# The Impact of Air Pollution and Greenhouse Gases on Respiratory Health: Exploring Renewable Solutions

**Introduction to the Report:**

The increasing awareness of climate change and its consequences has driven global attention toward understanding the sources, trends, and impacts of greenhouse gas (GHG) emissions. This report explores the intricate relationships between energy consumption, GHG emissions, renewable energy adoption, and public health outcomes across countries and over time. By integrating multiple datasets covering historical trends in emissions, energy use, and health impacts, this study aims to provide a comprehensive analysis of the factors influencing global and regional climate and health dynamics.

Key topics include the evolution of Methane ($CH_4$) and Carbon Dioxide ($CO_2$) emissions over time and their contribution to overall GHG levels. The report also investigates per capita $CO_2$ emission trends in relation to population growth and industrial development. Furthermore, it delves into the impact of renewable energy consumption on reducing GHG emissions, particularly $CO_2$, and its correlation with improvements in public health, specifically respiratory conditions.

This report leverages data on U.S. energy consumption, global GHG emissions, and health indicators such as mortality rates due to air pollution and chronic respiratory diseases. The analysis also considers the role of economic development, measured through GDP per capita, in influencing GHG emissions trends across different countries. By exploring these relationships, the report seeks to highlight the regional disparities and emerging opportunities for climate action, particularly in the context of renewable energy and public health benefits.

Through this multidimensional approach, the report aims to address critical questions about the interplay between environmental, economic, and health factors, providing valuable insights for policymakers, researchers, and stakeholders in their efforts to combat climate change and its impacts.

**Data Sources:**

Energy Consumption Data - https://cfpub.epa.gov/roe/indicator.cfm?i=93#1
Emissions and Death rate data - https://ourworldindata.org/greenhouse-gas-emissions
Combined UN data - http://data.un.org/Explorer.aspx

**Research Questions:**

**1. How do per capita greenhouse gas emissions, methane emissions, and nitrous oxide emissions evolve over time across different regions, and what trends can be observed in their relative contributions to overall emissions?**

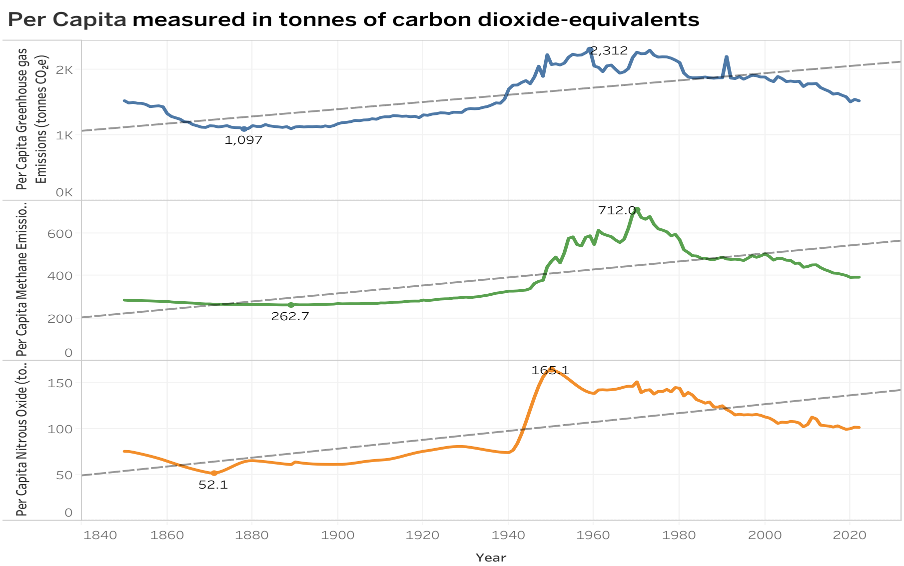
**2. What is the relationship between energy consumption by sector (industrial, residential, transportation, etc.) and overall energy efficiency improvements in the U.S. from 1949 to 2017?**

**3. How do global $CO_2$ emissions vary by country, and which countries have contributed the most to total emissions historically?**

