grants and other fundraising, the group is engaging community residents in outreach for this initiative.

The Cuyahoga County Solar Cooperative, a part of the Solar United Neighbors network, was launched in 2016 and has completed over 100 installations to-date in the County.[24] This program offers a lower cost of installation to residents by leveraging group purchasing power, and has been a successful mechanism for promoting the benefits of on-site solar as a clean energy resource to the community. In 2020, Go Green Energy Fund was launched by the Growth Opportunity Partners to scale community solar in Cuyahoga County and provide a solar Power Purchase Agreement (PPA) product to small/mid-sized businesses.[25]

Cleveland Solar Cooperative (CSC) is a member-owned cooperative business that helps groups of neighbors in Greater Cleveland come together to envision, develop, and own clean energy assets like solar gardens. Right now, CSC is supporting two resident groups in Detroit-Shoreway and Lakewood developing solar gardens in their neighborhoods. Using the commons model, CSC and its members promote a Just Transition to a new energy economy by increasing access to solar in Northeast Ohio, building community wealth, and fighting barriers of race and class in the environmental movement.

LOOKING FORWARD

In order to reach Cleveland's 100 percent clean energy goals, there needs to be a substantive push forward from the strong foundational initiatives already in place. Taking a business-as-usual (BAU) approach, where the City, community, and utilities stick to existing programs with no additional actions to reduce energy consumption or increase renewable energy generation, will not be sufficient to meet Cleveland's goals.

Under this approach, Cleveland will see an increase in electricity generation from solar installations and a decrease from coal and natural gas by 2050. This is driven by the growth of the solar industry and the continually decreasing costs associated with solar technologies. The areas of PJM primarily responsible for servicing Cleveland will also see a decrease in their reliance on coal as a source of electricity and will expand the role of solar. However, as you can see in **[Figure 2-2]**, the majority of power fueling Cleveland will still rely on coal, nuclear, and natural gas plants for its energy generation in 2050.

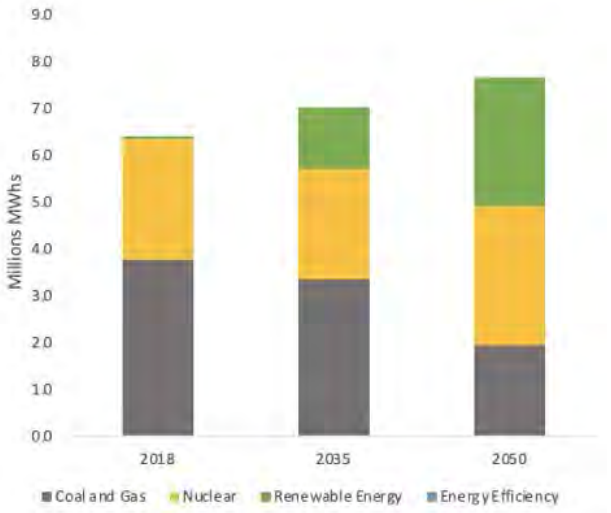


Figure 2-2: Cleveland's projected electricity generation sources under Business-As-Usual

More aggressive action on clean energy is required to achieve broader clean energy benefits not just at the city level but also by partners in the industrial, commercial, residential, and utility sectors, as well as the State and Federal government.

Cleveland's Clean and Equitable Energy Future Plan demonstrates that there are realistic, achievable, and economic pathways to transition the city to 100 percent clean energy by 2050. Moreover, those pathways enable a multitude of other benefits for the entire community. The potential environmental, equity, and economic opportunities outlined in this Plan make it a foundational piece to support a clean and resilient Cleveland. As the City and community embark on *Cleveland's Clean and Equitable Energy Future* Plan, there is an immense opportunity to provide equitable access to better and cleaner energy infrastructure, providing pathways to more just and sustainable outcomes.


FIRE

Stakeholder Engagement Process

Civic participation and engagement were key to the development of *Cleveland's Clean and Equitable Energy Future*. Since launching this project in early 2020, the Mayor's Office of Sustainability engaged a wide variety of Cleveland residents and stakeholders. Although social distancing requirements due to the COVID-19 pandemic limited the project team's ability to have direct, in-person engagement around this important topic, the team was still able to employ virtual engagement strategies to develop the values, direction, priorities, and commitments in this plan. The engagement process sought a broad range of input and consisted of community presentations; an online survey of residents; and discussions with subject matter experts such as CHN Partners, the Federal Reserve Bank of Cleveland, and other stakeholders. The City is committed to conducting continual community engagement and outreach throughout the implementation process, especially with communities that disproportionately bear the impacts of climate inequities.

SURVEY DATA

One engagement pathway for this project was a public, online community survey. Through this process, over 550 Cleveland residents provided their input for Cleveland's 100% Clean Energy Survey. Survey respondents were equally male and female, but were more likely to be middle age, middle to high income, white, and own their homes than the general population in Cleveland. Statistical weights were applied to make the results more generalizable. The results have a margin of error of +/- 7 percent. Below are short summaries of key findings from the survey data – more details can be found in Appendix A.

COMMUNITY SUPPORT

The majority of surveyed Cleveland residents overwhelmingly support the 100 percent clean energy goal with 88 percent of residents supportive of the goal.

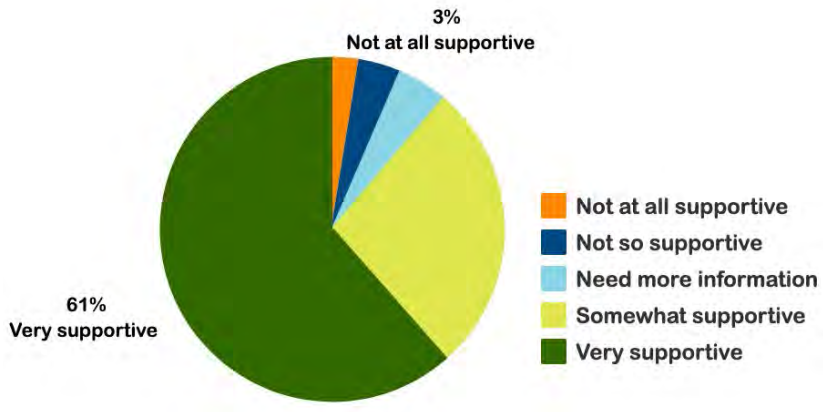


Figure 3-1: How supportive are you of Cleveland's 100% electricity goal?

COMMUNITY PRIORITIES

Residents were surveyed on the level of importance they placed on certain priorities as the city transitioned to 100 percent clean energy.

The top three priorities residents believe are very important for the City to take are ensuring all city residents receive the benefits of clean energy (66 percent), protecting the environment (64 percent), and creating local jobs (61 percent). Using local sources of energy was generally deemed less important.

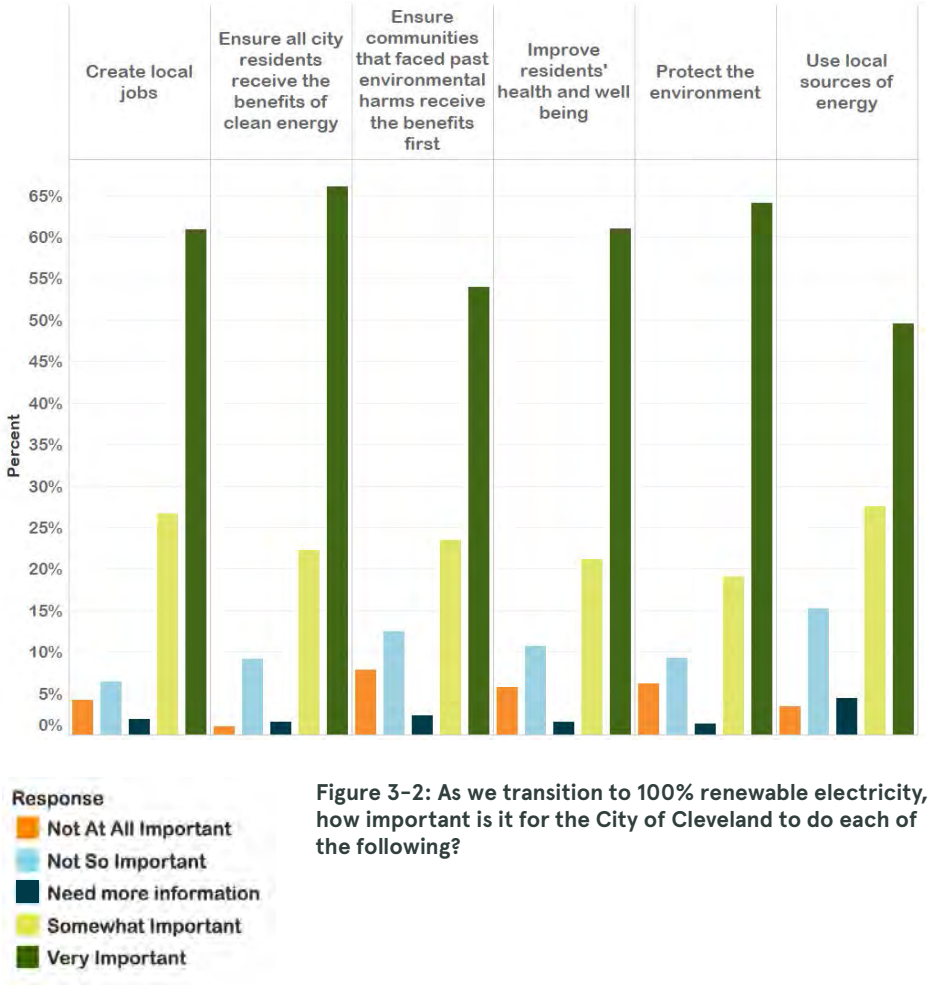


Figure 3-2: As we transition to 100% renewable electricity, how important is it for the City of Cleveland to do each of the following?

COMMUNITY INTEREST

Residents were asked whether they would consider transitioning to 100 percent renewable electricity for their home electricity usage. There was significant community interest in transitioning to clean energy, with 20 percent of survey respondents already participating and 61 percent who are interested but not sure how to make the transition. Creating more awareness of clean energy programs and electric utilities offerings could help increase clean energy deployments rapidly.

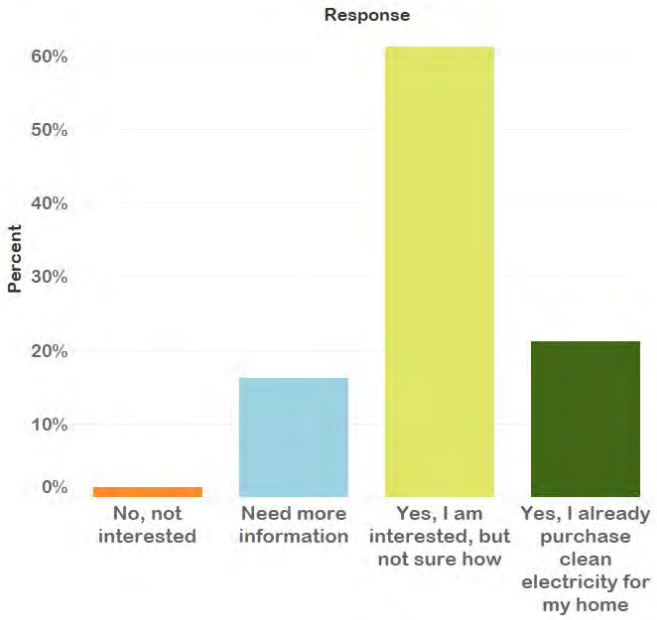


Figure 3-3: Would you consider transitioning to 100 percent renewable electricity for your home electricity usage?

The top three actions residents believe are very important for the City to take are ensuring all city residents receive the benefits of clean energy (66 percent), protecting the environment (64 percent), and creating local jobs (61 percent).

COMMUNITY VALUES

These findings show that surveyed Cleveland residents strongly support the 100 percent clean energy goal and prioritized environmental impacts, equity, and jobs as top clean energy objectives. This community feedback aligns and reinforces three of Cleveland CAP's cross-cutting priorities: (1) social and racial equity, (2) good jobs, green jobs, and (3) resilience to the impacts of climate change. As a result, the City of Cleveland intends to utilize these priorities to evaluate clean energy pathways and actions in this plan.

SOCIAL AND RACIAL EQUITY

The barriers for communities to access clean energy – and its accompanying benefits – are unequal and have been shaped by intentional policy decisions made to institutionalize inequity, disparity, and racism. A meaningful effort is required in order to ensure participation in 100 percent clean energy initiatives is available to historically underserved communities. Because of this focus on equity, the City should take special care to understand and overcome the barriers that help affected communities gain access to the 100 percent clean energy goal. Addressing energy efficiency in Cleveland with an equitable focus and approach is considered a high priority for Cleveland residents as well as investing in clean energy resources that would create more jobs and contribute towards a healthier and more resilient Cleveland.

JOBS AND ECONOMIC DEVELOPMENT

Cleveland has a sizable opportunity for equitable clean energy job creation and workforce development. According to a report completed in 2019 from the nonpartisan business group, E2, Ohio ranked eighth among states for people employed in the clean energy sector. Nearly 113,000 people are employed in Ohio's clean energy sector.[26]

Clean energy industries to watch focus on products and services to improve energy efficiency and building performance, including:

- New construction and remodelers
- Electrical, plumbing, and HVAC (heating, ventilation, and cooling) contractors
- Architectural and engineering services
- Lighting equipment manufacturing

In 2017, the average annual employment wages were $68,038 in these industries in Cleveland, well above the city's median income of $20,400.[27]

CLIMATE IMPACTS

Although all energy sources have some sort of impact on the environment, fossil fuels such as coal, oil, and natural gas do significantly more harm than renewable energy resources. Environmental damage from fossil fuels harms the air, water, wildlife habitat, public health, and is related to increased GHG emissions. Using renewable resources that do not contribute to climate change or air pollution would positively impact the environment, improve public health, and be a core solution to climate change. Additionally, renewable energy sources support climate resilience in the community by broadening the energy supply, providing more options for on-site energy generation and storage, and reducing demand on finite resources.

"Nearly 113,000 people are employed in Ohio's clean energy sector."

Pathways to 100% Clean Energy

"By 2050, the City of Cleveland's total electricity demand is expected to be about 7.7 million MWh if no new actions are undertaken in the Business-As-Usual (BAU) pathway."

As Cleveland looks to achieve the goal of 100 percent clean energy by 2050, there are a multitude of energy resource pathways to consider. At a high level, these pathways include:

- Energy efficiency;
- Clean energy generation including solar, wind, and other potential sources;
- Energy storage;
- Renewable energy credits (RECs); and
- Electric vehicle (EV) adoption and other transit solutions.

