

Analyzing Cities' Renewable Energy Targets for Climate Resilient Future

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ABSTRACT

As the world continues to urbanize and grow, the problem with energy and fossil fuels is hard to ignore. Fossil fuels are harmful to the environment and human health and will run out in the near future. Currently, many cities are trying to convert to renewable energies to address climate change and promote energy independence. One big step towards energy transition is renewable energy targets (RETs), policy goals aimed to introduce renewable energies. In this report, we take an in-depth look at what RETs are and their positives and negatives. We also analyze some cities' energy targets to understand the world's current renewable energy targets. Cities can significantly reduce their emissions if renewable energies are implemented in the energy sector. Our study clarifies RETs and how they should be implemented so that future cities work together to build a climate-resilient future.

I. INTRODUCTION

(1) CLIMATE CHANGE AND CITIES

Climate change is an ongoing global phenomenon that greatly affects the world, and human-induced greenhouse gases cause it. Due to climate change, Earth's temperature has risen by a little more than 1 degree Celsius since 1880 (NASA, 2023). As the Earth becomes warmer, cities are concerned about the numerous impacts climate change will have on a global scale. For example, as the ocean absorbs heat, ice sheets and glaciers melt, and thus, the sea level rises. This particularly threatens coastal cities such as Lagos and Cape Town in Africa since they are poised to experience being submerged underwater in the near future (OCHA, 2023).

Climate change is also predicted to be one of the top reasons for the increase of large-scale natural disasters, which are usually floods, cyclones, earthquakes, hurricanes, and landslides. Indeed, the number of disasters has increased by a factor of five over the 50 years, causing \$202 million in losses and killing more than 100 people every day (WMO, 2022). Droughts and storms were the top two disasters, causing the highest number of deaths, while floods were recorded to have the highest economic losses from 1970 to 2019 (WMO, 2022). Of all cities, urbanized areas located in China, Taiwan, the Philippines, and Japan are known to be hotspots of upscaled natural disasters (Kumar, 2021).

Population in cities is also affected as the rise in temperatures is causing the occurrence of heatwaves. Urban areas are particularly affected by this phenomenon because of 'urban heat islands,' which occur when dense concentrations of buildings replace the natural land. The occurrence of harsh heat waves and sudden rise in temperatures can cause deterioration inside and on the surface of buildings; heating and melting of asphalt, which in turn may also affect car tires; and traffic in airports due to the tarmacs being too hot to hold planes safely. These circumstances directly affect people living in highly populated cities in their daily lives. (Kumar, 2021).

In turn, cities are now leading the way in efforts to address climate change. Due to cities being responsible for "71% of global energy-related carbon emissions" (Rosenzweig et al., 2010), mitigation efforts, especially in larger cities like New York City and Beijing, will have positive results on average global temperatures and carbon emissions. Most importantly, cities that rest just a few meters above sea level, like Lagos, risk the loss of homes of almost 3.6 million residents who live less than 5 meters above sea level in the city's slums, caused by just a 1-meter rise in sea level due to a 1-degree increase in average global temperatures (Rosenzweig *et al.*, 2010). To prevent this, cities worldwide have been rushing to change parts

of their power consumption into renewable energy sources and to write up renewable energy goals that will benefit the climate and the world in the future.

In this report, we will go over the fundamentals of renewable energy targets and development and document which cities have chosen to have RETs. We will also analyze cities in the world, especially the EU region, where there is a large focus on renewables and popular cities with different types of RETs, in order to have a better understanding of how to make an emission-free environment.

(2) CLIMATE CHANGE AND RENEWABLES

Renewable energy is often mentioned as one of the essential changes needed to address climate change. Unlike fossil fuels, which release a large percentage of greenhouse gases during burning, renewable energy sources release little to none. Thus, air pollution and climate change would be significantly reduced if cities shifted their energy sources from fossil fuels to renewable sources.

Expanding renewable energy is important because it is currently the cheapest option for clean energy in many countries. The falling prices of solar and wind power make them appealing options for many countries, especially for low income developing countries. In fact, the United Nations (2023) said that “cheap electricity from renewable sources could provide 65% of the world’s electricity supply by 2030. It could decarbonize 90% of the power sector by 2050, massively cutting carbon emissions and helping to mitigate climate change”. Additionally, \$5.9 trillion was spent on subsidizing the fossil fuel industry in 2020, while \$4 trillion is projected to be invested every year, including infrastructure and technology related to renewable energy sources.

There are many different types of renewable energies, with solar, wind, biofuels, bioenergy, and hydropower making up most of the world’s production of renewable energies. Sources such as biofuels replace traditional fuel for automobiles, while solar, wind, and hydropower are usually used to produce electricity.

Further, energy like wind and solar are a worldwide and domestic resource. In the United States, wind power is the largest renewable energy source, adding \$20 billion to its economy (Department of Energy, 2023). Similarly, solar energy also benefits the climate by having low environmental impacts. It also allows energy independence for homeowners if they use solar panels due to panels being able to store energy (Collins, 2023). Together, wind and solar power

still comprise only 9% of the global renewable energy share (Morris, 2023). Currently, almost 60% of renewable energies are made from hydropower, with wind and solar power fast growing in the renewable energy market (Morris, 2023).

One advantage of renewables is that our nature continuously replenishes them. In other words, even developing countries would have access to these renewable energy sources, so they could easily adopt clean energy without worrying about the unpredictable price swings of fossil fuels. Due to the abundant nature of renewable energy sources, many countries will be able to replace carbon-concentrated energy sources and lower their carbon emissions.

(3) BENEFITS of RENEWABLE ENERGY DEVELOPMENT

Expanding and switching over to renewable energies from fossil fuels also include many different benefits for cities: health, environment, economy, and energy independence and security. As the demand for renewable energy use and development increases worldwide, renewable sources not only benefit the environment, but cities have also seen positive increases in their economy (Heineke et al., 2022).