**4. What is the impact of high global warming potential (GWP) gases, such as $SF_6$ and PFCs, on overall greenhouse gas emissions relative to $CO_2$, and how significant are these contributions globally?**

**Analysis:**

1. **How have per capita emissions of greenhouse gases (GHG), methane ($CH_4$), and nitrous oxide ($N_2O$) evolved over time, and what trends are observable in their relative contributions to overall emissions?**




The trends of sum of Per-Capita-Ghg-Emissions, sum of Per-Capita-Methane-Emissions and sum of Per-Capita-Nitrous-Oxide for Year (ghg-emissions-by-gas.csv). The data is filtered on Country or Area (ghg-emissions-by-gas.csv), which keeps 240 of 240 members.

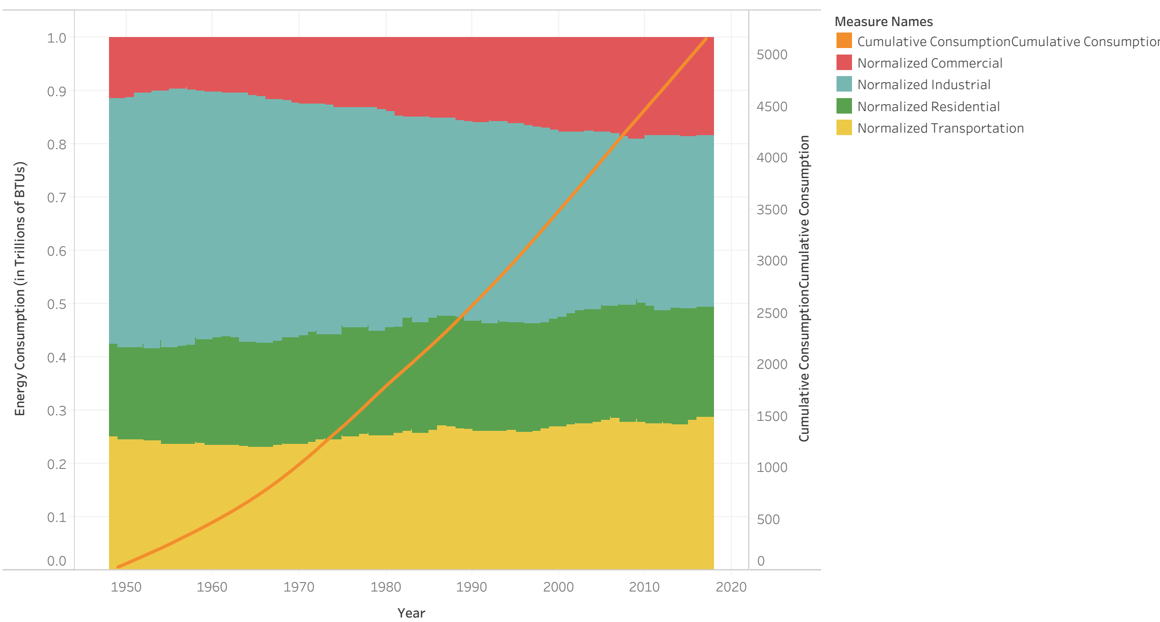
**Interpretation:**

The trends in per capita greenhouse gas (GHG), methane ($CH_4$), and nitrous oxide ($N_2O$) emissions directly address the research question of how these emissions have evolved over time and their relationship with overall GHG emissions. The decline in per capita GHG emissions from a peak of 2,312 tonnes $CO_2e$ in 1959 to 1,529 tonnes $CO_2e$ in 2022 reflects advancements in renewable energy usage and industrial efficiency. Similarly, the reduction in methane emissions, which peaked at 712 tonnes $CO_2e$ in 1970, suggests the impact of improved waste management, agricultural practices, and shifts in energy production methods. Nitrous oxide emissions, with a slower but steady decline to 102 tonnes $CO_2e$ by 2022, highlight the gradual transition in agricultural practices and industrial emissions controls.

These trends are essential for analyzing the impact of industrial and population growth on emissions and exploring the relationship between renewable energy adoption and GHG reductions. For example, the consistent decline in methane and nitrous oxide emissions supports the hypothesis that renewable energy adoption and stricter environmental regulations contribute to lower emissions levels. Furthermore, these trends provide a foundation for understanding the regional disparities in emissions and their implications for chronic respiratory diseases, as higher per capita emissions correlate with increased pollution-related health risks.