By 2050, the City of Cleveland's total electricity demand is expected to be about 7.7 million MWh if no new actions are undertaken in the Business-As-Usual (BAU) pathway. However, with proactive clean energy actions, that demand can be cut substantially through energy efficiency measures, with the city's remaining electricity demand being met by a combination of different clean energy resources. Each clean energy resource has different benefits and limitations depending on the technology and costs, and these are expected to change over time.

Implementing one clean energy resource impacts the need of other resources. For example, if significant energy efficiency investments drive down the total amount of electricity used across the city, less solar energy and fewer RECs may be needed to achieve the 100 percent clean energy goal. It will be essential to determine the right mix of clean energy resources and analyze the costs and benefits of that mix to ensure it achieves the outcomes Cleveland residents desire.

As outlined in the survey results and CAP, equity, green jobs, and climate impacts are several of the highest concerns of Cleveland residents and should be the priority of the City in prioritizing pathways for this 100% clean energy plan (see Section 3 for more details). The modeling provided in the following analysis enables the City to use these three priorities as guiding principles for evaluating the benefits of clean energy resource mixes, in addition to other benefits such as public health, and economic impacts.

MODELING ENERGY PATHWAYS AND ASSUMPTIONS

*The analysis presented in this section represent the best understanding Greenlink Analytics could produce of Cleveland's current and future energy and emissions positions. Some of the methodologies and approaches taken to arrive at these conclusions use advanced modeling techniques and machine learning to derive high temporal and geographic resolution that is not contained in standard protocols. As a result, some numbers presented here may not align with reports that rely on other methodologies.

This analysis utilizes the Advanced Clean Energy Scenario (ACES) tool to evaluate the potential for 12 clean energy resources to contribute to achieving Cleveland's 100 percent clean energy goal without requiring actions outside Cleveland's sphere of control. This approach allows the user to explore an unlimited number of resource pathways to achieving Cleveland's 100 percent clean energy goal and to see the impacts on the future development of the city by achieving specific levels of cost-effective resource potentials. Projected impacts of financial benefits, costs, community-wide energy equity, job creation and economic development, public health, and bill implications are all captured and presented by ACES.

The ACES tool utilizes data from ATHENIA, a machine-learning model of the electricity system developed by Greenlink Analytics. This iteration of ATHENIA constructs hourly electricity demand and supply profiles for the Cleveland grid. Electricity demand modeling uses 60 different building profiles found throughout Cleveland, accounting for differences in building type, age, occupancy patterns, and size. Electricity supply modeling includes the operational characteristics, fuel prices and generation cost, emissions, and waste impacts of each power plant used to generate electricity for Cleveland. ATHENIA is able to determine the price of different kinds of energy resources as well as how much power that resource could provide to Cleveland's grid over time. For example, the cost of solar is expected to decline in the future in Cleveland; this becomes a component of the analysis to determine how much investment in solar compared to different clean energy strategies could lead to 100 percent clean energy for Cleveland.

Using ATHENIA data, the ACES tool offers the ability to forecast and closely investigate how various clean energy pathways can feasibly get Cleveland to 100 percent clean energy, and how those pathways will affect finances, energy bills, jobs, energy burden, and pollution-related health impacts. Several critical definitions of the analysis are outlined below:

- **Total Investment:** Total investment is the capital outlay required to implement a resource pathway. It can be thought of as the total cost of the effort level for a particular pathway.

- **Total Benefits:** Total benefits represent the positive financial and economic benefits resulting from a particular pathway. Benefits include both energy savings and emissions reductions. Energy savings are calculated using a peer-reviewed methodology to simplify utility ratemaking processes starting with current average rates for both the commercial and residential sectors, and projected into the future using anticipated sales, revenues, administrative and programmatic costs, changes in load shapes, and other considerations.[28] Emissions benefits are calculated for seven pollutants (see public health bullet).

- **Net Benefits:** Net Benefits are Total Investment minus Total Benefits.

- **Benefit-Cost Ratio:** One way that people discuss cost-effectiveness is through the benefit-cost ratio, which divides the present value of the benefits by the present value of the costs. There are many variations of this calculation that try to account for different perspectives. The ratio calculated in this tool is an attempt to provide one that looks at the benefits and costs to all stakeholders, called a social benefit cost ratio. A ratio greater than 1 is referred to as "cost-effective".

- **Bill Impacts:** Using the energy savings algorithms mentioned above, ACES determines the total utility costs for each 100 percent clean energy pathway and produces rate and bill impacts for the residential and commercial sector disaggregated into "participants" and "non-participants," where "participants" are those who receive the clean energy interventions called for under the pathway and "non-participants" are those who do not. This is one way to consider access and equity in a pathway.

- **Economic Development Impacts:** A Cleveland-specific characterization of the economy calculates economic development impacts, such as changes in job creation and income. Jobs are calculated as total full-time equivalents for one year of employment. These include direct, indirect, and induced jobs across the economy. Net job-years reflect the investment made toward clean and renewable energy sectors as well as the decrease in investments toward traditional fossil fuel jobs and spillover effects from both across the economy.

- **Energy Equity:** The tool estimates the percentage of Cleveland's residents' income spent on energy bills in 2050, if and when clean energy actions are undertaken.

- **Public Health:** The model analyzes where and when power plant pollution emissions will change and how those pollutants such as nitrogen oxide (NOx), sulfur dioxide (SO_2), particulate matter with a diameter of 10 microns (PM10), particulate matter with a diameter of 2.5 microns or less (PM2.5), ammonia (NH_3), volatile organic compounds (VOC), and carbon dioxide (CO_2) will be dispersed. It then determines how much clean energy could potentially reduce pollution levels and decrease corresponding health care costs. All pollutants except CO_2 receive damage estimates based on a reduced form Gaussian plume dispersion and gross economic damages model that has been widely cited in the environmental economics literature.[29] CO_2 uses the central damage trajectory from the U.S. Interagency Working Group 2016 Technical Support Document for the Social Cost of Carbon.[30] The "social cost of carbon" (SCC) is an estimate of the monetized damages associated with an incremental increase in carbon emissions in a given year. It is intended to include changes in net agricultural productivity, human health, property damages from increased flood risk, and the value of ecosystem services.

- **Additional Modeling Assumptions:** All cash flows are 2018 dollars, discounted at 3 percent to produce present-value dollar values per guidance for government investments from Circular A-4.[31]

Overall, ACES helps the City better understand the investments, benefits, and costs of different clean energy resource pathways, which will enable Cleveland to make more efficient and equitable decisions that best align with public values as it takes action in achieving its clean energy goal.

"BUSINESS-AS-USUAL" (BAU) CALIBRATION

The first step of the Cleveland clean energy analysis is considering the electricity demand for Cleveland under BAU conditions. This BAU calibration considers Cleveland-specific economic growth, technology development, changes to the power supply, and more to solve for the most likely outcome if no new clean energy policies are adopted.

Baseline information regarding Cleveland's current levels of energy consumption and building and transportation footprint are taken from Google Environmental Insights Explorer and City of Cleveland greenhouse gas inventories.[32] ATHENIA was calibrated to Cleveland's electricity system balancing area and achieved explanatory power of 0.82 (R^2) in its ability to replicate the hourly behavior of Cleveland's energy system (in practical terms, ATHENIA was able to predict when power plants would be called on to generate with less than 1 percent error). This goodness of fit provides confidence that ATHENIA can successfully forecast future electricity system operations and is capable of projecting new energy futures.

Figure 4-1: 2020 Solar suitability of residential and commercial buildings near the lakefront (left) and Cleveland City Hall (right)[33]

CLEAN ENERGY FEASIBILITY

Following this BAU calibration, the second step is to perform a technical, economic, and achievable study of the dozen clean energy resources. This is informed by the limitations and boundaries for each resource and ensures that no resource in a pathway goes beyond feasible, cost-effective deployment levels. Each resource is assessed individually, accounting for technology improvements, industry learning curves, Cleveland-specific observed adoption behaviors, price effects, and more. Each component of this approach has been peer-reviewed, and the combination and interactions of all resources at this "outer boundary" represent the maximum level of clean energy that City-led policymaking could deliver without changing the policy or program offerings from any other organization or government. This pathway is run separately through ATHENIA to ensure that power grid reliability standards are not harmed, ensuring technical feasibility in the process.

Table 4-1 below shows typical clean energy achievable potentials for Cleveland; some caution should be taken as ACES does not simply hold these values as a constant over the forecast, it accounts for changes in technology, cost, and incentives. This information is intended to provide a ballpark sense of what average year-to-year potentials look like in ACES.

Table 4-1: Maximum achievable clean energy resource levels through 2050 assumptions in ACES

RESOURCE	TYPICAL MAXIMUM ACHIEVABLE LEVEL
Sector-wide Residential Energy Efficiency	1.4% year-over-year consumption savings
Sector-wide Commercial Energy Efficiency	2.6% year-over-year consumption savings
Sector-wide Industrial Energy Efficiency	0.6% year-over-year consumption savings
Sector-wide Residential Rooftop Solar	52 kW per year (new)
Sector-wide Commercial Rooftop Solar	150 kW per year (new)
Community Solar and Utility-Scale Solar	8 MW per year (new)
Increased Utility-Scale Wind	4 MW per year
Sector-wide Residential Battery Storage	940 kWh per year
Sector-wide Commercial Battery Storage	1.4 MWh per year
Light-Duty Electric Vehicle Adoption	Ownership grows by 20% per year
Transit Bus Electrification	100% electrification by 2050
Renewable Energy Credits	Use as necessary to achieve 100% target in 2050

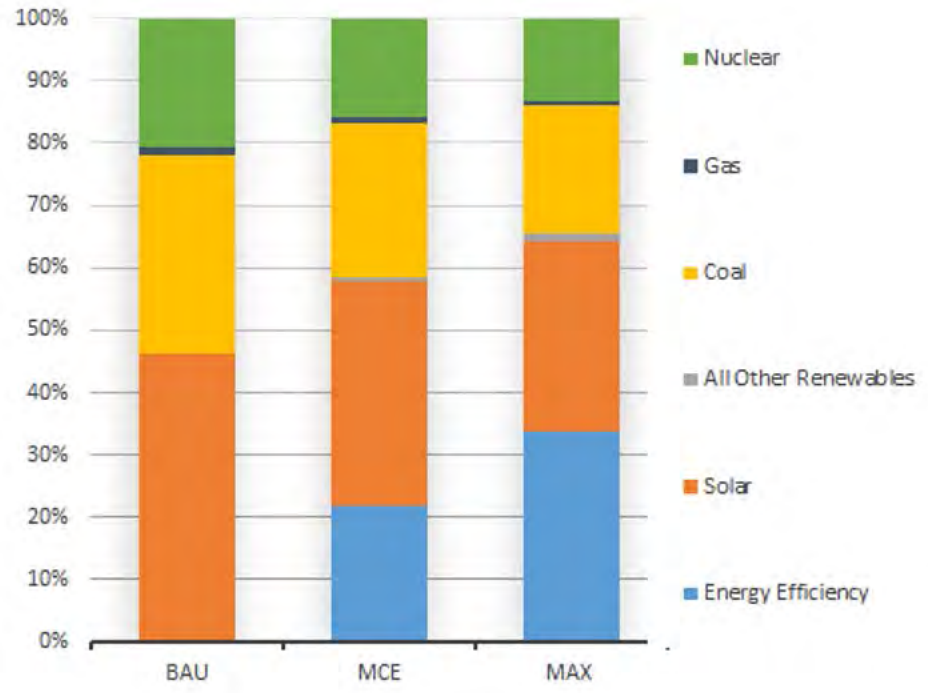
CLEAN ENERGY PATHWAYS

Once BAU and feasibility potentials are derived, the ACES tool enables users to construct different clean energy resource pathways and better understand their impacts. While there are a multitude of different resource pathways possible, three pathways were developed to highlight how the city might achieve 100 percent clean energy and what the associated costs and benefits are. These pathways are all based on existing legal local, state, and federal policies as of Fall and Winter 2020 and will need to be updated periodically due to policy, program, and regulatory changes. The three pathways analyzed in this report are:

1. *Business-As-Usual Pathway (BAU)*
2. *Most Cost Effective Pathway (MCE)*
3. *Maximum Clean Energy Potential Pathway (MAX)*

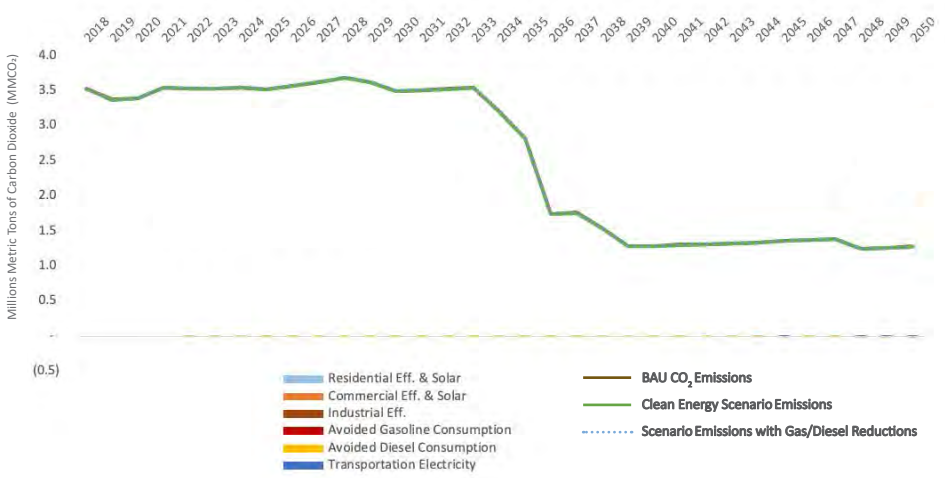
Figure 4-2 shows the different energy fuel mixes for each pathway. These pathways are discussed in more detail below.

Figure 4-2: Fuel mix for each pathway



Business-As-Usual (BAU) Pathway: The BAU Pathway assumes no additional clean energy actions are taken between now and 2050. In 2050, when Cleveland consumes 7.7 million MWh, the City will be required to buy 5 million RECs to achieve its 100 percent clean energy goal to offset its coal, gas, and nuclear use. Cumulatively, CO_2 emissions would drop, but there are few local benefits to Cleveland around equity, green jobs, health impacts, or bill savings, because RECs will support the development of clean energy in other areas of the country, not locally.