The change to renewable energy sources will improve public health due to its low carbon emissions. Air pollution, which causes almost 7 million early deaths yearly, is closely linked to climate change and the carbon emissions caused by fossil fuels (UNEP, 2022). According to the World Health Organization, about 99% of people breathe air that exceeds the average air pollution quality. Air pollution, which was made worse by the ongoing climate change crisis, increases health problems that include, but are not limited to, asthma attacks, heart attacks, strokes, respiratory illness, and lung cancer, according to the American Lung Association. Using renewable resources would create a much cleaner, reduce the threats caused by air pollution, and lower carbon emissions.

Due to the continuous use of fossil fuels, most often coal, oil, and natural gas, for the last century, the levels of greenhouse gasses – mostly carbon dioxide and methane – "are higher than any point over the past 800,000 years ([National Geographic, 2019](#))" and have detrimental side effects to the world. The greenhouse gasses are trapping heat, so much so to the point that Earth's average temperature has "risen by an average of 0.14° Fahrenheit (0.08° Celsius) per decade since 1880 (Lindsey & Dahlman, 2023)." The world is burning more fossil fuels and emitting more carbon dioxide than the natural process can remove from the atmosphere, increasing the world's temperature year by year (Lindsey & Dahlman, 2023). The use of renewable energy sources will help mitigate the surplus of carbon emissions and also help

reduce global warming. According to Union Concerned Scientists, coal burning releases around 1.4 to 3.6 pounds of carbon dioxide, and natural gas releases around 0.6 to 2 pounds.

On the other hand, wind only emits 0.02 to 0.04 pounds. Increasing the use of renewable energy will decrease global warming, as renewable sources emit less greenhouse gasses and mitigate climate change. Sources such as biofuels will not impact or barely impact the climate with their greenhouse gas emissions because they are renewable. Since the burning of plants accounts for the energy production of biofuels, cities can regrow the plants they burn, which, in turn, absorbs gasses like carbon dioxide (Morris, 2023).

Transitioning to renewable energy will also decrease the hold the world has on fossil fuel reliance. However, renewables may be a more expensive option for developing and semi-developed countries as the demand for renewable energy increases. Renewables may also provide energy independence and security, as they are free from scarcity, which fossil fuels have. Climate change mitigation and energy security have always gone hand-in-hand. At speed the world is going through fossil fuels, by the late 2060s, the world will run out of oil and natural gas reserves, and in the next century, coal (Lotzof, 2023). Renewable energy could provide energy security as there are a lot of different ways to generate renewable energy. If oil or petroleum were to fall, many people would be out of energy, and the price would spike. However, if one type of renewable energy plant falls, many different types of energy can back it up. Also, renewable energy plants can be put anywhere, whereas fossil fuel harvesting locations are very concentrated.

Unlike fossil fuel-based technologies and energy sources, which run primarily on machines and automatic mechanics, renewable energy is more "labor intensive (UCS, 2023)". For example, solar power is carried through solar panels, which people must install, and wind power is gathered through turbines, which need interim technicians for maintenance. The transition to renewable energies will bring more job openings in each country, benefiting the economy and the climate (UCS, 2023). In 2016 alone, the United States employed over 100,000 people to be stationed in the wind energy industry, and the over 500 factories that provide parts for various renewable energy source gathering technologies employed much more (UCS, 2023). 260,000 people were employed in the solar industry, increasing job creation by almost 25% (UCS, 2023). Another study conducted by UCS shows that by 2025, the United States alone will have three times the current number of job openings and creations just in the renewable energy industry.

II. RENEWABLE ENERGY TARGETS

(1) What are renewable energy targets (RETs)?

Renewable energy targets are policy goals aimed to introduce renewable energy sources to be generated and consumed in countries or cities. The energy sector contributes most of the GHG emissions so changing to renewable is a step towards reducing GHGs (European Commission, 2023). It is important to start implementing as many renewable energy sources as possible so that cities can become 100 percent clean energy by 2050. This is important because if the Paris climate goal of 1.5C is to be met, cities need to start working now. Currently, over 1 billion people live in a city that has a renewable energy goal. 610 of these cities have set 100% renewable energy targets (REN21 2021). Even cities whose emissions have not peaked yet should proactively start implementing renewable energy sources. 100% renewable energy can provide cheapness and stability to the energy sector, significantly less air pollution and provide a large amount of jobs (C40 Cities Climate Leadership Group 2019).

Why is adopting a renewable energy target in cities important? Most pollution and GHG emissions come from cities and their use of energy, there's lots of people using transportation, and there's a lot of construction. The burning of fossil fuels is much more concentrated in large urban cities. Thus, making a renewable energy target in cities is important because making a city have more clean and renewable energy could significantly cut down on the cities GHG emissions.

Some environmental and economic benefits of using renewable energy include not generating some types of air pollution, diversifying energy supply, reducing dependence on imported fuels, and creating economic development and jobs in, for example, manufacturing and installation (US EPA, 2023).

Additionally, On-site power generation provides local governments with direct access to renewable energy. With the additional benefits, on-site projects can also prevent financial risks, improve power quality, and supply reliability (US EPA, 2023).

Regardless, governments taking into account on-site power generation may still face potential technical, financial, and regulatory challenges. In order to overcome said challenges, local governments can assess the availability of local renewable energy sources, consider the costs of different renewable technologies, examine the costs and benefits of on-site green power, consider permitting requirements for locations where the facility could be sited, involve local stakeholders, and assess available sources of financing and other incentives(US EPA, 2023).