2. **How has total energy consumption by sector in the U.S. evolved from 1949 to 2017, and what does this indicate about the relationship between sector-specific energy use and overall GHG emissions?**

Total U.S. Energy Consumption by Sector (1949–2017)




The trends of Normalized Commercial, Normalized Industrial, Normalized Residential, Normalized Transportation, Cumulative ConsumptionCumulative Consumption and Cumulative ConsumptionCumulative Consumption for Year (Total U.S. energy consumption by sector, 1949-2017.csv). Color shows details about Normalized Commercial, Normalized Industrial, Normalized Residential, Normalized Transportation and Cumulative ConsumptionCumulative Consumption. Details are shown for Normalized Commercial, Normalized Industrial, Normalized Residential, Normalized Transportation and Cumulative ConsumptionCumulative Consumption.

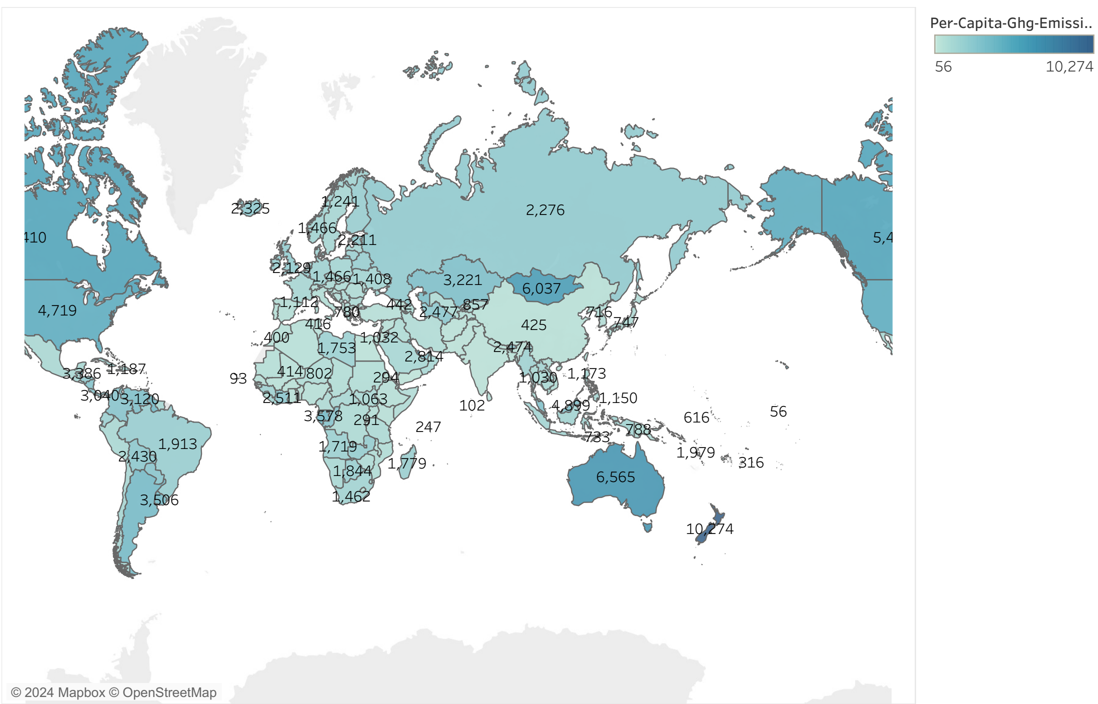
**Interpretation:**

The cumulative energy consumption in the U.S. rose from 31.98 trillion BTUs in 1949 to 5,148.68 trillion BTUs in 2017. Among sectors, the industrial sector consistently dominated energy use until the 1980s, after which transportation and residential consumption gained prominence. For instance, normalized industrial consumption declined from 46% in 1949 to 32.2% in 2017, while transportation increased slightly from 24.9% to 28.8% over the same period. This shift in energy consumption patterns is directly linked to evolving industrial activities, urbanization, and increasing reliance on transportation systems powered by fossil fuels.