Figure 4-3: Cleveland CO_2 emissions trajectories and sources of emission reduction (BAU Pathway)



Most Cost Effective (MCE) Pathway: The MCE Pathway represents the City of Cleveland undertaking strategies to maximize the benefit-cost ratio while achieving the 100 percent goal. ACES shows that the MCE Pathway is an effective mix of energy efficiency, solar, wind, RECs, EVs, and transit. This pathway achieves an average energy efficiency potential of 58 percent across residential, commercial, and industrial sectors; for the residential sector alone, that is equivalent to 58,000 homes cutting their electricity bill in half. Rooftop solar power reaches 65 percent of its total potential, along with 60 percent battery storage, increasing the number of buildings with clean and resilient power supplies by several hundred. The cumulative cost of this pathway is $194 million and has the highest benefit/cost ratio of the three pathways at 6.0, providing $1.2 billion in cumulative benefits. Moreover, the MCE Pathway reduces emissions 17 percent from the BAU Pathway in 2050. REC purchases are reduced to 4 million.

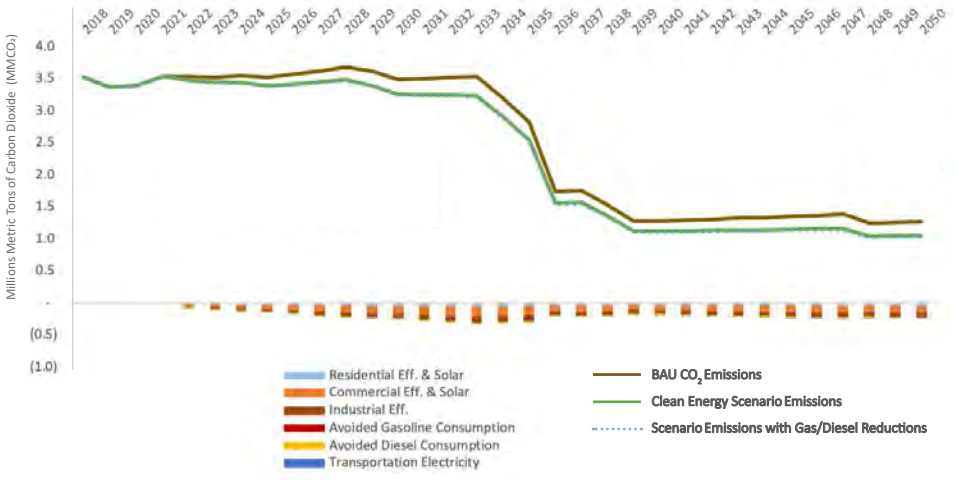
From an equity standpoint, energy burdens on average across Cleveland would decrease from a high energy burden of 6 percent to 3.3 percent by 2050, close to the national average energy burden. This drop in energy burden may be due to several factors, including:

- Expected declines in residential electricity bills,
- A forecast of incomes growing faster than electricity rates over the projection,
- Residents relocating, and
- Successful program implementation for low-income communities.

In 2050 alone, there are $16 million in household bill savings, reducing average monthly electricity bills by $96 for program participants. For jobs, following the most cost-effective approach in this analysis, there will be 2,800 net jobs added.

Figure 4-4 shows the annual tons of CO_2 reduced as a result of the MCE Pathway, broken out by sector source. The brown line shows the CO_2 reductions that would have occurred if no policies had been put in place, while the green line shows the MCE Pathway emissions. In 2050, electricity-related CO_2 emissions will be reduced by 17 percent from BAU, with most reductions coming from expanded energy efficiency efforts.

Figure 4-4: Cleveland's CO_2 emissions trajectories and sources of emission reduction (MCE Pathway)



Maximum Clean Energy Potential (MAX) Pathway: Under the MAX Pathway, Cleveland will invest in reaching all achievable potentials for local clean energy resources including local solar, wind, and renewable energy storage, given regulations in January 2021. The MAX Pathway provides Cleveland with a diverse energy mix of energy efficiency, solar, wind and other renewable electricity to meet electricity demand by 2050. Along with an abundance of renewables and energy efficiency, public and private transportation fleets are electrified in the MAX Pathway. Electrifying the entire bus fleet would enable driving passengers over 20 million miles around Cleveland on completely electrified vehicles through 2050.

The cumulative cost for this pathway is $2.1 billion, however the benefits are about 3.1 times greater than the MCE pathway. Emissions are 67% lower in 2050 than they were in 2018. Public health savings would double compared to the MCE Pathway. From an energy equity standpoint, the average residential energy burden would decrease to 2.9 percent by 2050, below the national average energy burden. In 2050, there will be $24 million in household bill savings. For jobs, the MAX Pathway would add 5,150 net jobs.

In the MAX Pathway, coal and nuclear are significantly displaced by energy efficiency and renewables. Although fewer solar MWs are allocated to Cleveland in the MAX Pathway than the BAU Pathway, this is the result of a smaller energy footprint requiring less utility-scale solar to provide the same total percentage in the grid mix. This Pathway also provides more stability in electricity during times of natural disaster or fuel shortage with more distributed solar plus storage systems deployed. REC purchases are still required, but are reduced again, this time to 3.4 million.

Figure 4-5 shows the annual tons of CO_2 reduced as a result of the MAX Pathway, broken out by sector source. The brown line shows the CO_2 reductions that would have occurred if no policies had been put in place, while the green line shows the MAX Pathway emissions. In 2050, electricity-related CO_2 emissions will be reduced by 9 percent from BAU, with commercial efficiency leading these reductions. However, this story is more complicated, because the greatest emissions reductions overall come from electrification of the transportation sector. Emissions from electricity consumption increases by 230,000 metric tons to charge electric vehicles, but the reduction in gasoline and diesel enabled by this conversion is 900,000 metric tons. If this plan explicitly included the reduction in emissions from transportation liquid fuels, the net reduction in citywide emissions is substantially greater than other pathways.

Figure 4-5: Cleveland's CO_2 emissions trajectories and sources of emission reduction (MAX Pathway)

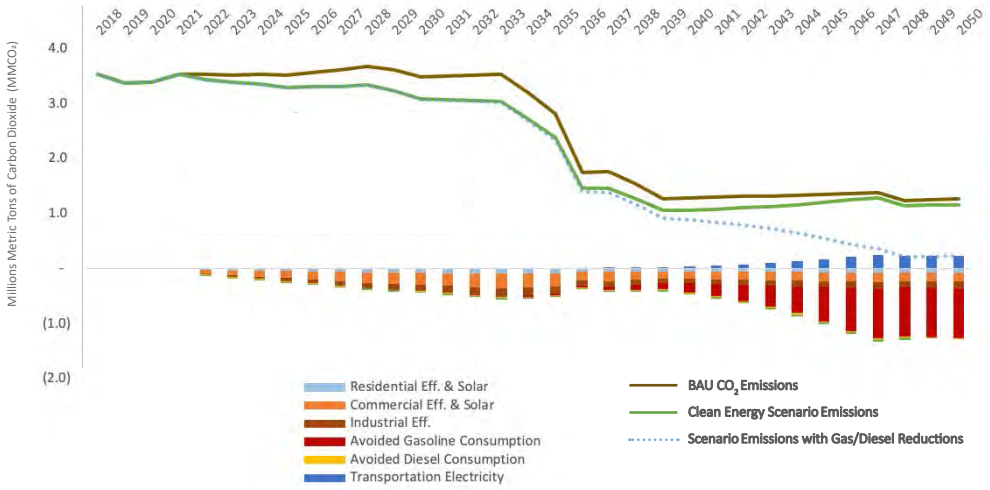


Table 4-2: Summary of benefits of different clean energy pathways

	BAU PATHWAY	MCE PATHWAY	MAX PATHWAY
Cumulative Benefits:	0	$1.2 Billion	$3.6 Billion
Cumulative Costs:	0	$194 Million	$2.1 Billion
Net Benefits:	0	$1.0 Billion	$1.5 Billion
Benefit/Cost Ratio	0	6.0	1.7
Cleveland's Electricity Offset by Building Energy Efficiency	0%	18%	28%
Utility Scale Solar Dedicated Capacity (MW)	1,822	1,498	1,307
Residential Solar Capacity Installed (MW)	0	0.4	0.6
Commercial Solar Capacity Installed (MW)	0	1	1
REC Purchases	5 Million	4 Million	3.4 Million
Reduction in Gasoline Consumption from 2018	48%	48%	100%
Electric Vehicles as a percent of Light-duty Vehicles	23%	23%	100%
Energy Equity: Community wide average of percent of income spent on utility bills	4.2%	3.3%	2.9%
Jobs Created Equal to (x Cleveland Clinic Workforce)	0	2,800 (0.1)	5,150 (0.2)
CO_2 Reduced (MT) (Months Without Cars)	0	17.4 MMT (28)	19.9 MMT (32)
Income Increased (Per Cleveland Resident Per Year)	0	$407 Million ($35)	$1.56 Billion ($135)
Public Health Savings (Monthly Insurance Savings)	0	$130 Million ($1)	$247 Million ($2)
Household Bill Savings	0	$16 Million	$24 Million
Monthly Bill Savings (Participants)	0	$96	$78
Monthly Bill Savings (Non-Participants)	0	$30	$33

CONCLUSION

The BAU Pathway is the least-cost pathway where 5 million out-of-state RECs are purchased to achieve the 100 percent clean energy target for roughly $2.5 million in 2050. However, there are no increased local benefits associated with this Pathway. In comparison, the ACES modeling shows that both the MCE Pathway and the MAX Pathway have high net benefits and billions of dollars of local Cleveland impacts across priorities such as climate impact, equity, green jobs, and public health. Regarding resource mix, both the MCE and MAX Pathways align with the CAP Green Building and Energy Efficiency as well as Clean Energy focus area objectives which include:

- Make more homes affordable, comfortable, healthy, and energy efficient;
- Prioritize energy efficiency in small and mid-size businesses;
- Support community hubs to be more efficient and resilient;
- Promote new construction and major renovations that meet high green building standards;
- Generate more solar energy locally;
- Improve access to affordable clean energy for residents and small organizations;
- Reduce commercial and industrial emissions with advanced technologies;
- Establish an offshore wind industry in Ohio;
- Use advanced technology to build a cleaner, safer, smarter city; and
- Support clean energy policy.

Both pathways prioritize first utilizing energy efficiency to decrease energy use from businesses and residents overall, then generating more clean energy through solar and wind resources, and finally the purchasing of RECs to hit Cleveland's 100 percent target. Given current local, state, and federal regulations, all three pathways require REC purchases, indicating that even if Cleveland did everything it could to maximize energy efficiency and clean energy generation, its efforts alone would still not be sufficient to achieve the 100 percent clean energy goal. This highlights the critical need for clean energy action from many partners across sectors including utilities, the state, and federal government.

Using these modeled resource benefits and costs, the City of Cleveland can identify energy efficiency, solar, and other resource pathways that are economic and feasible with significant local benefits. The next section explores an extensive list of policy and program actions associated with each clean energy resource identified in ACES that can be used by Cleveland and other stakeholders to achieve the 100 percent clean energy goal.

Both the MCE and MAX Pathway have high net benefits and billions of dollars of local Cleveland impacts across priorities such as climate, equity, green jobs, and public health.

Clean Energy Actions

The Clean Energy Pathways modeled in Section 4 demonstrate that there are a multitude of potential pathways the City of Cleveland can take to reach its 100 percent renewable electricity demand target, spanning across energy efficiency, solar, wind, energy storage, RECs, EV adoption, and transit sectors. The Clean Energy Toolkit provides a wide range of policy and programmatic actions in each of these sectors that can be considered for how they will enable Cleveland to reach its clean energy goals.

These actions are tied to best practices or policies and programs that have proven successful in other cities and communities. Each of these actions was evaluated – specifically in the Cleveland context – on three criteria (technical, regulatory, and financial feasibility; environmental emissions impact; and equity impact) and assigned a summed overall score. The policies and programs in this toolkit have been categorized by different energy sectors (although some may have cross-sector impacts), and have multiple potential ownership structures (municipal, utility, community, and shared). **Table 5-1** contains the ranking criteria and **Table 5-2** contains the full toolkit broken out by different energy sectors.

Table 5-1: 100% Clean Energy Policy Toolkit Rating Scale

RATING SUMMARY			
	FEASIBILITY	IMPACT	EQUITY
1	Extremely high level of barriers or very large amounts of financial and/or political resources needed	Very low emissions impact	Very low impact on energy burden or very limited scalability, likely to exacerbate inequity
2	Somewhat high level of barriers or moderate amounts of financial and/or political resources needed	Low emissions impact	Low impact on energy burden or limited scalability, potential to exacerbate inequity
3	Moderate level of barriers or moderate amounts of financial and/or political resources needed	Moderate emissions impact	Moderate impact on energy burden or limited scalability, potential to exacerbate inequity
4	Slight level of barriers or mild amounts of financial and/or political resources needed	High emissions impact	High impact on energy burden or easy scalability, potential reduce inequity
5	Low level of barriers or low amounts of financial and/or political resources needed	Very high emissions impact	Very high impact on energy burden on very easy scalability, likely to reduce inequity

The overall summed score for a policy (Σ) is equal to adding the Feasibility Rating, Impact Rating, and Equity Rating together.
Please note, the equity rating is recorded (1 = -2); (2= -1); (3 = 0); (4 = 1); (5 = 2) due to likely or potential negative impacts on equity.