(2) Positive and negative sides of RET

RETs give a country or city a starting target for them to fulfill while also helping reduce greenhouse gasses inside the atmosphere. These reductions in greenhouse gas levels can help slow climate change and climate disasters. It also improves the air quality and the health of the citizens as RETs can help provide clean and safe energy instead of burning and using harmful fuels. RETs generally help yield climate benefits – improvement in local air quality, reduction of local greenhouse gas emissions – and usually positively affect the climate it is working in. The targets also allow for the expansion of renewable energy use and organizes specific deadlines by countries and/or cities need to fulfill their goal.

However, RETs have some major drawbacks. RETs can quickly become majorly complex during the planning stage and become too complex for cities to carry out. They can pose an economic barrier to some cities. The city might not have enough money to support a fuel change or implementation of renewable plants. RETs could also distract from other problems in the city, such as poverty or water cleanliness. Spill as outlines another potential problem with RETs: “setting a target (a quantitative threshold to be attained; for example, 80% wind energy), rather than an objective (a qualitative direction in which to go; for example, maximize wind energy) can blind us to trade-offs when evaluating different policy actions.”

RETs also take up much space in a city, space that the city needs for expansion or may not have the rights to. Land-use changes have to be done in order to fulfill the task of the RETs, which causes increased carbon emissions during the process of changing the landscape. Changing the landscape also leads to biodiversity change as the habitats that they have adapted to have changed.

III. C40 Cities AND GCoM CITY

(1) C40 Cities

C40 is a global network comprising nearly 100 mayors from different cities that lead the action towards tackling climate change. Members of the C40 are dedicated to cutting down carbon emissions in half by 2030. Mostly, they are large cities in developed and developing nations, and some Global South cities are Bogota, Cape Town, and Rio de Janeiro. Global North cities are Shanghai, Seoul, Tokyo, London, Paris, Los Angeles, New York City, and Mumbai.

For instance, Los Angeles, a global north city, has one of the largest oil farms in the world, having around 2,930 active oil wells. The city had created a group called the ‘Just Transition

Task Force', consisting of labor groups, workforce development experts, environmental justice leaders, the oil industry, Tribal Nations, academic institutions, and state and local governments. It was tasked with developing recommendations for meeting the needs of impacted workers and communities. The task force had helped oil workers to find new jobs, close down oil wells, and transition the land and financial situation of the area. With the C40 Inclusive Climate Action (ICA) Cities Fund support, Los Angeles will continue to ensure frontline communities are not left behind in the ambitious step towards a green and just transition of the oil phase by continuing its Just Transition Task Force. Another example is Bogota, a global south city, which is training women to join the workforce as e-bus drivers, green jobs, and the city's green transition.

(2) Global Covenant of Mayors (GCoM) for Climate and Energy (GCoM)

The Global Covenant of Mayors for Climate & Energy (GCoM)¹ is the largest global alliance for city climate leadership, built upon the commitment of over 11,500 cities and local governments to tackle the challenges of climate change. The GCoM gathers cities and local governments of all sizes worldwide, mobilizing and supporting cities' ambitious, measurable, planned climate and energy action in their communities. It also works with city/regional networks, national governments and other partners to achieve its shared vision.

GCoM has established Regional/National Covenants, which serve as local chapters of the broader GCoM alliance and convene, encourage, and strengthen stakeholders at the local, national, and regional levels to accelerate climate action. Each engages city, sub-national and national governments, community-based organizations, regional alliances and parallel initiatives to encourage and support climate action from the ground up. Additionally, more than 10,000 cities stand ready to partner with national and international institutions to tackle both climate and economic crises through local initiatives, innovative financing models, and sustainable infrastructure.

IV. METHODS

First, we did basic research on renewable energy and renewable energy targets. We gathered data on cities' pollution index for our data sets in which the sample size was 346 cities. We looked at descriptive statistics of the cities by region, population, and renewable energy targets. Also, we attempted to find the correlation between renewable energy targets

¹ For the more detailed information, refer to <https://www.globalcovenantofmayors.org/>

and factors such as location, country, population, C40 membership, and pollution index. We looked at the world and the EU, comparing them both. We also did in-depth studies on popular cities, Berlin, Paris, Rome, Copenhagen, and London, their climate goals and energy mix in order to examine how those large cities are dealing with greenhouse gas emissions and climate change with renewable energies. The following section presents results.

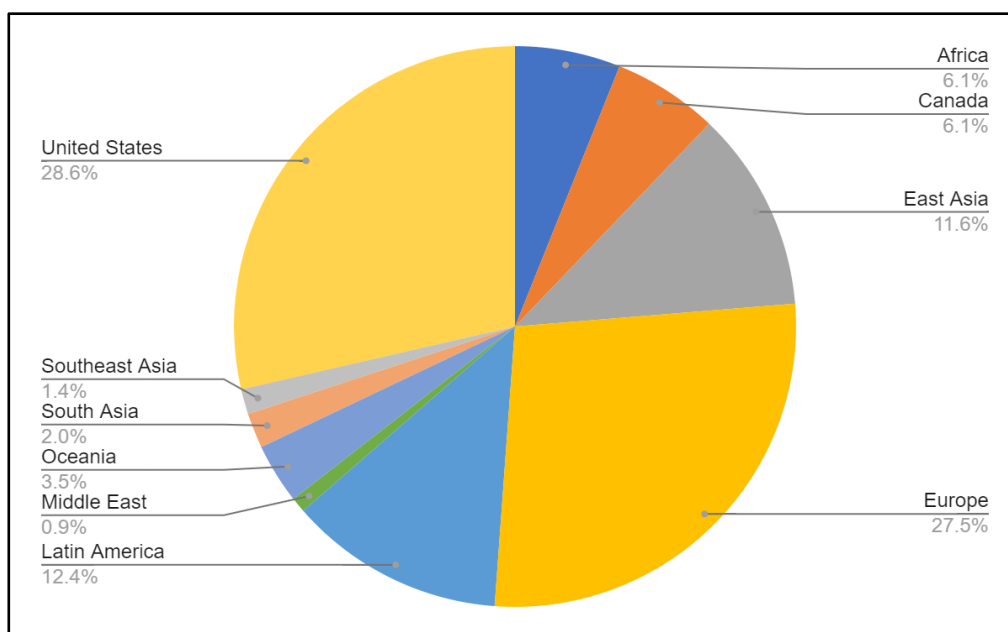
V. RESULTS

(1) Exploring Cities' Renewable Energy Targets (RETs)

RETs by Region. The United States and Europe had the most cities with a renewable energy target, making up 56% of the cities. The Middle East and South Asia had the lowest percentages. Most of Europe and the US are developed, so changing to more renewable energy would be much easier because they have already passed industrialization. However, most of the Middle East and South Asia are underdeveloped, so these countries use fossil fuels to urbanize.