This analysis provides critical insights into the research question regarding the relationship between energy consumption and GHG emissions. The steady rise in energy demand across all sectors underscores the role of energy-intensive activities in contributing to GHG emissions. For example, the industrial and transportation sectors, which rely heavily on non-renewable energy, are key drivers of $CO_2$ and methane emissions. This data highlights the necessity of adopting renewable energy sources and improving energy efficiency to achieve significant reductions in overall emissions. Moreover, understanding sector-specific trends helps identify targeted strategies to mitigate emissions in the most impactful areas.

3. **How do per capita GHG emissions vary across countries, and what does this reveal about global emission disparities and their relationship to economic and energy consumption patterns?**

**Map Visualization of Emissions by Country**




Map based on Longitude (generated) and Latitude (generated). Color shows sum of Per-Capita-Ghg-Emissions. The marks are labeled by sum of Per-Capita-Ghg-Emissions. Details are shown for Entity (copy). The data is filtered on Year (Combined Emissions Data per capita.csv), which keeps all values. The view is filtered on Latitude (generated) and Entity (copy). The Latitude (generated) filter keeps non-Null values only. The Entity (copy) filter keeps 200 of 213 members.

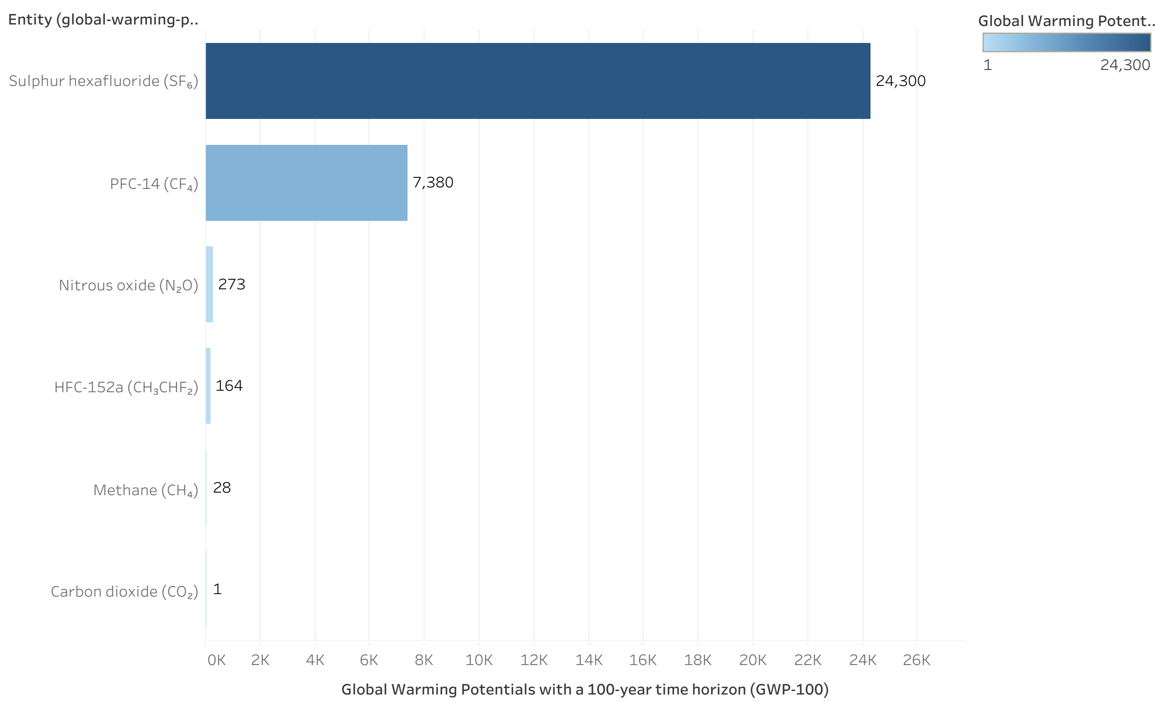
**Interpretation:**

Per capita greenhouse gas emissions show significant disparities globally, reflecting varying economic development and energy consumption patterns. High-income countries like New Zealand (10,274 tonnes), Qatar (6,882 tonnes), and Australia (6,564 tonnes) have some of the highest emissions per capita, driven by industrial activity, energy-intensive lifestyles, and reliance on fossil fuels. In contrast, developing nations like Bangladesh (279 tonnes) and India (290 tonnes) exhibit significantly lower emissions, despite having large populations, indicating limited industrialization and lower energy use per capita.