Table 5-2: 100% Clean Energy Policy Toolkit

ENERGY EFFICIENCY

City

COMPLETED OR UNDERWAY	POLICY AND PROGRAM OPTION	FEASIBILITY	IMPACT	EQUITY	Σ
	Green building rebate for new construction proportional to level achieved via tax abatement	4	3	3	7
	Incentivize greywater use and rainwater harvesting to reduce water usage	3	1	4	5
Completed	**Hire a full-time energy manager**	5	3	4	9
Underway	Ongoing outreach to keep the public aware of progress towards EE and equitability goals	5	3	4	9
	Create a workforce training collaborative to develop a CE and EE workforce	4	2	5	8
	Create Municipal Energy Task Force to identify ongoing municipal EE and CE opportunities	5	2	3	7
	Adopt a building "stretch" code to require new construction to be more EE than state code	1	2	3	3
	Increase EE through updated energy codes and increased enforcement	3	4	3	7
	Phase-in net-zero energy code for new construction	2	5	3	7
	Phase-in net-zero water code for new construction	2	3	3	5
Underway	Improve municipal building lighting	5	2	3	7
	Require energy-using products purchased by municipality to meet EE equipment standards	4	2	3	6
Completed	**Install LED streetlights and traffic signals**	5	2	3	7

EE – Energy Efficiency · CE – Clean Energy · ESPC – Energy Services Performance Contract · LT – Long Term
PPA – Power Purchase Agreement · PV – Photovoltaic · LMI – Low-and-Moderate Income · CHP – Combined Heat and Power

Utility					
COMPLETED OR UNDERWAY	**POLICY AND PROGRAM OPTION**	**FEASIBILITY**	**IMPACT**	**EQUITY**	**Σ**
	Commercial efficiency customer rebate programs to reduce cost of EE technologies and upgrades	3	4	3	7
	On-bill financing for CE and EE upgrades	2	4	4	7
	"Round-it-up" energy and water efficiency programs	3	3	4	7
	Incentives to help business owners reduce energy usage	2	4	3	6
	Incentives to help residents reduce energy usage	2	4	4	7
	Deploy smart grids and meters to allow residents and businesses to monitor and adapt energy use	2	4	4	7
Community					
COMPLETED OR UNDERWAY	**POLICY AND PROGRAM OPTION**	**FEASIBILITY**	**IMPACT**	**EQUITY**	**Σ**
Underway	PACE Program that finances commercial EE and CE investments via property taxes	5	3	3	8
	PACE Program that finances residential EE and CE investments via property taxes	3	3	2	5
	Promote "green loans" to support EE and CE projects	3	5	3	8
	Incremental sales tax option that provides funding for EE and CE expenditures	1	2	1	1
	Implement commercial building audit efforts	2	2	3	4
	Encourage businesses to obtain water efficient certifications for buildings	4	2	3	6
	Improve water and wastewater energy and efficiency	3	2	3	5
Underway	Reduce urban heat island effect	4	3	4	8

Shared					
COMPLETED OR UNDERWAY	POLICY AND PROGRAM OPTION	FEASIBILITY	IMPACT	EQUITY	Σ
	ESPC's to encourage energy savings at no upfront cost to business owners	5	3	3	8
	Bundle EE financing along with CE investments	2	4	5	8
	Create a clean energy task force to identify CE opportunities and provide accountability on goals	5	2	3	7
Underway	Create voluntary EE programs for businesses, manufacturers, and governments	5	2	3	7
	Create a benchmarking and transparency program for building energy and water efficiency	3	4	3	7
	Water efficiency equipment bulk purchasing to reduce cost of water saving equipment	2	2	3	4
Underway	Support EE demonstration projects	4	1	4	6

EE – Energy Efficiency · CE – Clean Energy · ESPC – Energy Services Performance Contract · LT – Long Term
PPA – Power Purchase Agreement · PV – Photovoltaic · LMI – Low-and-Moderate Income · CHP – Combined Heat and Power

CLEAN ENERGY (SOLAR AND WIND POWER)

City

COMPLETED OR UNDERWAY	POLICY AND PROGRAM OPTION	FEASIBILITY	IMPACT	EQUITY	Σ
Completed	**Track, publish, and review municipal energy usage**	5	3	3	8
Completed	**Update and publish GHG inventories**	5	3	3	8
Completed	**Utilize community choice aggregation to increase CE sources**	5	4	3	9
Underway	Utilize municipal facility aggregation to increase CE through RECs and offsite solar development	4	4	3	8
Underway	Install solar PV installations on City owned facilities	4	3	3	7

Utility

COMPLETED OR UNDERWAY	POLICY AND PROGRAM OPTION	FEASIBILITY	IMPACT	EQUITY	Σ
	LT solar energy purchase agreements to buy solar built on municipal or commercial property	5	3	2	7
	Virtual PPA to provide a financial hedge against price fluctuations	3	4	3	7
	Install floating solar PV panels	2	3	3	5

Community

COMPLETED OR UNDERWAY	POLICY AND PROGRAM OPTION	FEASIBILITY	IMPACT	EQUITY	Σ
Completed	**Create solar co-ops to obtain competitive installations through combined purchasing power**	4	2	4	7
	Establish LMI solar funding model	3	3	5	8
	Create community-based solar energy group purchasing campaigns	4	3	5	9
	Expand wastewater CHP	3	2	3	5

Shared					
COMPLETED OR UNDERWAY	**POLICY AND PROGRAM OPTION**	**FEASIBILITY**	**IMPACT**	**EQUITY**	**Σ**
	Develop community solar plants that share solar electricity across more than one property	4	4	5	10
	Promote awareness of existing incentive programs	4	2	4	7
	Develop local micro-grids for critical infrastructure	2	4	3	6
	Revolving CE Loan Fund	3	5	3	8
Completed	**Renewable Energy Credit (REC) procurement**	5	1	3	6
	Compensate for local GHG emissions through purchase of carbon offset certificates	5	1	1	4

EE – Energy Efficiency · CE – Clean Energy · ESPC – Energy Services Performance Contract · LT – Long Term
PPA – Power Purchase Agreement · PV – Photovoltaic · LMI – Low-and-Moderate Income · CHP – Combined Heat and Power

ENERGY STORAGE

City

COMPLETED OR UNDERWAY	POLICY AND PROGRAM OPTION	FEASIBILITY	IMPACT	EQUITY	Σ
Underway	Invest in energy storage technology to support resilience at critical municipal facilities	4	3	3	7

Utility

COMPLETED OR UNDERWAY	POLICY AND PROGRAM OPTION	FEASIBILITY	IMPACT	EQUITY	Σ
	Invest in utility-scale battery systems	2	3	3	5

Shared

COMPLETED OR UNDERWAY	POLICY AND PROGRAM OPTION	FEASIBILITY	IMPACT	EQUITY	Σ
	Energy storage equipment bulk purchasing to reduce cost	2	3	3	5
	Recycle EV batteries in order to provide electricity services and resilience	1	3	3	4

TRANSPORTATION (EV ADOPTION AND PUBLIC TRANSPORTATION)

City

COMPLETED OR UNDERWAY	POLICY AND PROGRAM OPTION	FEASIBILITY	IMPACT	EQUITY	Σ
Underway	Implement high priority segments in walking and bicycling network to reduce motorized trips	4	2	4	7
	Transition city fleet to EVs	4	3	3	7
Underway	Increase mobility options to reduce motorized trips	4	2	4	7
Underway	Upzone near transit stations and decrease parking requirements to boost transit ridership	2	2	4	5
	Surcharge motor vehicle drivers during peak congestion zones to encourage alternative mobility	1	1	3	2
	Increase parking fees in high congestion zones to encourage alternative mobility	1	3	3	4
	Create low emissions zones where high emitting vehicles are restricted	2	1	4	4

Community

COMPLETED OR UNDERWAY	POLICY AND PROGRAM OPTION	FEASIBILITY	IMPACT	EQUITY	Σ
Underway	Expand the existing public transit network to increase efficiency of routes and ridership	3	3	4	7
	Reduce commuting trips through carpooling, parking incentives, and transit incentives	3	4	3	7
	Public transit investments to expand service and increase passenger miles traveled	2	3	4	6

EE – Energy Efficiency · CE – Clean Energy · ESPC – Energy Services Performance Contract · LT – Long Term
PPA – Power Purchase Agreement · PV – Photovoltaic · LMI – Low-and-Moderate Income · CHP – Combined Heat and Power

Shared					
COMPLETED OR UNDERWAY	**POLICY AND PROGRAM OPTION**	**FEASIBILITY**	**IMPACT**	**EQUITY**	**Σ**
	Provide investments in EV education programs to increase the adoption of EVs	3	1	3	4
Underway	Implement behavioral "nudging" program to decrease single vehicle motorized trips	3	1	4	5
	Market transformation programs and financial incentives to increase EV adoption	3	1	4	5
Underway	Ubiquitous EV charging infrastructure	3	3	3	6

Section 6

Economic and Workforce Development Potential with Equity

In addition to the macro-economic and community level health, emissions, and equity data (described in Section 4), ACES has also been designed to estimate new jobs created by clean energy opportunities in various economic sectors. This data is particularly useful as it provides a starting point for communities to assess the potential for new jobs in emerging industries, and align any necessary workforce programs to meet future gaps in available labor supply. **Table 6-1** below contains sectoral employment data for the MCE and MAX Pathways in Cleveland.

Table 6-1: Green job opportunities in Cleveland through 2050 in the MCE and MAX Pathways

NET JOB-YEARS THROUGH 2050		
Sector	*Net Job-Years (MCE Pathway)*	*Net Job-Years (MAX Pathway)*
Construction	464	1,159
HVAC&R	259	648
Water Heating	38	94
Lightning	131	327
Material for Envelope	85	208
Motors, Drives, and back-up generators	29	75
Other Electrical Equipment	56	139
Energy and Environmental Management and Smart Controls	316	794
Insurance and Finance	23	58
Program Administration	127	318
Architecture and Engineering Services	119	298
General Economy	11,550	41,719
Fuel and Utilities	(2,076)	(25,323)
GAIN	13,196	45,836
LOSS	(2,076)	(25,323)
TOTAL NET JOB-YEARS	**11,120**	**20,513**
TOTAL NET JOBS	**2,800**	**5,150**

Individual sectors are measured using "Net Job-Years." A job-year is an economic concept that represents one full-time equivalent maintained for one year or the total number of full-time jobs (40 hours a week) equivalent to one year. For example, one new, full-time job that lasts for five years is equal to five job-years. For the purpose of this report, it is assumed that the average duration of a job is 4 years as the conversion factor between net job-years and net jobs. Measuring net job-years is the best method of assessing employment changes in this analysis because it allows us to account for both non-permanent and/or project-driven employment and when new jobs are created during the relatively long timeline included in this analysis.

"The MAX Pathway would yield 5,150 net jobs in the Cleveland economy."

Following the MCE Pathway, transitioning to 100 percent clean energy- excluding clean public transportation- could create 2,800 net jobs in the Cleveland economy through 2050. By comparison, the MAX Pathway would yield 5,150 net jobs in the Cleveland economy. The corresponding effects on fuel and utilities employment and the full employment picture is shown in job-years in **Table 6-1.** The sectors with the potential for the most job growth can be seen in construction; heating, ventilation, air conditioning and refrigeration (HVAC & R); energy and environmental management and smart controls; program administration; lighting; and in the general economy.

General economy jobs include potential jobs created as a result of investments in energy efficiency and renewable electricity. As efficiency gains and access to renewable electricity result in bill savings, Cleveland residents have more spending power within the local economy. This additional spending power leads to job demand in non-energy focused economic sectors such as entertainment, home improvement, healthcare, and small business.

Nationally-based data show that green energy jobs, such as those included in the analysis above, have higher wages than many other sectors. A Cleveland-specific green employment analysis was completed as a part of the Cleveland CAP process. This analysis supports the conclusion that "green jobs" are "good jobs" in the Cleveland employment market. On average, annual wages of workers in clean energy and energy efficiency related jobs in Cleveland were 13 percent higher than wages in other jobs. More specifically, average annual wages in energy efficiency and green building positions were over $68,000, and average annual wages in clean energy jobs were in excess of $82,000.[34]

Similar to the potential $1.0 billion to $1.5 billion net benefit highlighted in the ACES models in Section 4, these average annual wages, combined with the potential employment growth outlined above under both the MCE and Max Pathways, present another way to understand the economic potential of making the transition to 100 percent clean energy. Being able to effectively

capitalize on these benefits, however, is contingent on ensuring that a sufficiently prepared labor force is available to meet these demands. This has already been contemplated in Cleveland's clean energy planning. The 2018 CAP update includes an objective to "Advance Green Jobs Through Workforce Development."

The specific implementation for this objective included multiple specific actions to follow in order to advance workforce preparedness. This included a task to update green jobs analysis at least every 1-2 years and incorporate a workforce development assessment. After the first analysis completed during the CAP update, the City of Cleveland and Cuyahoga County committed to continue to develop research and institutional partners to fine-tune the analysis approach going forward.[35]

Additionally, the implementation plan included a task to develop a working group comprised of workforce development and training organizations to integrate green jobs into existing work. This working group, led by the City of Cleveland Mayor's Office of Sustainability and Workforce Development, would:

- Develop a tracking method for the above analysis;
- Develop a strategy to engage employers around sharing annual updates, testing trends, and localizing regional/state/national data and share information collected by employers, as well as determining credentials and soft skills needed;
- Work with engagement organizations to determine resident interest in certain green job industries; and
- Develop an engagement strategy that would include, among other things, focus groups, an annual event, a survey, and one-on-one meetings.

Finally, the implementation plan highlights the need to engage community organizations to more effectively build a green jobs awareness and recruitment strategy. Community organizers often get left out of the workforce conversation but are important based on the injustice experienced by those they are organizing. They have to be a part of the early conversations, funded to do organizing, and engaged to understand the present state of the workforce system (with a green jobs context). Their job is not to recruit, but to help raise awareness about the opportunities and why they are important. That way when recruitment begins, residents know what they are being recruited for.

This implementation plan provides a valuable framework to advance the workforce training needs the transition to 100 percent clean energy will create. Data driven best practices highlight the value of workforce pathways that start early. Through exposure to clean energy careers, opportunities for exploration, and experiential learning, youth- with the assistance of caring adults- can be prepared for future clean energy jobs. Programs which include environmental literacy, academic skills, work readiness and career pathways, leadership development, financial literacy, and social entrepreneurship will help support Cleveland's youth to be successful in these roles.

Programs such as Roots of Success utilize a teaching approach and materials which immediately engage individuals who have struggled in school and have barriers to employment. These programs are directly relevant to people who come from low-income communities, and focus on 125 careers that can provide individuals and their families with economic security. The curriculum strengthens academic and professional skills, increases environmental literacy, and inspires individuals to become activists and leaders who can improve conditions in their communities and in society more broadly.