Figure 1.

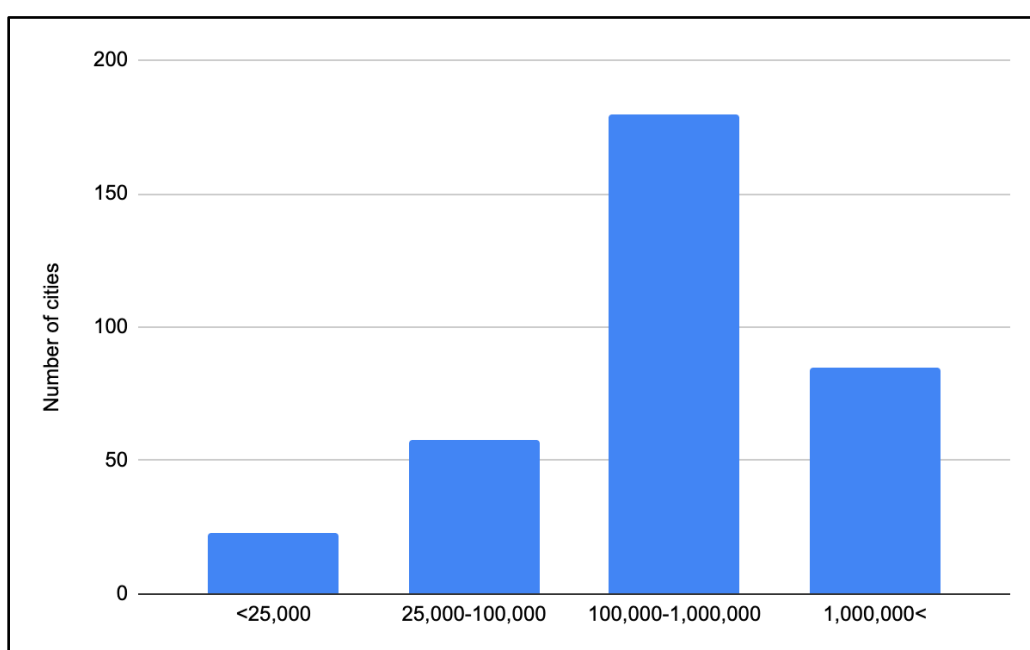
Renewable Energy Targets by Region



RETs by Population. The majority of cities with targets are 100,000+ in population size. These large cities have more resources and money that they can utilize to change to renewable energy sources. However, there could be another reason why cities over 1,000,000 have fewer targets. Cities with over a million people are very urbanized and likely need more space for large renewable generation facilities like dams or wind turbines. Thus, smaller, more suburban cities have more room to implement renewable energy sources.

Figure 2.

Renewable Energy Targets by Population



RETs by C40 Support. The majority of cities are not in the C40 club. C40 is a network of almost 100 mayors who first confront the world's climate crisis by cutting their own emissions in half by 2030. C40 cities mostly include big cities in each region, such as Madrid for Europe and Beijing for Asia. Many cities were small, lacked international power, and needed more economic growth. Therefore, financial resources needed to be fully incorporated to C40 are a limiting factor.

RETs by GCOMCE. On the other hand, almost 75% of the cities are part of GCoM, indicating that much more diverse cities, despite their sizes or economic status, are committed to climate leadership compared to C40. Therefore, it is easier for cities located in both developed and

developing cities to join the initiative since there are far fewer prior requirements to be involved.

Figure 3a.

Renewable Energy Targets by C40 City Membership

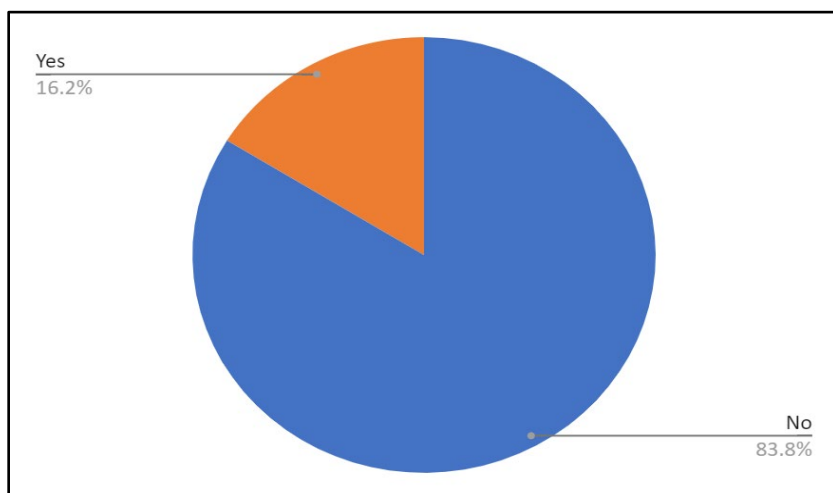
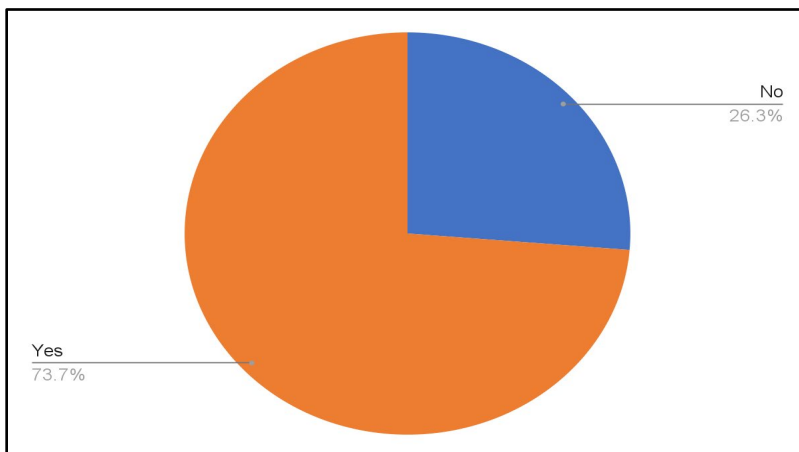