This variation directly relates to research questions concerning the relationship between economic growth, energy consumption, and GHG emissions. Developed nations' higher emissions highlight the need for transitioning to renewable energy sources and enhancing energy efficiency to reduce their global environmental impact. Meanwhile, supporting developing countries in adopting sustainable energy strategies can help curb their emissions growth as they industrialize. The data emphasizes the need for tailored climate policies considering economic capabilities and emission footprints.

4. **How do the global warming potentials (GWPs) of greenhouse gases compare, and what does this imply for prioritizing mitigation strategies to reduce climate change impacts?**

**Global warming potential of greenhouse gases relative to CO2**




Sum of Global Warming Potentials with a 100-year time horizon (GWP-100) for each Entity (global-warming-potential-of-greenhouse-gases-over-100-year-timescale-gwp.csv). Color shows sum of Global Warming Potentials with a 100-year time horizon (GWP-100). The marks are labeled by sum of Global Warming Potentials with a 100-year time horizon (GWP-100).

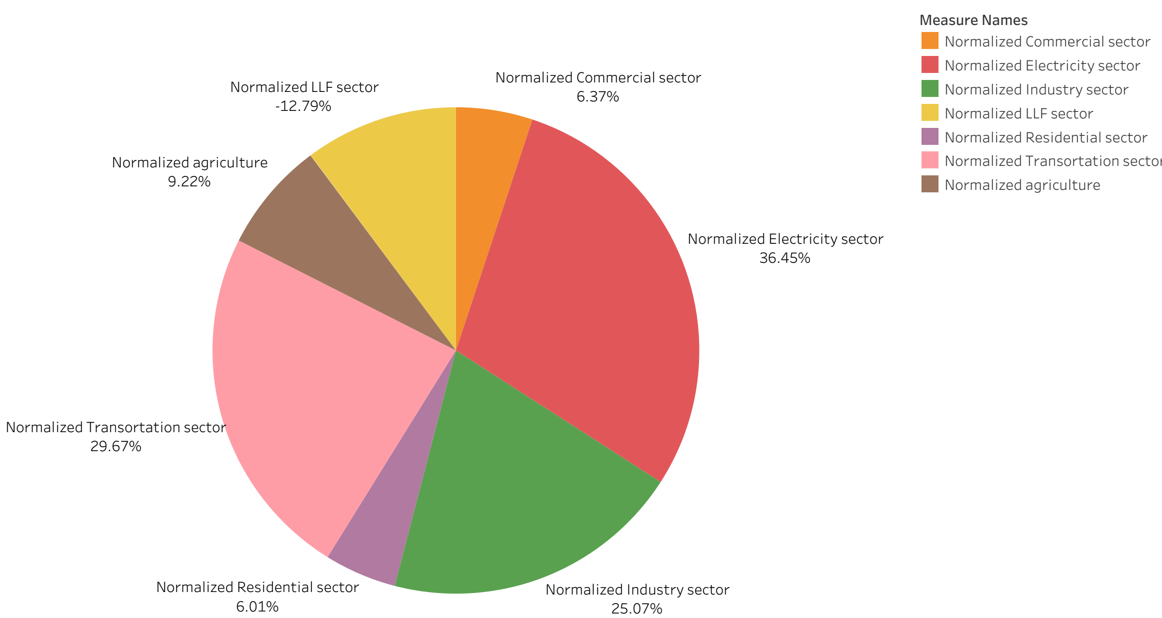
**Interpretation:**

The global warming potential (GWP) of greenhouse gases highlights the disproportionate impact of certain gases despite their lower atmospheric concentrations. Sulphur hexafluoride ($SF_6$) has the highest GWP of 24,300, followed by PFC-14 (7,380) and nitrous oxide ($N_2O$) at 273. Methane ($CH_4$), a common emission from agriculture and energy production, has a GWP of 28, significantly higher than carbon dioxide ($CO_2$), which is set at a baseline of 1. These figures underline the urgent need to target emissions of high-GWP gases, such as $SF_6$ and PFC-14, even if they represent a smaller proportion of total emissions.