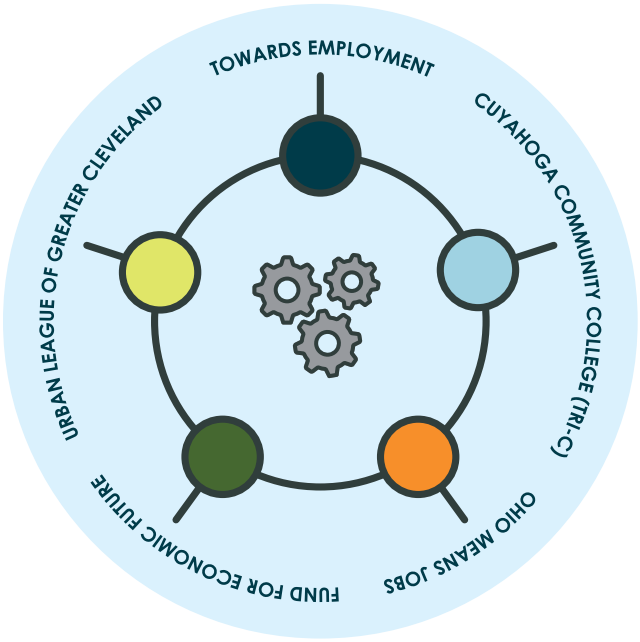
When thinking about the trusted adults that guide and support youth, it is important to consider how to best help frontline community members get trained in clean energy jobs and secure lucrative career paths. In an environment where racial and economic inequality are the defining issues of this time, dismantling systemic racism; reversing inequality; and ensuring that all people can participate, prosper, and reach their full potential are key to the success of the economy and democracy. Achieving equity requires developing bold, targeted, race-conscious strategies that eliminate barriers and expand opportunities. Building systems and programs

that take this into consideration, serve all Clevelanders, and center on innovative, equitable solutions with racial and economic justice as core goals will match the scale and urgency of the challenges being faced- ultimately broadening the probability of frontline community members participating fully in the clean energy economy.

There are multiple potential partners operating in the Cleveland market to support these inclusive strategies, including:

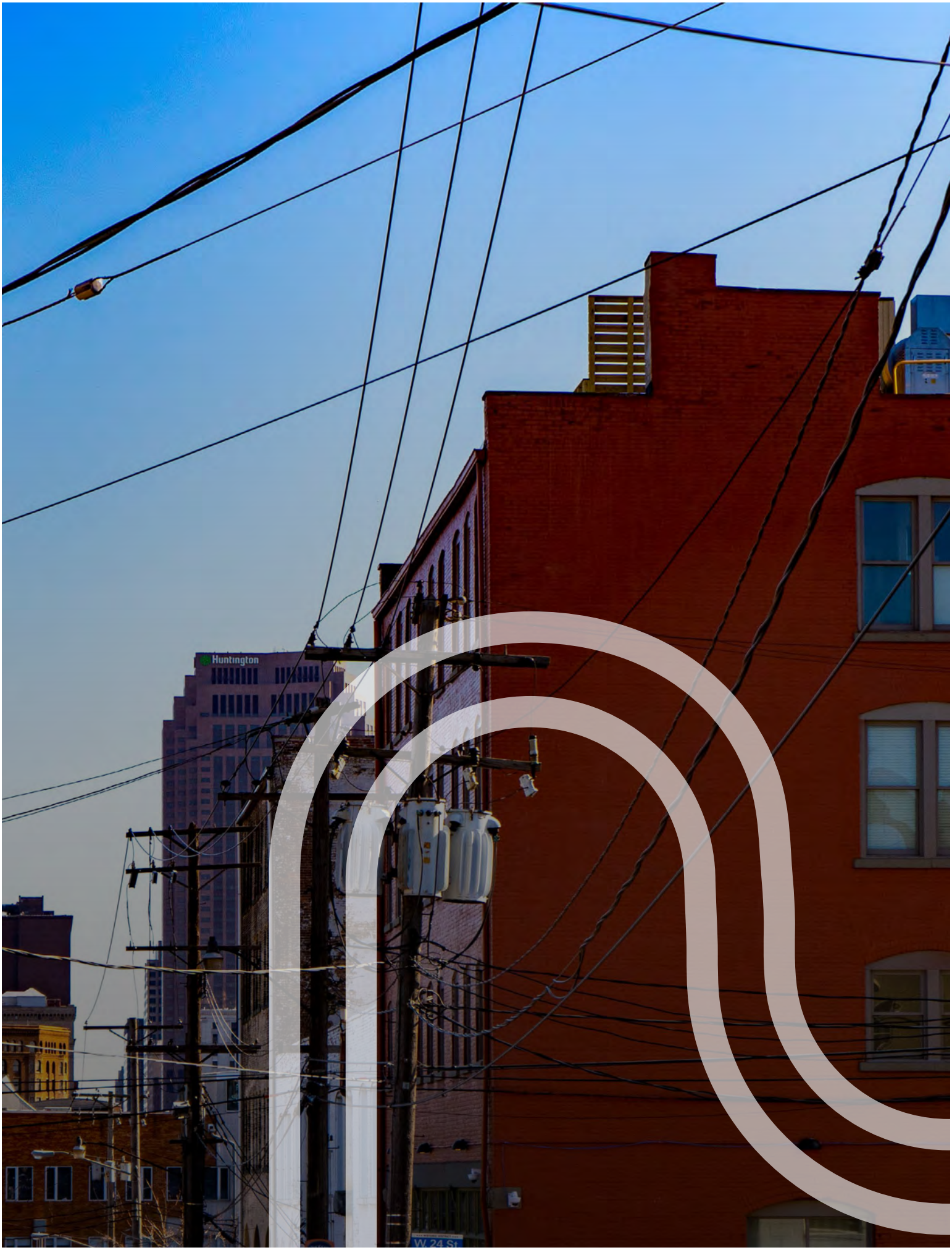
- Towards Employment
- Ohio Means Jobs
- Cuyahoga Community College (Tri-C)
- Fund for Our Economic Future
- Urban League of Greater Cleveland

In order to meet the stated objective of using the transition to 100 percent



clean energy to create a more equitable city, it is imperative that any workforce development efforts place an intentional focus on ensuring that historical and contemporary inequity, disparity, and racism are accounted for and addressed. While the reduction in energy burden and improved environmental conditions described in Section 4 advance equity on their own, without ensuring all residents – particularly those who have traditionally been left out of economic growth and opportunity – have access to the emerging "good jobs, green jobs" through a 100 percent clean energy transition, a substantial amount of equity enhancement is being left on the table.

In addition to intentional workforce development policies, Cleveland should continue to utilize inclusive procurement and contracting policies. While there is no "one-size-fits-all" policy for inclusive procurement and contracting, there are policy levers, revenue streams, business motives, and strategies to strengthen inclusive procurement in the energy efficiency and clean energy sectors. Cleveland has had success in implementing Cleveland Small Business (CSB), Minority Business Enterprise (MBE), and Female Business Enterprise (FBE) contracting targets, and these can be extended to support procurement in clean energy areas. Due to the complexity of work in these areas, it is critical that the City of Cleveland provide contractor training and take steps necessary to align cross-sector policy environments as much as possible to reduce duplicative qualifications, diminish systems hurdles, lessen bureaucracy, and achieve and expand goals.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Section 7

Commitments and Next Steps

Cleveland's commitment to 100 percent clean energy is a critical component of its overall efforts to substantially reduce greenhouse gas emissions, create healthier and more vibrant neighborhoods, and provide economic opportunity for all residents. Based on the different pathways in Section 4, transitioning to 100 percent clean energy will, among other things, create thousands of jobs, increase wages, and lead to substantial avoided health incidents for Cleveland residents.

As an early adopter of a 100 percent clean energy goal, Cleveland has already started along the road to achieving its goal. Since launching its Sustainable Cleveland initiative, Cleveland has taken intentional action to advance its transition to 100 percent clean energy. The Policy Toolkit outlined in Section 5 provides a menu of options that have proven successful in advancing 100 percent clean energy goals across the country. As described in Section 2, Cleveland is not starting from scratch, the City of Cleveland has already implemented eleven specific policies and programs – across multiple energy sectors – that can assist in a transition to 100 percent clean energy. Below is a summary of the existing policies and programs grouped by energy sectors.

Existing City of Cleveland Energy Efficiency Policies and Programs

- Hire a full-time energy manager -- The City hired its first full-time energy manager in 2007 and has tasked this position with supporting broad-based efforts to make City operations more energy efficient, to conduct community-based analyses, and to support efforts to reduce emissions across the region. Recently, these efforts were expanded as the City added an Energy Analyst to create increased capacity to perform this work.
- Install LED streetlights and traffic signals -- In 2019, the City launched an effort to upgrade over 61,000 streetlights – the entirety of its inventory – to LED technology under the City's SafeSmartCLE banner. This program was designed to reduce energy usage, improve lighting conditions across the city, and serve as a platform on which to build additional smart cities solutions. As of February 12, 2021, approximately 90 percent of streetlights have been upgraded and the City is beginning an assessment of energy savings related to the project.
- Track, publish, and review municipal energy usage -- The City has invested in energy tracking software which allows it to assess usage at City facilities, track overall trends, identify opportunities for improvement, and regularly report on progress and savings. This reporting is best encapsulated in annual reports to the Mayor's Cabinet, annual submissions to the U.S. Department of Energy's Better Buildings Challenge portfolio, and the Sustainable Cleveland Municipal Operations (SC-MAP) GHG inventory updates.
- Update and publish GHG emissions inventories -- The City also updates community-level GHG data on an annual basis. This data provides a common platform for analysis and coordination and is disseminated through multiple channels including the Sustainable Cleveland dashboard of indicators, Carbon Disclosure Project (CDP) annual report, and to the Global Covenant of Mayors (GCoM).

Approximately 90% of streetlights have been upgraded and the City is beginning an assessment of energy savings related to the project.

- Create voluntary energy efficiency/conservation programs for businesses, manufacturers, and governments -- Cleveland has a 2030 District affiliate that includes more than 60 million square feet of properties in two districts covering Downtown Cleveland and University Circle. The District has adopted energy, water, and transportation related goals that are aligned with the CAP and its broader objectives.

- Fund energy efficiency/conservation programs -- CPP, as well as the City's water and sewer utilities, provide funding support to energy efficiency and conservation programs through direct funding mechanisms to CHN Housing Partners, a local non-profit that provides comprehensive support services to low-income residents in Northeast Ohio.

Existing City of Cleveland Clean Energy Policies and Programs

- Establish an alternative portfolio standard for CPP -- In 2008, the City established an alternative portfolio standard for CPP with targets of having 15 percent of energy from renewable sources by 2015, 20 percent by 2020, and 25 percent by 2025. Currently, CPP has achieved approximately 21 percent.

- Utilize community choice aggregation to increase clean energy sources -- Since not all customers are served by CPP, the City also has the ability to engage in community choice aggregation on behalf of residential and small commercial CEI customers. In the most recent iteration, the City required bidders to provide 100 percent of energy through clean sources. As a result, an additional 41,000 residential and small commercial customers are now receiving electricity backed by Renewable Energy Certificates (RECs).

- Create a solar co-op to obtain competitive installations through combined purchasing power -- Cleveland residents can participate in the Cuyahoga County Solar Cooperative which is part of the Solar United Neighbors network. Although Cleveland residents are able to participate, to date participation has been lower in the city than the rest of the County.

- Renewable Energy Credit (REC) procurement -- As the City looks to implement clean energy strategies, it has, due to a variety of regulatory and market forces (described in detail earlier), utilized RECs as a part of its overall strategy. While RECs are necessary to support Cleveland's effort to achieve its clean energy goals, they are not ideal due to outsourcing environmental and economic benefits associated with clean energy investments.

Existing City of Cleveland Transportation Policies and Programs

- Implement high priority segments in the walking and bicycling network to reduce motorized trips – The City has adopted a Complete and Green Streets (CGS) ordinance. Since adopting this policy, the City has incorporated CGS elements into every street project. Between 2011 and 2022, the City has constructed, or will construct, over 174 miles of bike infrastructure.

As the City continues with its clean energy transition, it must be cognizant that the current Ohio state policy environment plays an outsized role in its ability to achieve the goal of 100 percent clean energy while building on the cross-cutting priorities outlined in the CAP and this plan. Looking at the primary drivers outlined in the ACES model described in Section 4, the City's ability to pursue effective strategies to achieve 100 percent clean energy are severely hampered by the recent pattern of policymaking. Turning the entire energy system towards sustainable and equitable solutions requires better decisions.

This is particularly true in light of the importance ACES identified for energy efficiency and solar energy development. State-level policy in Ohio has, historically, not been supportive of these areas. For example, over the past several years, Ohio has enacted various policies

Cleveland has a 2030 District affiliate that includes more than

60 million sqft

of properties in two districts covering Downtown Cleveland and University Circle.

that have curbed the ability to implement energy efficiency and clean energy solutions, including:

- Subsidizing coal generation;
- Reducing the percentage of energy that is required to come from renewable resources and entirely eliminating the solar requirements;
- Enacting more stringent set-back rules for on-shore wind development that makes developing these facilities more difficult;
- Eliminating the 50 percent in-state REC requirement;
- Eliminating energy efficiency requirements for utilities and replacing them with a lower-percentage compliance process;
- Allowing large customers to opt-out of energy efficiency programs and requirements, reducing the overall energy baseline for compliance;
- Allowing utilities to bank and pool savings in order to comply with the new lower-percentage compliance values for energy efficiency; and
- Charging higher than standard vehicle registration fees for electric vehicles.

These factors, combined with the relatively large percentage of electricity usage among the industrial sector, leaves Cleveland with limited ability to achieve its 100 percent clean energy goal without purchasing a substantial number of RECs. As outlined in **Table 4-2**, under all three pathways modeled using the ACES tool, Cleveland is dependent on RECs to get to 100 percent clean energy. Under the BAU Pathway, Cleveland needs 5 million RECs to achieve its 100 percent clean energy goal. Even if Cleveland does everything it possibly can (MAX Pathway), it still requires the purchase of 3.5 million RECs – only 30 percent less than the BAU Pathway.

Over 174 miles

of bike infrastructure has or will be constructed between 2011 and 2022.

While RECs are included in the Policy Toolkit, and are currently being used by Cleveland, they are one of, if not the least, impactful policy options for achieving Cleveland's broader equity related goals because they do not sufficiently localize the environmental and economic benefits of clean energy investments. For example, under the current community choice aggregation program, Cleveland's contracted provider is supplying CEI residential and small commercial customers with clean energy by procuring RECs from a wind farm in Texas. This effectively eliminates the local Cleveland environmental and economic benefits of these investments.

Despite challenges and limitations, Cleveland hopes to adopt more electric vehicle friendly policies and programs.