Figure 3b.

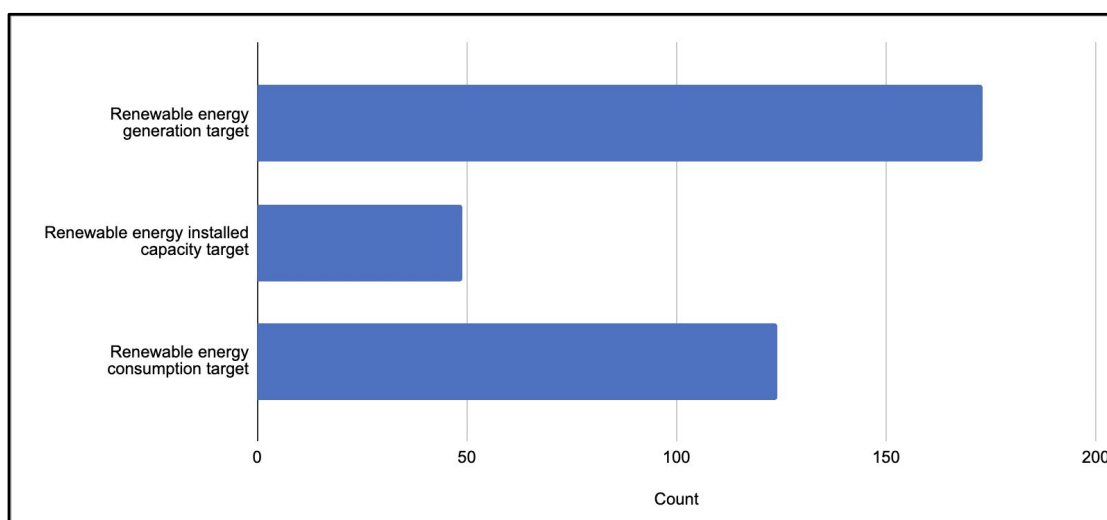
Renewable energy targets by GCOMCE



RETs by Target Type. Most cities chose the renewable generation energy target, with the consumption target just behind it. The renewable energy installed capacity target was the least picked option. This might be because the generation target would be the easiest to complete. A city only needs to implement a renewable energy source such as wind turbines or hydro dams. However, for consumption, the city needs to stop consuming fossil fuels and start a switch to renewable sources, which is harder to accomplish and costs more. Further, a city might be opposed or less attracted to developing an installed capacity target because it would require more detailed planning and carrying out of ideas. Therefore, generation and consumption targets would be easier for cities to implement as their renewable energy targets.

Figure 4.

RETs by Renewable Energy Target Types

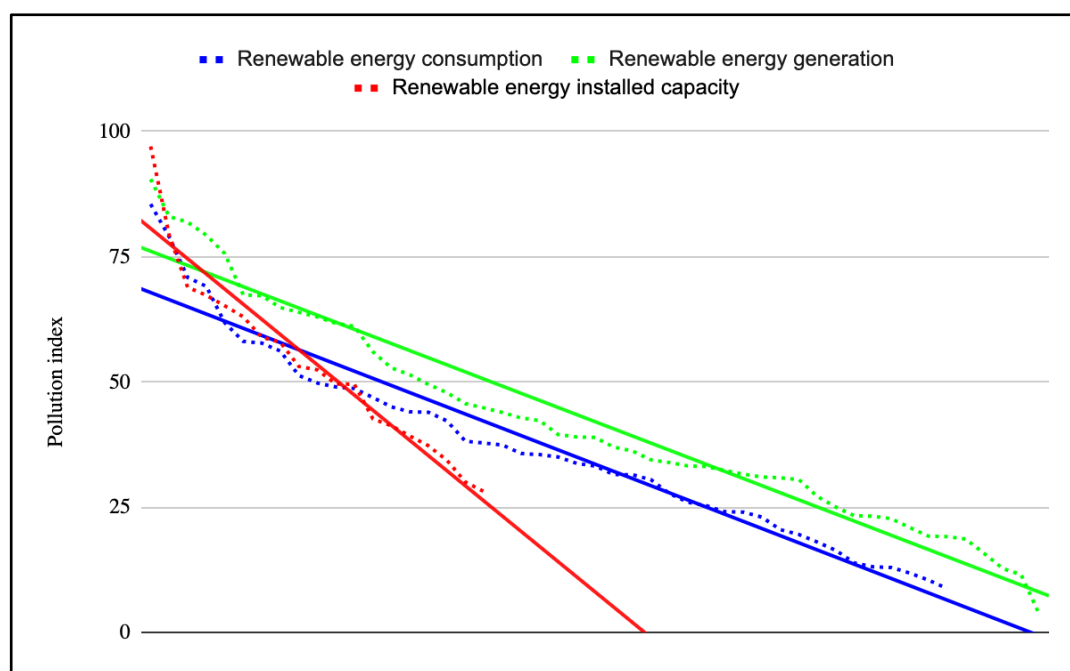


RETs by Air Pollution Intensity. A scatter plot of the cities with the RETs renewable energy consumption, generation, and installed capacity is shown below. The dotted lines are the actual values, and the trend lines are the solid straight lines. Based on the trends, cities that chose generation RETs have a higher pollution index on average than those that chose consumption. This could be because creating a renewable energy plant is easier than converting part of your energy consumption to renewable. Consumption requires not only a renewable plant but also a percentage consumption conversion. Generation requires only renewable plants. Generation would be the easier target to implement, especially for developing cities, which are primarily dependent on fossil fuels. Renewable energy installed capacity has the least amount of cities

that chose it; however, its average pollution index is much higher than those of generation and consumption.