This insight connects to the research questions by emphasizing the importance of reducing methane and nitrous oxide emissions, which contribute significantly to global GHG totals. Targeting sectors like agriculture, where nitrous oxide and methane are prevalent, and transitioning to renewable energy sources can mitigate these high-impact emissions. Furthermore, the substantial GWP of $SF_6$ and PFC-14 suggests the need for international regulations on industrial processes that release these gases, contributing to sustainable global mitigation efforts.

5. **What is the contribution of different economic sectors to U.S. greenhouse gas emissions, and how can targeting these sectors align with reducing overall emissions?**

**Emissions % by Sector (Pie Chart)**

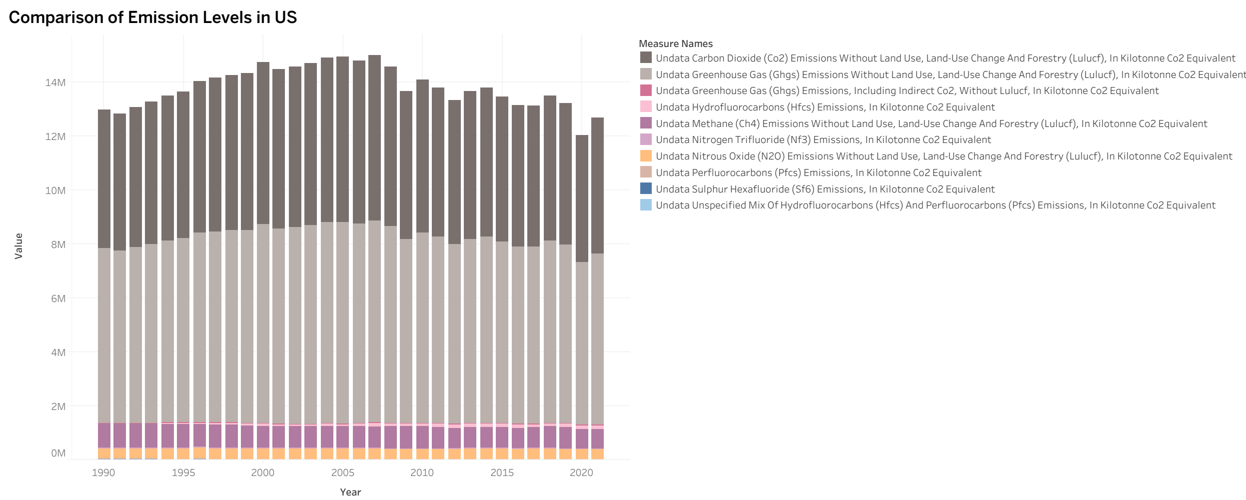



Normalized Commercial sector, Normalized Electricity sector, Normalized Industry sector, Normalized LLF sector, Normalized Residential sector, Normalized Transortation sector, Normalized agriculture, Normalized Commercial sector, Normalized Electricity sector, Normalized Industry sector, Normalized LLF sector, Normalized Residential sector, Normalized Transortation sector and Normalized agriculture. Color shows details about Normalized Commercial sector, Normalized Electricity sector, Normalized Industry sector, Normalized LLF sector, Normalized Residential sector, Normalized Transortation sector and Normalized agriculture. The marks are labeled by Normalized Commercial sector, Normalized Electricity sector, Normalized Industry sector, Normalized LLF sector, Normalized Residential sector, Normalized Transortation sector, Normalized agriculture, Normalized Commercial sector, Normalized Electricity sector, Normalized Industry sector, Normalized LLF sector, Normalized Residential sector, Normalized Transortation sector and Normalized agriculture. The data is filtered on Year (Greenhouse gas emissions and sinks in the U.S. by economic sector, 1990-2020.csv), which ranges from 2000 to 2000.