As a result, without substantial changes to the state-level regulatory environment, Cleveland is limited in how it can pursue, and achieve, its 100 percent clean energy goal. These changes include:

- Reinstate mandatory statewide Energy Efficiency and Renewables Portfolio Standards for investor owned utilities and certified retail electric suppliers (CRES), with limited opt-out mechanisms;
- Mandate Energy Efficiency be incorporated in all utilities' long-term integrated resource planning (IRP) processes;
- Coordinated advocacy at the PJM and the federal level by cities, regional government entities and the state, for optimizing renewables and storage, such as through the PJM Clean Cities Coalition network;
- Streamline the permitting and interconnection processes for large utility scale renewables deployment, thereby increasing the utility mix of renewables, which would impact the BAU projections;
- Allow for virtual net metering, which would make it easier for community solar and distributed generation resources to expand to scale;
- Allow for a more equitable net metering excess credits compensation for expanded distributed renewable generation growth;
- Mandate utilities to make it easier for utility data sharing for more effective and targeted clean energy program implementation; and
- Adopt more electric vehicle friendly policies and programs, including a combination of mandates and incentives. Eliminate disincentives, such as the additional vehicle registration fees for EVs.

Despite limitations, Cleveland can, should, and will still move toward 100 percent clean energy. As the ACES pathways in Section 4 show, even in the regulatory-limited environment, transitioning to 100 percent clean energy can have a substantial impact on the environmental, economic, and physical health of the city of Cleveland and its residents. In order to do so, Cleveland should take intentional action to not only achieve its 100 percent clean energy target but also its broader priorities of using sustainability to drive equity, creating "good jobs, green jobs," and preparing for the long-term, positive economic changes this transition can drive.

Returning to the Policy Toolkit outlined in Section 5, Cleveland should build off of their existing programs and policies by making additional commitments to advance beyond the BAU Pathway outlined in Section 4.

While it is difficult to draw a direct line from specific policies or programs to ACES model impacts (due to the complexity of interaction effects between policies and between factors in the background of the ACES model), the recommended changes are a critical first step in transitioning to 100 percent clean energy along either the MCE or MAX Pathway as outlined earlier. As the City works to advance this transition, there are several policies and programs the City has committed to implementing. Below is a summary of these commitments grouped by clean energy sectors.

Current City of Cleveland Energy Efficiency Commitments

- Ongoing outreach to keep the public aware of progress towards energy efficiency and equitability goals -- The City has invested, and continues to invest, time and energy in raising awareness around energy efficiency and clean energy goals. According to survey results detailed in Section 3, a large majority of residents are supportive, but even among interested respondents a substantial portion are unaware of the City's goals and progress. On-going outreach to raise awareness is a critical piece of advancing progress.

- Improve municipal building lighting -- Since 2009, the Mayor's Office of Sustainability has worked with various City of Cleveland Departments to improve lighting in multiple City facilities, most recently at the Public Auditorium and the EMS Headquarters. This has resulted in significant energy savings and generated updated specifications for ongoing facility lighting upgrades. The City has committed to continuing these efforts as they help lower costs, improve conditions in facilities, and signal the City's leadership to the broader public.

- PACE Program that finances commercial energy efficiency and clean energy investments via property taxes -- The City's Department of Economic Development has supported the use of Property Assessed Clean Energy (PACE) loans for commercial properties in limited instances, such as at the Shaker West Professional Building. This is an effective tool for spurring energy efficiency and clean energy investment that will be used as appropriate moving forward.

- Reduce the urban heat island effect -- The Mayor's Office of Sustainability has made combating urban heat island effects a critical part of its work. Addressing urban heat island has multiple positive benefits, including helping reduce energy use associated with cooling and energy bills. The CAP update process included multiple objectives that are being operationalized related to this including making more homes affordable and comfortable and growing the urban tree canopy.

- Support energy efficiency demonstration projects –The City has made a commitment to the U.S. Department of Energy's Better Buildings Challenge to update its showcase facility for energy efficiency improvements.

Current City of Cleveland Clean Energy Commitments

- Install solar photovoltaic (PV) installations on City owned facilities -- Currently, the City has obtained bids to install solar photovoltaic panels at select City facilities. While the initial phase is looking at 15 sites potentially, it provides potential proof of concept and signals the viability of on-site solar to the broader public. Legislation is currently pending with Cleveland City Council.

- Utilize municipal facility aggregation to increase clean energy through RECs -- The City is finalizing bid specifications for its new aggregation contract for CEI-serviced City facilities. Similar to its approach for consumer choice aggregation, this bid package will include a bid option that requires 100 percent clean energy through RECs.

Current City of Cleveland Energy Storage Commitments

- Invest in energy storage technology to support resiliency at critical municipal facilities -- Tied to

the above referenced solar PV project, the City has included battery storage for recreation centers covered under bid requirements. These recreation centers serve as potential warming/cooling centers during extreme weather events.

Current City of Cleveland Transportation Commitments

- Ubiquitous electric vehicle charging infrastructure -- The Mayor's Office of Sustainability is working with Northeast Ohio Areawide Coordinating Agency (NOACA) on efforts to expand EV charging infrastructure in publicly accessible locations across the city. Recently, the Mayor's Office of Sustainability applied for a portion of the Volkswagen settlement grant to help fund charging station installations in public parking lots at the Westside Market, Willard Garage, the new Ward 1 Recreation Center, and the Airport Red Lot.

- Increase mobility options to reduce motorized trips – Like many cities, Cleveland has begun expanding its mobility options. Additional work in this area will be incorporated further into the City's upcoming citywide plan development process.

- Upzone near transit stations and decrease parking requirements to boost transit ridership – This is the basis of the City's efforts to support transit-oriented design. This will be incorporated further into the City's upcoming citywide plan development process.

- Implement behavioral "nudging" program to decrease single vehicle motorized trips – This will be incorporated further into the City's upcoming citywide plan development process.

These current commitments represent significant first steps beyond the BAU Pathway for Cleveland. Even with these initial planned actions, Cleveland can do more to advance toward 100 percent clean energy. Though Cleveland has approximately 30 years to achieve the 100 percent clean energy goal, additional action should not be delayed. In modeling the benefits associated with this transition, earlier action is better, resulting in more benefits flowing to more residents and businesses for more time. As a result, there are several additional policies and programs Cleveland should commit to soon in order to advance more rapidly toward 100 percent clean energy. The following is a summary of these recommended commitments grouped by energy sector.

Recommended City of Cleveland Energy Efficiency Commitments

- Create a workforce training collaborative to develop a clean energy and energy efficiency workforce – The ACES Pathways show significant potential job gains (in excess of 5,000 in the MAX Pathway). Energy efficiency and clean energy jobs have higher median wages than the Cleveland region, therefore, the wealth creation opportunity is high. A properly structured workforce training plan can prepare the local workforce for future opportunities and address equity by ensuring opportunity is available to all residents.

- Create a Municipal Energy Task Force to identify ongoing municipal energy efficiency and clean energy opportunities -- This is happening informally already. The City's Energy Manager engages in individual discussions with multiple stakeholders from different departments and divisions individually. Creating a centralized venue for these discussions will help everyone see the bigger picture and identify more collaborative possibilities.

- Create a clean energy task force to identify opportunities and provide accountability on goals – Meeting clean energy targets will require more than just the City of Cleveland. It will take a broader set of corporate, philanthropic, and community stakeholders to invest at similar or expanded levels to the City's commitment. This group would provide a venue to identify best-practices and potential opportunities for collaboration as well as create an accountability mechanism for all stakeholders.

- "Round-it-up" energy and water efficiency programs – The ACES pathways show significant efficiency gains are possible. Expanding funding for conservation programs is critical to fulfill unmet demand in the city. The City should commit to determining the legality of a customer "round-it-up" program, and if legal, develop a program outline for how it would work. The City funds existing efficiency programs already, and these funds should expand those programs to assist more customers.

Recommended City of Cleveland Clean Energy Commitments

- Long-term solar energy purchase agreements to buy solar built on municipal or commercial property -- This is not a short-term policy option. This is a way to in-source renewable generation in a difficult state environment. This could be a way to replace RECs which outsource the environmental and economic benefits associated with clean energy investment. This could be done through CPP and via direct purchase to replace bulk CEI purchases. Generation on this level would be "front-of-the-meter" and would require a longer-term planning process. The commitment here should be to study the feasibility of this on existing properties in the City of Cleveland, and work to include it in the City's broader economic portfolio. This should also be coordinated with the citywide clean energy task force, for broader and larger citywide commitments from other stakeholders.

- Utilize municipal facility aggregation to increase offsite clean energy resources -- Currently, the City is working to use the aggregation contract for its CEI facilities to increase clean energy through the purchase of RECs. Longer-term there is an option to use a procurement process to invest in more locally focused generation that is not located on-site. This will require a longer-term commitment than the City's current annual/bi-annual contract process.

- Establish a Low- and Moderate-Income solar funding model -- Cuyahoga County has an existing solar co-op that provides a mechanism for increasing residential, on-site solar installations in our region. Data from the co-op, however, indicates that installations are more common outside of the city. Within the city, the installations that do occur are concentrated in a few neighborhoods. Lack of solar participation is largely a function of the high initial capital expenditure and limited borrowing capabilities. Lowering these initial costs can help deliver savings and clean energy to residents who will benefit the most. The City should commit to making an initial investment to leverage philanthropic and corporate funds in a pilot program to show the benefits of such a program while a more sustainable funding source is worked out.

- Develop community solar projects that share solar electricity across more than one property -- This was the highest scoring policy/program option. It helps meet the clean energy goals, but also has a very high equity impact. In addition to potentially lowering bills, if done right, these programs can create community ownership long-term. Community solar is dependent on utility interconnection and other arrangements (primarily virtual net metering). CEI has not generally been supportive, and CPP does not have a cost recovery mechanism for virtual net metering. The commitment here should be to establish a mechanism for CPP to support community solar during its next rate study process.

Recommended City of Cleveland Transportation Commitments

- Transition City light-duty fleet to electric vehicles – The City has already started down this path – adding three EVs in the 2019 capital ordinance, another ten in the 2020 capital ordinance, as well as pre-identified additional vehicles in the 2021 capital ordinance. The City should establish a date-certain commitment to transition the light-duty fleet to EVs based on a reasonable and achievable replacement schedule.

By committing to 100 percent clean energy and implementing multiple policies, Cleveland has taken important initial steps toward achieving its broader sustainability and resilience goals. These actions should be celebrated as a strong foundation to build off of moving forward. Even though Cleveland faces a difficult set of state policies related to energy efficiency, clean energy, and sustainable transportation, the City remains committed to enacting local policies and programs that can create a healthier and more equitable city. This too should be celebrated. By following the roadmap outlined in this report, Cleveland, together with its critical utility, regulatory, legislative, business, NGO, academia, and residential partners can achieve the 100 percent clean energy goal while advancing equity for all residents.

"By committing to 100 percent clean energy and implementing multiple policies, Cleveland has taken important initial steps toward achieving its broader sustainability and resilience goals."

Section 8:
Appendices

Appendix A: Public Community Survey

BACKGROUND

The City of Cleveland conducted community engagement regarding Cleveland residents' perception and knowledge of clean energy. This input was used to develop the values, direction, priorities, and initiatives of this Plan. The engagement process sought a broad range of input from residents and various stakeholder groups, and consisted of community presentations, discussions with subject matter experts and stakeholders, and an online survey of over 550 residents.

SURVEY RESULTS

Overall, the survey found that 88 percent of survey respondents were supportive of Cleveland's 100 percent clean energy goals. Respondents were particularly interested in seeing more support for creating local jobs, ensuring all city residents receive the benefits of clean energy, and protecting the environment. There was also a significant desire to participate in existing clean energy programs but residents lacked information on how to make that transition. Below you will find the full survey results.

The survey was taken by over 550 Cleveland residents. Survey respondents were equally male and female, but were more likely to be middle age, middle to high income, white, and own their homes than the general population in Cleveland. Weights have been developed to aid in the generalizability of the results. We estimate the results to have a margin of error of +/- 7 percent based on the controls that could be applied and the response volume.

Figure 8-1: Survey Responses Background

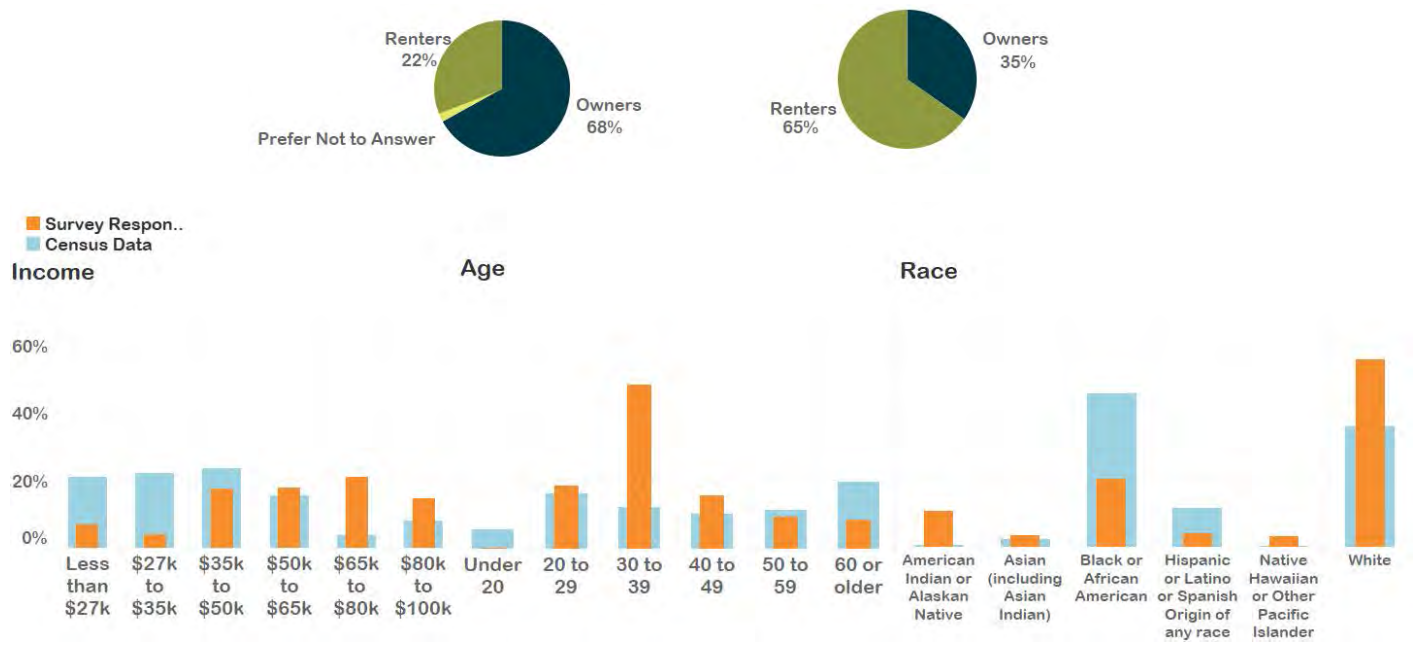


Figure 8-2: How supportive are you of Cleveland's 100% renewable electricity goal?