Figure 5.

RETs by Air Pollution Intensity



(2) RETs in European Union Cities

RETs by Target Types in European Cities. Between the countries inside the EU, the renewable energy generation target was the most chosen out of all three targets. Compared to the percentages of the global data, more than half of the countries in the EU chose the renewable energy generation target and less than 10% chose the renewable energy installed capacity target. This lines up with the data that was collected globally, since 53% of countries world-wide chose to use the renewable energy generation target. Due to the renewable energy generation target being the most-compatible with large cities because of its simplicity – generate a certain amount of power through renewable sources – the ratio of the countries that chose the target does not differ too much between the global data and the EU data.

The different target types between the EU and the world do not differ that much. The difference is only around 3% at the most and 1.4% at the least. Renewable energy installed capacity target remains the least picked option, with 12.8% in the EU and 14.2% in the world. Renewable energy consumption target is the 2nd most picked, 34% in EU and 35.8% in the world. And finally Renewable energy generation target is the most picked with 53.2% in EU and 50.0% in the world.

Figure 6a.

RETs by Target Types in EU

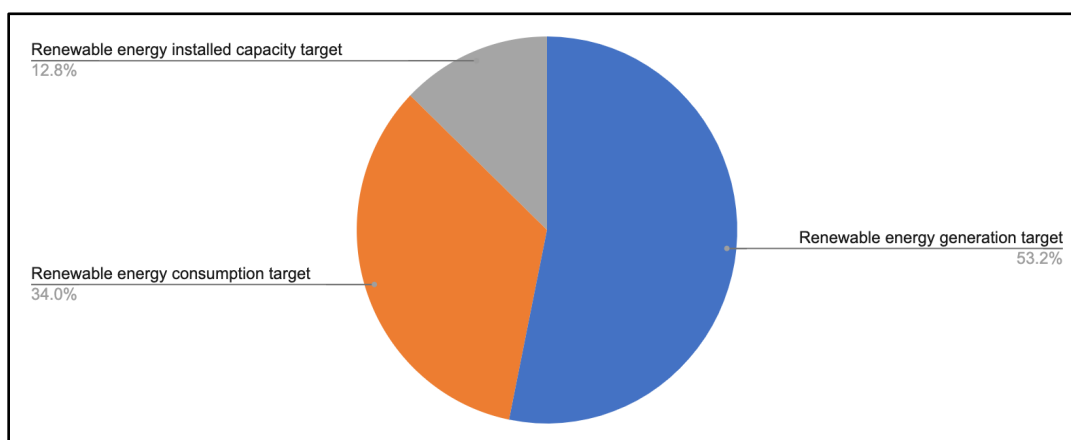
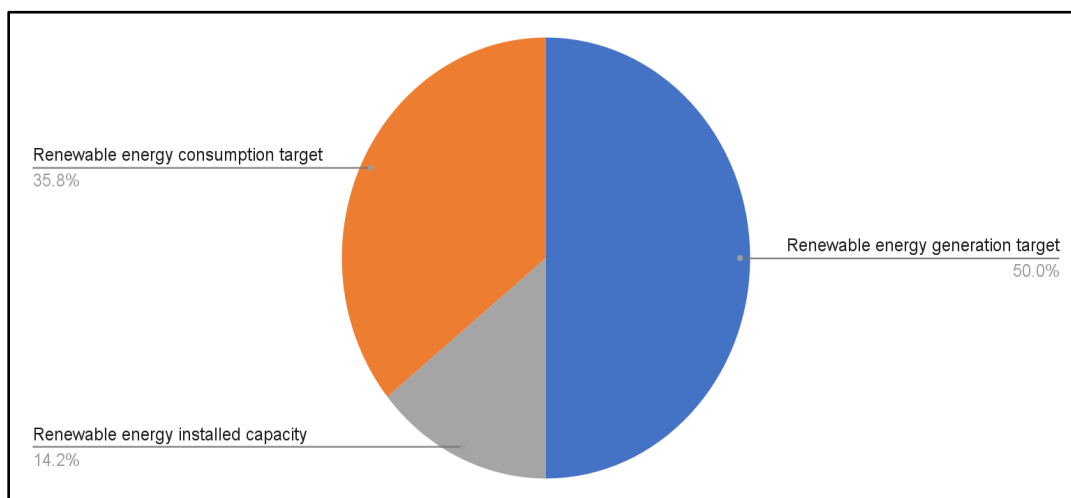


Figure 6b.