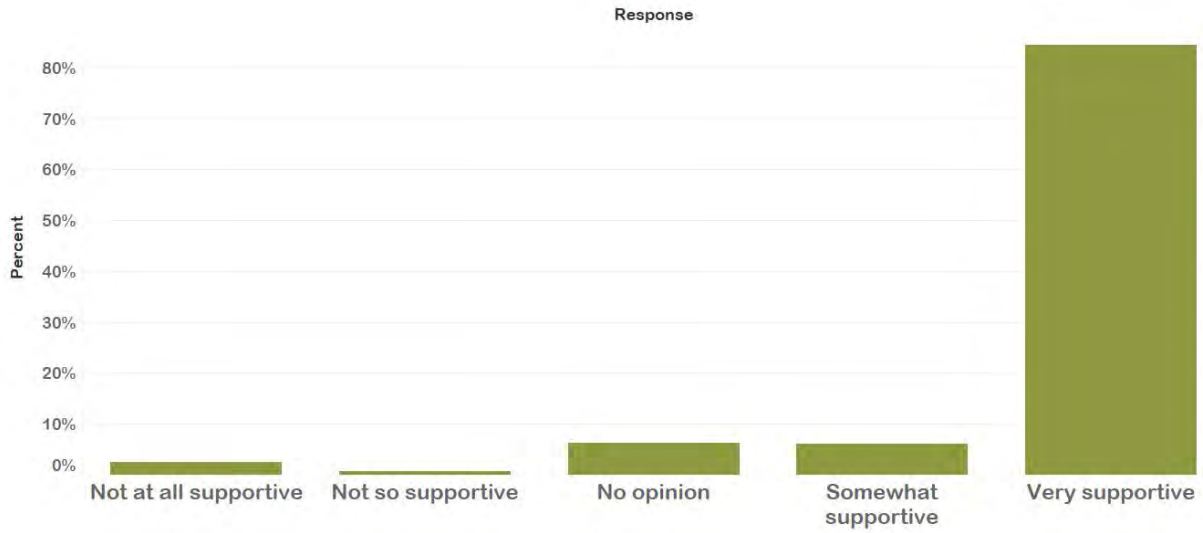


Figure 8-3: As we transition to 100% renewable electricity, how important is it for the City of Cleveland to do each of the following?

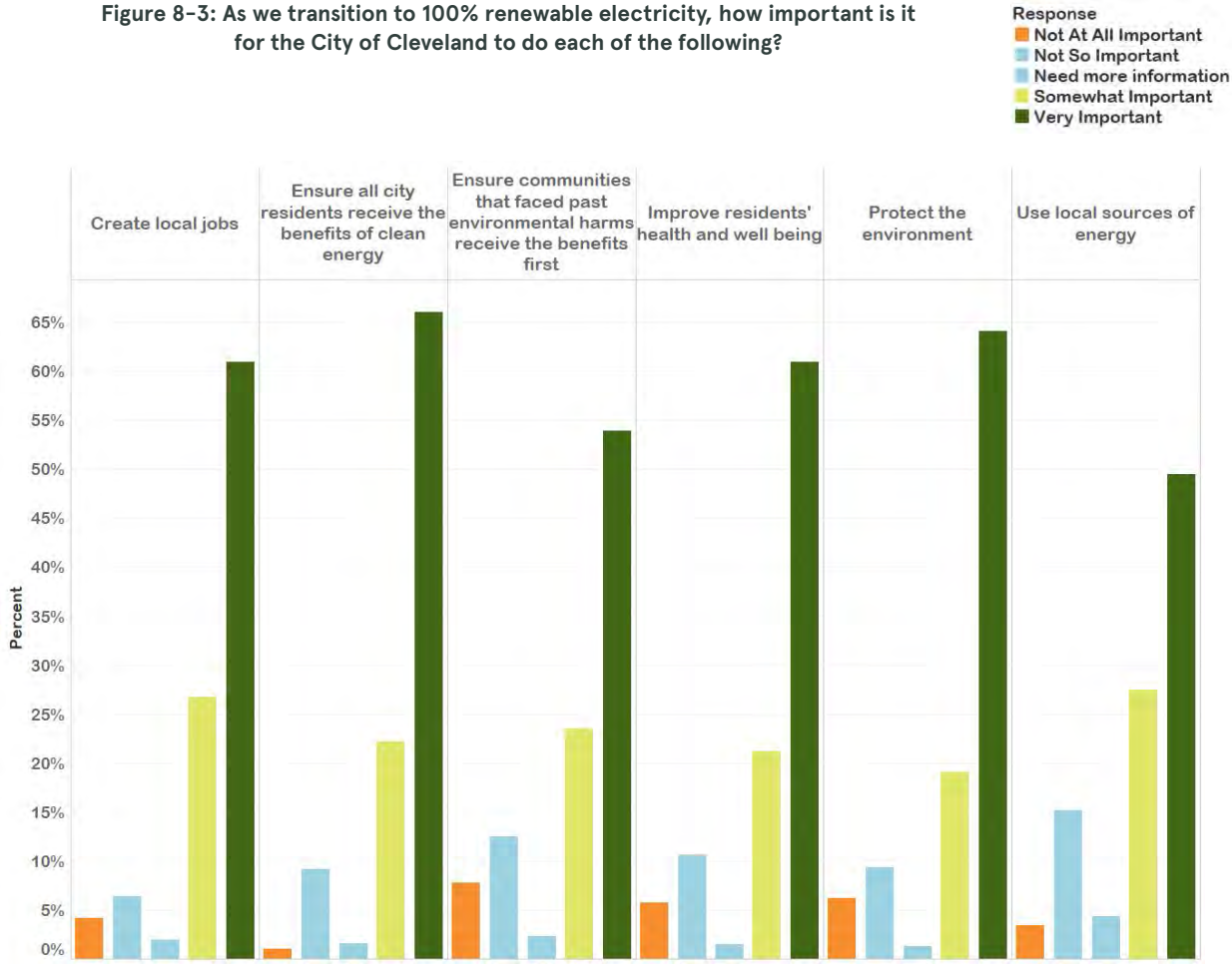


Figure 8-4: Buildings such as apartments, homes, offices and factories are City of Cleveland's largest consumers of electricity. To help buildings get to 100% renewable electricity, how important is it for City of Cleveland to do each of the following?

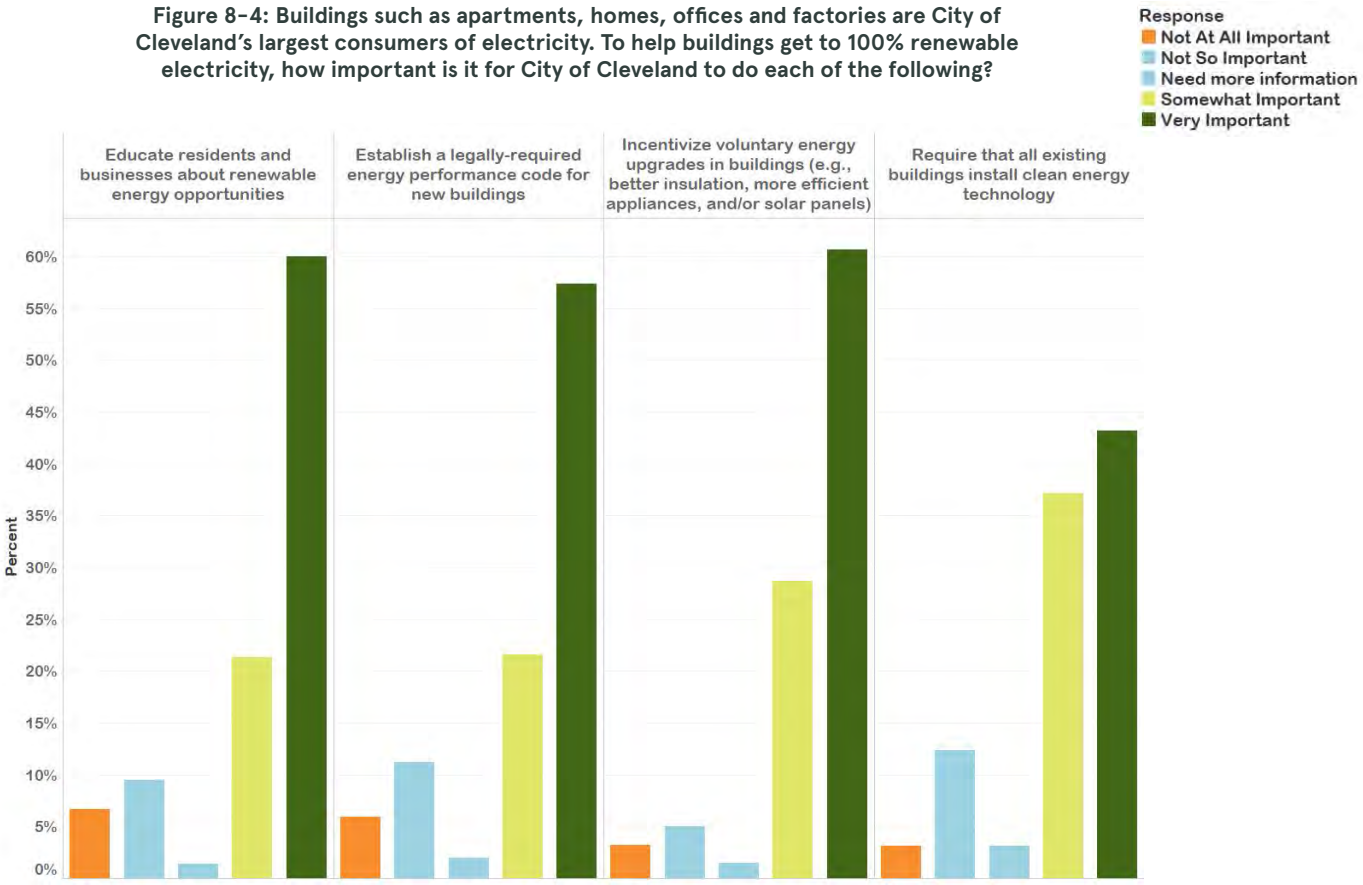


Figure 8-5: Do you participate in any energy savings and/or clean energy programs provided by your electric utility?

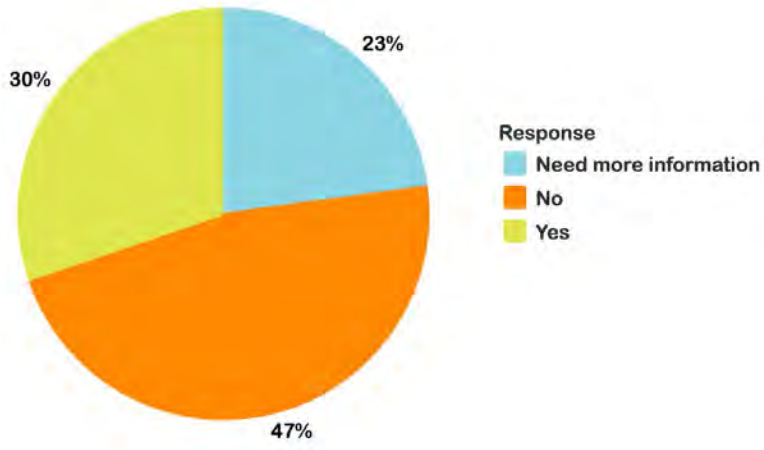


Figure 8-6: What should local electric utilities do to help the City of Cleveland get to 100% renewable electricity?

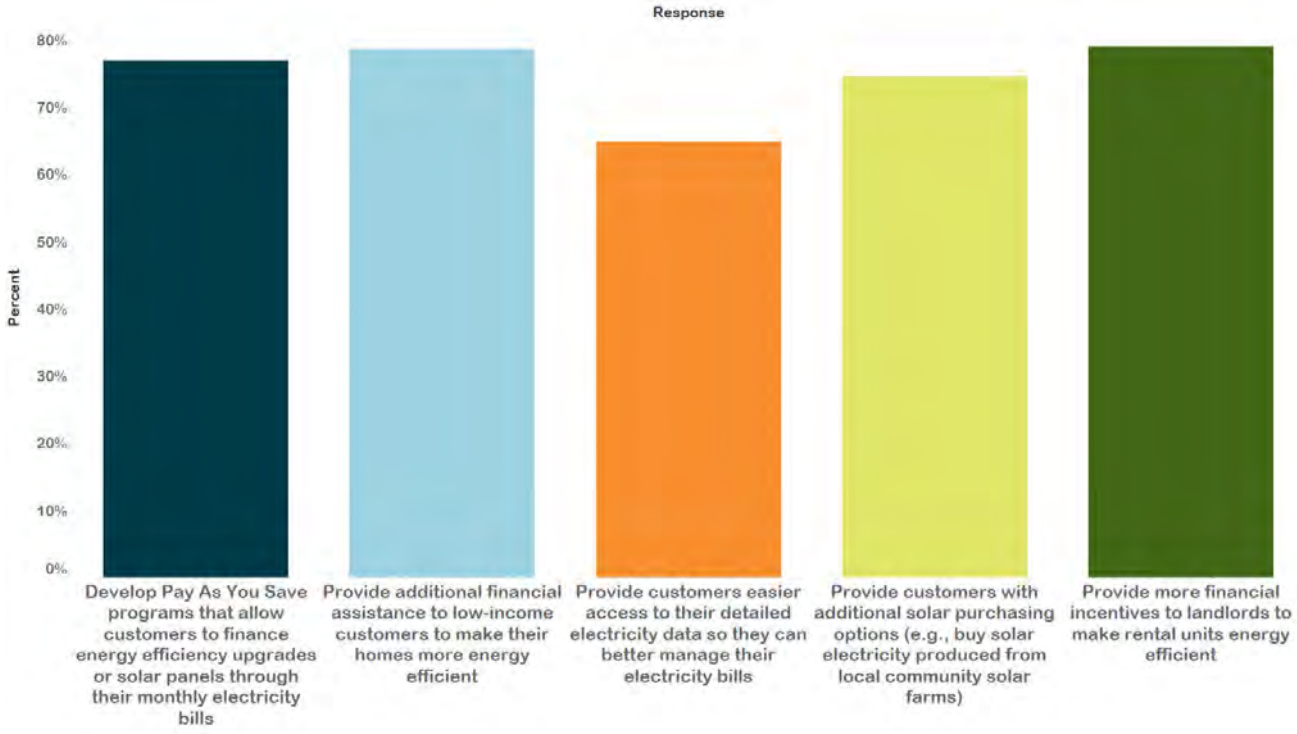


Figure 8-7: When deciding what actions to take in your household to support renewable electricity, how important are each of the following?