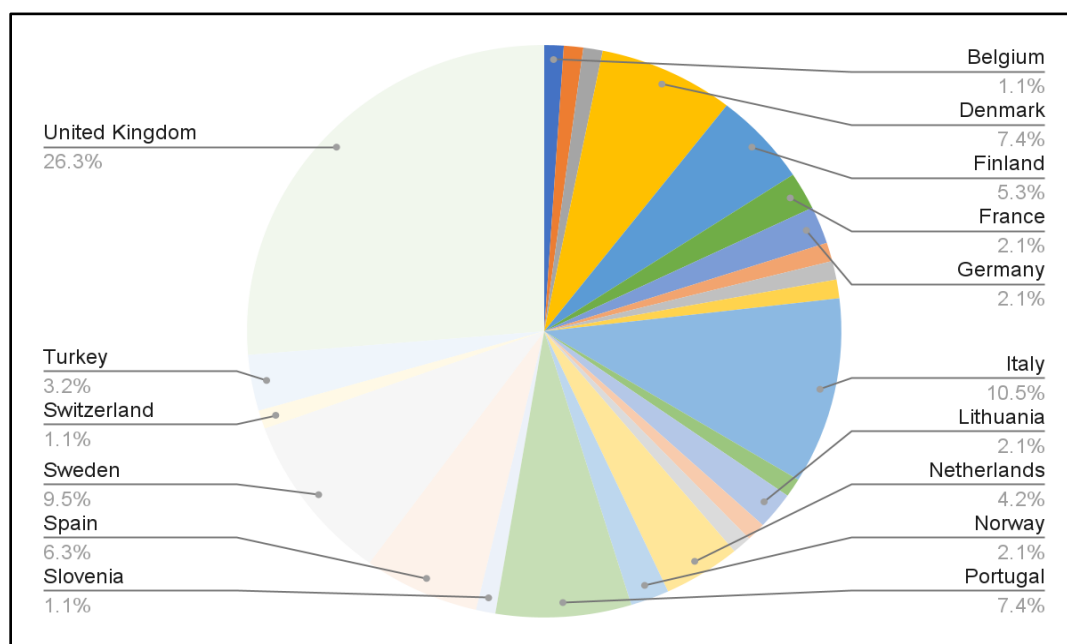
RETs by Target Types in the World



RET Country Distribution in EU. The bar graph displays the number of renewable energy goals of cities, with the UK having the most at 25, Italy having 10, Denmark having roughly 7, and so on. Furthermore, the countries with the highest counts are in the Scandinavia region, such as Finland, Sweden, and Denmark. These countries rely on biomass or off-shore wind energy in deep-sea areas.

Figure 6.

Cities' RET Country Distribution in EU



RETs in EU Cities. The pie chart illustrates the number of cities in the European Union with RETs. It indicates that the United Kingdom has the most cities with RETs, comprising about a quarter of the entire countries in EU. Next comes Italy, Sweden, Portugal, and Denmark, each comprising 10.5, 9.5, 7.4, and 7.4% of the entire countries in EU with RETs. The countries with the lowest number were Belgium, Switzerland, and Slovenia, making 1.1% of all. This disparity likely comes from the fact that developed countries such as UK is already actively using renewable sources to generate electricity, while developing countries continue to rely on fossil fuels.

(3) Major European Cities' RET In-Depth Analysis

a. Rome

Current energy usage for the City of Rome is as follows: 43% natural gas, 32% oil, 4% coal, and 20% of other renewable sources such as fossil fuels and electrical power generation. To this end, the City of Rome plans to eliminate coal by 2025 and bring renewables' share of final gross electricity production to 72% by 2030 and 95%–100% by 2050. It will have to add 70 GW of electric renewables, which, when added to the current 58 GW, will reach a total of 128 GW by 2030, meeting the 72% quota, and it would be necessary for it to install at least 60 GW of new, large sized reserves, while also strengthening electric networks.

b. Paris

In Paris, nuclear energy, a zero-carbon but non-renewable energy type, makes up around 76% of the country's energy mix. Although nuclear energy does not release carbon, Uranium, which is used during the energy-making process, is technically non-renewable. Due to the majority of energy production being from nuclear power plants, France's next highest energy is hydropower, which makes up around 13%. For annual hydroelectricity power, France is ranked 10th in the world. It is the second largest source of electricity generation and the highest overall in renewable sources. Gas, wind, bioenergies, and oil make up less than 6% of France's energy production. Worldwide, France is one of the highest in use of renewable energy sources and gained attention for its commitments during the Paris Accords and its Climate Change laws. France is one country that hopes to reduce their net carbon emission to zero by 2050, which is also frequently called carbon neutral or zero carbon. The city of Paris has also set renewable targets for the upcoming years. The city's mayor reported that Paris is hoping to have an 80% reduction in carbon footprint compared to 2004, equip 20% of all Parisian rooftops with solar panels by 2030, discontinue the use of fossil fuel vehicles by 2030, and increase the amount of renewable energy sources used in the city's heating networks to 75%. In France, housing networks account for around 45% of energy consumption and around a quarter of France's carbon emissions. Regarding public transportation, Paris' mayor has announced that she wishes Paris can be a 100% bikeable city by slowly reducing automobile space on roads and increasing pedestrian walkways.

c. London

In London, natural gas, a type of fossil fuel, unfortunately makes up the highest percentage of energy use. However, the second highest energy consumption is wind energy: onshore wind is considered the cheapest method for scaling up renewable energy. Next come nuclear, biomass, solar, and hydro energy. Currently, the London government is generating energy through energy supply programs, which means they

use less energy than conventional energy systems in meeting the same demand. London has also set its renewable energy target to supply 15% of its energy from renewable sources and reach net-zero in carbon footprint by 2030. London also aims to increase its solar capacity by 20 times and construct new buildings with electric heating through 2.2 million heat pumps by 2030.

d. Berlin

Up until recently, Germany has mainly depended on coal and gas for its energy. Most of the coal comes from Russia. In 2015, Berlin used 30.2% Natural Gas, 36.2% Mineral Oil, 4.6% Lignite and 15.1% Hard Coal. Most of the energy came from gas and coal, non renewable resources. However, following the invasion of Ukraine by Russia, Germany stopped buying coal from Russia. This is causing a huge problem as Germany now needs a source of energy to resupply what was lost. Fortunately, it seems that they are replacing it with renewable energy. As of 2023, renewables make up 57.7 percent of German energy consumption. Lignite was down 21%, hard coal down 23%, natural gas down 4% and nuclear down 57% from 2022 values.