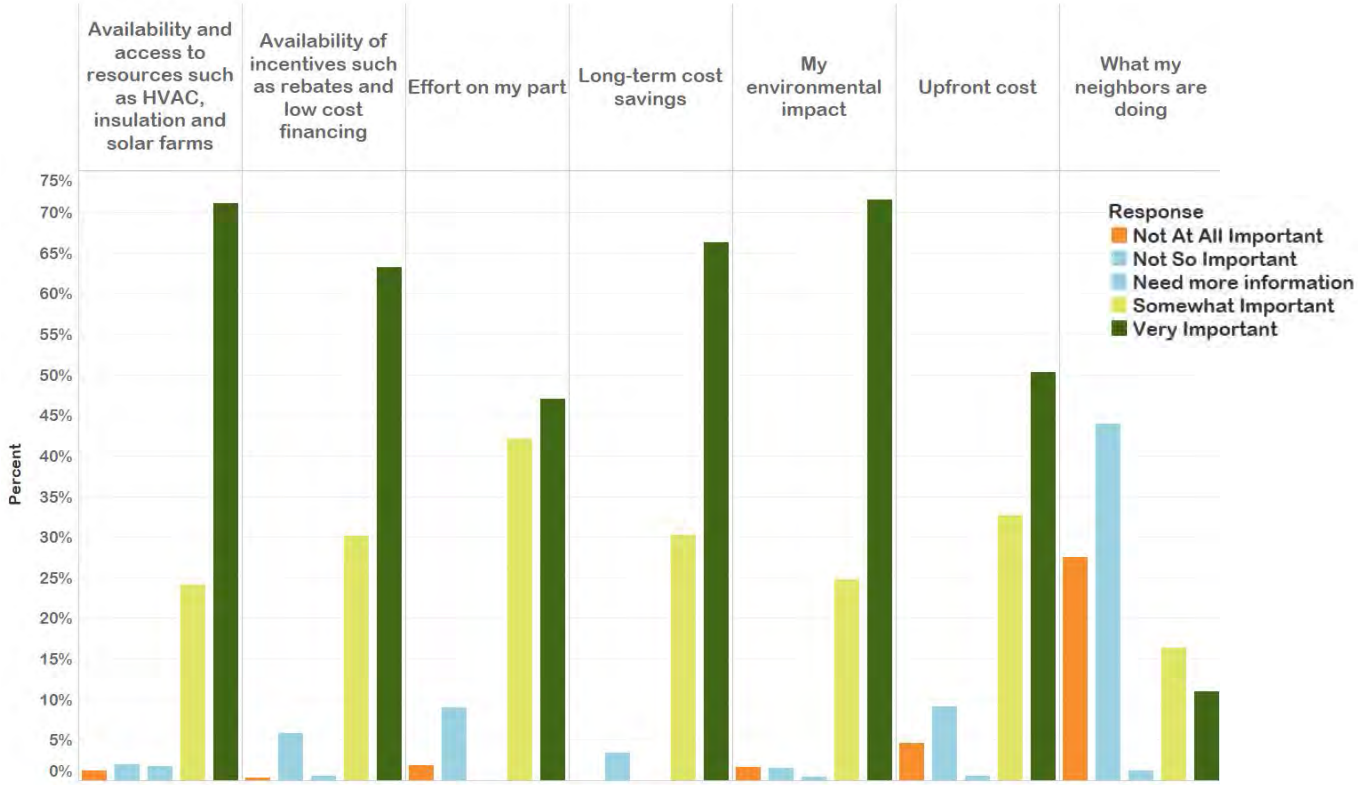


Figure 8-8: Would you consider transitioning to 100% renewable electricity for your home electricity usage?

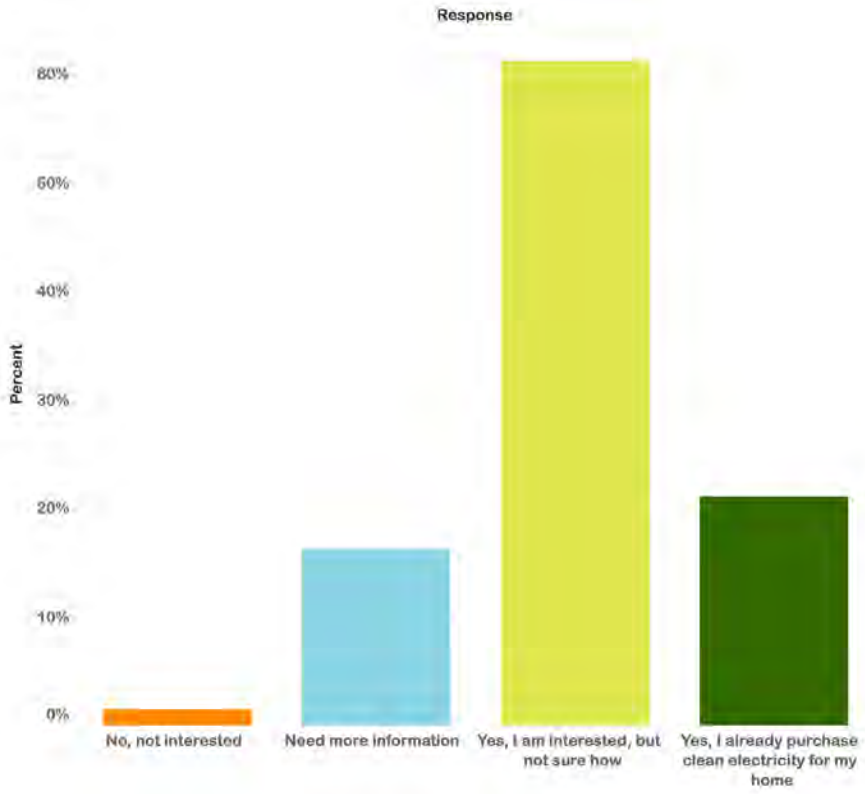


Figure 8-9: In addition to your monthly electricity bill, what is the maximum amount you could or would be willing to spend to receive electricity from renewable sources?

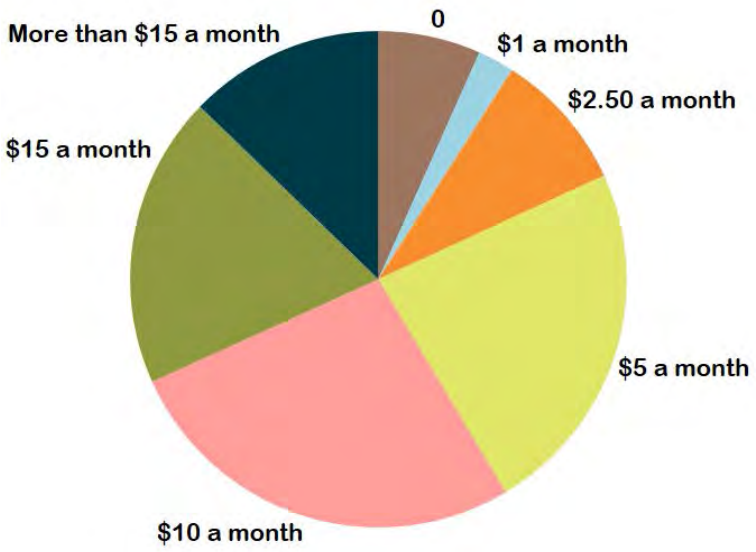


Figure 8-10: Before today, did you know that the City of Cleveland has a 100% renewable electricity goal?

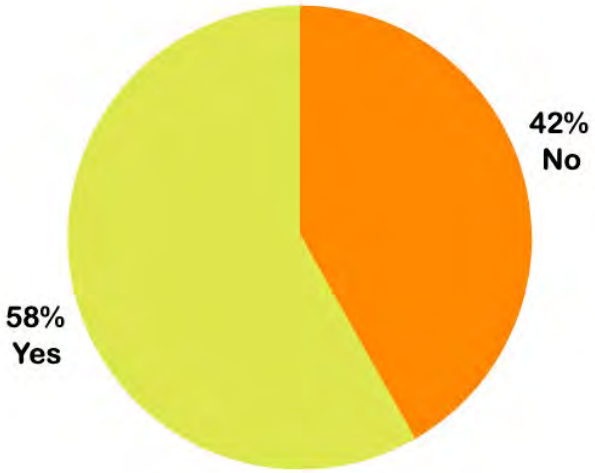
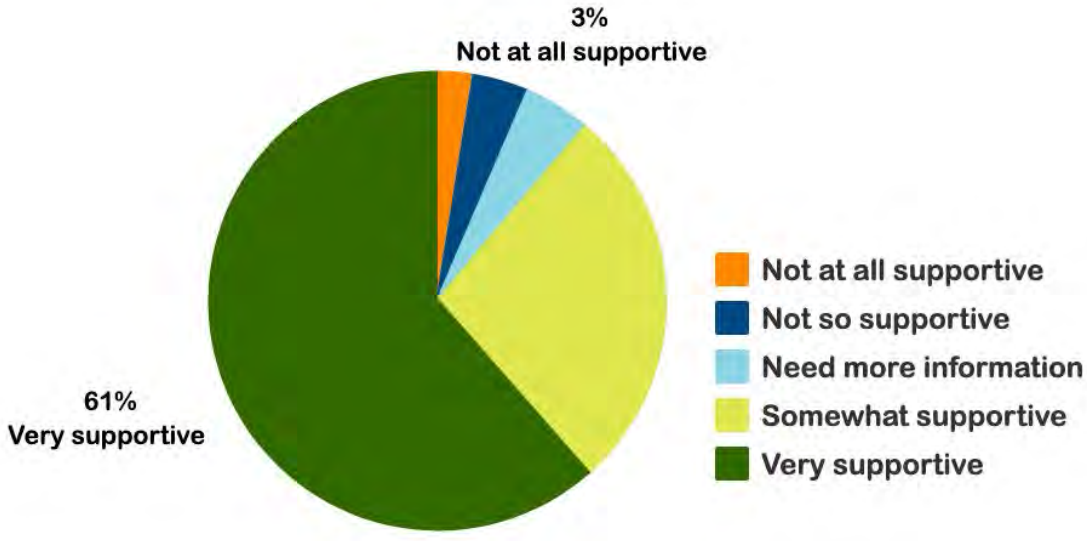


Figure 8-11: Now that you've answered these questions, how supportive are you of the City of Cleveland's 100% renewable electricity goal?



Appendix B: References

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Appendix C: Glossary

Advanced Clean Energy Scenario Tool (ACES): A modeling tool developed for the City of Cleveland by Greenlink Analytics to quickly assess the impacts of different approaches to achieving the 100 percent clean energy goal. It takes the existing state and federal policy and programmatic framework as a given, allowing the user to select a clean energy resource mix for Cleveland. The user is presented with a number of model outputs that describe the cost-effectiveness, the resulting energy burdens, the economic development potential, the public health and emissions implications, and the bill impacts of the user-defined pathway.

ATHENIA: Greenlink Analytics' ATHENIA model utilizes a deep learning neural network architecture to learn and project hourly dispatch behavior at the unit level for generation plants meeting Cleveland's electricity demand as well as the projected dispatch behavior for proposed plants in the BAU and MAX Pathways. With different generator technologies and capacities brought online and retired throughout the various scenarios, ATHENIA's least-cost planning module determines which resources should be selected to satisfy electricity demand requirements.

Business-As-Usual (BAU): A standard in nearly all studies with future projections, the BAU (aka Baseline or Reference) refers to a forecast where new market interventions are not envisioned; current policies and programs continue or expire as currently planned.

Better Buildings Challenge: A challenge led by the Department of Energy encouraging CEOs, and executives of U.S. companies, manufacturers, universities, school districts, multifamily organizations, and state and local governments to reduce their energy use throughout their portfolios by at least 20 percent between 2010 and 2020.

Clean Energy: Electricity derived from renewable fuel resources such as solar, wind, hydroelectric, geothermal, biogas, tidal, energy storage, and renewable energy credits (RECs), as well as energy efficiency and conservation related to electricity.

Cogeneration: The simultaneous generation of electricity and useful heat.

Economic Development: The process by which a community improves the socio-economic wellbeing of its people.

Electricity: An energy resource resulting from the conversion of other primary energy resources, such as sunlight, wind, fossil fuels, and other sources, used for many applications in modern life.

Energy: The physical property that must be transferred to an object in order to perform work on, or to heat, the object.

Energy Burden: The percent of household income used to pay energy bills.

Energy Efficiency: Reducing the amount of energy required to provide the same service.

Energy Equity: Fair and just access to energy services, including an equitable distribution of the costs and benefits of energy services.

Equity: Respectful treatment and fair involvement of all people in a society. It is the state in which everyone has the opportunity to reach their full potential. Additionally, the National Academy of Public Administration, which has been studying the use of equity as a means of evaluating public policy describes equity as the "fair, just, and equitable management of all institutions serving the public directly or by contract; the fair, just, and equitable distribution of public services and implementation of public policy; and the commitment to promote fairness, justice, and equity in the formation of public policy." This definition lays the groundwork for measuring equity in Resilient Cleveland's initiatives, including *Cleveland's Clean and Equitable Energy Future* Plan.

Job-year: Employment equal to one full-time job held by an individual for one year.

Megawatts (MW) / Megawatt-hours (MWh): A megawatt is 1 million watts. Watts are the standard unit for power, defined as 1 joule (an energy unit) per second. Most utility-scale power generators are rated in megawatts. A megawatt-hour is an energy unit, equal to a MW of power provided for an hour. 1 MW of power demand held constant for an hour would use 1 MWh of energy. Recent electricity demand in Cleveland has ranged from 6 to 6.5 million MWh per year.

Public Health Benefits: Public health benefits in *Cleveland's Clean and Equitable Energy Future* are the result of reducing population exposure to air pollution. Benefits are therefore avoided instances of expected negative health outcomes from the BAU, such as asthma attacks, heart attacks, missed work days, and others. These results can be quantified as distinct outcomes or monetized to provide useful information about community benefits from different clean energy choices.

Renewable Energy Credit (REC): A tradable, non-tangible energy commodity that represents proof that 1 MWh of electricity was generated from an eligible renewable energy resource and was fed into the U.S. electric power grid.

Utility Burden: The percent of income households use to pay utility bills, including electricity, water, and gas.

Water Burden: The percent of income households use to pay water and wastewater bills.