Germany is expected to have around 46% renewable energy consumption by this year. Germany has set a target for 80% renewable energy generation by 2030, aiming to be fully renewable by 2035. Currently, Germany is falling behind the threshold of these goals if they want to reach it by 2030. In order to try and accelerate this process of becoming carbon neutral by 2045, Berlin not only raised its renewable energy targets but also passed bills to ease restrictions to make the production of wind and solar power easier.(Fraunhofer, 2023)

e. Copenhagen

Copenhagen's main source of energy comes from wind as it is very north. Copenhagen also is moving very quickly to 100% renewable energy as only 16% of their total energy comes from fossil fuels. Copenhagen's fossil fuel usage is one of the lowest in the world and are quickly moving towards a fully carbon neutral city.

Copenhagen's goal is achieving 100% renewable energy by 2025, they will achieve this by changes in energy production, energy consumption, and green mobility. They are increasing wind turbines and biomass in the city in order to achieve carbon neutrality. While also increasing renewables, Copenhagen is using its energy responsibly and are cutting down on unnecessary waste by promoting green mobility. Promoting the use of cycling and public transportation.

Table1.*Current Energy Mix and Renewable Energy Targets by Major Five European Cities*

Cities	Current Energy Mix	Renewable Energy Targets
Berlin	30.2% Natural Gas 36.2% Mineral Oil 4.6% Lignite 15.1% Hard Coal (from 2015)	· 46% renewable energy consumption by this year. · 80% renewable energy generation by 2030, aiming to be fully renewable by 2035. · passed bills to ease restrictions to make the production of wind and solar power easier.
Copenhagen	Wind 55% Bioenergy 23% Fossil Fuel 16% Solar 5%	· 2025 is to become the first city to achieve carbon neutrality. · Energy Production: 80% of greenhouse gas reduction in Copenhagen will come from energy production. · Green Mobility: 66% of all transportation is currently done on foot, bike, or public transportation, and the goal for 2025 is 75%.
London	Natural Gas 38.5% Wind 26.8% Nuclear 15.5% Biomass 5.2% Solar 4.4%	· Supply 15% of London's energy from renewable sources by 2030 · Reach net-zero in carbon footprint by 2030 · Increase London's solar capacity by 20 times
Paris	Nuclear energy 76% Hydro 13% Wind 4%	· Be "carbon neutral" by 2050, which means that the country Will not produce any carbon

	Natural gas 6% Bioenergies 2% Oil and other renewables 0-1%	· Reach 32% of renewable energy in gross final power by 2030 · Increase renewable energy share in electricity generation to 40%
Rome	Natural gas 43% Oil 32% Coal 4% Other renewable sources (fossil fuels and electrical power generation) 20%	· Plans to eliminate coal by 2025 and bring renewables' share of final gross electricity production to 72% by 2030 and 95%–100% by 2050 · Add 70 GW of electric renewables, which, when added to the current 58 GW, will reach a total of 128 GW by 2030, meeting the 72% quota. · Be necessary to install at least 60 GW of new, large-sized reserves, in addition to strengthening electric networks.

VI.DISCUSSION

Renewable energy goals are oriented toward generation rather than consumption, which is shown in Berlin's case. Especially in the EU, in the face of natural gas phase-out needs in the region. In Graph 6a, generation was the most picked type of renewable energy target in the EU. In Berlin, most climate goals are pushed towards generation, trying to achieve 100% generation by 2035. This shift towards more renewable forms of energy was caused by the increase in climate goals and renewable energy targets and a lack of imported fossil fuels. A couple of years ago, when Russia invaded Ukraine, the EU member states banned buying and importing coal from Russia. Later, the EU would limit the importation of natural gas as well. This caused a huge deficit in the amount of energy the EU had access to, and they are now trying to fill the gap with renewable sources. This is why so many goals in the EU are driven towards the generation as cities try to generate as much renewable energy as possible.

In the end, GCoM would be much more helpful than C40 when cities desire to reduce greenhouse gases through renewable energy targets, considering how only about 15% of all the cities are currently involved in C40 while about 75% are involved in GCoM. This huge disparity in involvement comes from the fact that there are far fewer requirements for cities to join the global alliance provided by GCoM, making this organization much more accessible for developing countries that might lack the resources to reach renewable energy targets. Moreover, local and state governments in GCoM are working hard to reach the goals of the Paris Climate Agreement; therefore, joining this alliance would encourage the cities to mitigate the effects of climate change voluntarily.

Renewable energy targets were more seen in cities in developed countries, with a regional uneven distribution in cities with renewable energy targets. However, more cities in developing countries need renewable energy targets to avoid air pollution and reduce greenhouse gases. The majority of cities with targets are 100,000+ in population size. This is probably because large urban cities are mostly done with industrialization that they do not need a large amount of fossil fuels. Also, these large cities have more resources and money that they can utilize to change to renewable energy sources.

VII. CONCLUSION

In conclusion, in this report, we analyzed cities' renewable energy targets to mitigate cities' dependency on fossil fuels and the effects of climate change. We identified that climate change has numerous impacts on our environment, causing large-scale natural disasters, rise in sea levels, and various health problems. Since cities are responsible for about 70% of the global carbon emissions, shifting to renewable energy is becoming extremely important. We found that developed countries such as the US and Europe have the most cities with Renewable Energy Targets, while most cities with RETs are 100,000+ in population size. Moreover, about 75% of all cities were involved in GCOMCE, which is a much more accessible environmental alliance to join compared to C40. We also analyzed RETs by renewable energy target types and discovered that renewable energy generation target is the most commonly used type by many cities, potentially due to their simplicity in generating power. Our research highlights that cities play a critical role in alleviating climate change, which could be achieved through renewable energy targets.

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