The electricity sector accounts for the largest share of emissions at 36.45%, followed by transportation at 29.67% and industry at 25.07%. Combined, these sectors contribute over 90% of the total emissions, highlighting their critical role in driving greenhouse gas outputs. Sectors like residential and commercial have comparatively smaller shares, at 6.01% and 6.37%, respectively. Interestingly, the Land Use, Land-Use Change, and Forestry (LLF) sector has a negative contribution of -12.79%, indicating its role as a net carbon sink, offsetting emissions from other sectors.

This breakdown aligns with research questions exploring the relationship between energy use, industrial activity, and emissions. Targeting the electricity and transportation sectors with renewable energy adoption and efficiency improvements could yield the most significant reductions in greenhouse gas emissions. Moreover, enhancing carbon sequestration in the LLF sector can amplify its offsetting capacity, supporting climate goals and mitigating the public health impacts of emissions-intensive sectors like transportation.

6. **How have greenhouse gas (GHG) emissions in the U.S. evolved over time, and what role do different gases play in contributing to these emissions?**




The plots of Undata Carbon Dioxide (Co2) Emissions Without Land Use, Land-Use Change And Forestry (Lulucf), In Kilotonne Co2 Equivalent, Undata Greenhouse Gas (Ghgs) Emissions Without Land Use, Land-Use Change And Forestry (Lulucf), In Kilotonne Co2 Equivalent, Undata Greenhouse Gas (Ghgs) Emissions, Including Indirect Co2, Without Lulucf, In Kilotonne Co2 Equivalent, Undata Hydrofluorocarbons (Hfcs) Emissions, In Kilotonne Co2 Equivalent, Undata Methane (Ch4) Emissions Without Land Use, Land-Use Change And Forestry (Lulucf), In Kilotonne Co2 Equivalent, Undata Nitrogen Trifluoride (Nf3) Emissions, In Kilotonne Co2 Equivalent, Undata Nitrous Oxide (N2O) Emissions Without Land Use, Land-Use Change And Forestry (Lulucf), In Kilotonne Co2 Equivalent, Undata Perfluorocarbons (Pfcs) Emissions, In Kilotonne Co2 Equivalent, Undata Sulphur Hexafluoride (Sf6) Emissions, In Kilotonne Co2 Equivalent and Undata Unspecified Mix Of Hydrofluorocarbons (Hfcs) And Perfluorocarbons (Pfcs) Emissions, In Kilotonne Co2 Equivalent for Year. Color shows details about Undata Carbon Dioxide (Co2) Emissions Without Land Use, Land-Use Change And Forestry (Lulucf), In Kilotonne Co2 Equivalent, Undata Greenhouse Gas (Ghgs) Emissions Without Land Use, Land-Use Change And Forestry (Lulucf), In Kilotonne Co2 Equivalent, Undata Greenhouse Gas (Ghgs) Emissions, Including Indirect Co2, Without Lulucf, In Kilotonne Co2 Equivalent, Undata Hydrofluorocarbons (Hfcs) Emissions, In Kilotonne Co2 Equivalent, Undata Methane (Ch4) Emissions Without Land Use, Land-Use Change And Forestry (Lulucf), In Kilotonne Co2 Equivalent, Undata Nitrogen Trifluoride (Nf3) Emissions, In Kilotonne Co2 Equivalent, Undata Nitrous Oxide (N2O) Emissions Without Land Use, Land-Use Change And Forestry (Lulucf), In Kilotonne Co2 Equivalent, Undata Perfluorocarbons (Pfcs) Emissions, In Kilotonne Co2 Equivalent, Undata Sulphur Hexafluoride (Sf6) Emissions, In Kilotonne Co2 Equivalent and Undata Unspecified Mix Of Hydrofluorocarbons (Hfcs) And Perfluorocarbons (Pfcs) Emissions, In Kilotonne Co2 Equivalent. The marks are labeled by Undata Carbon Dioxide (Co2) Emissions Without Land Use, Land-Use Change And Forestry (Lulucf), In Kilotonne Co2 Equivalent, Undata Greenhouse Gas (Ghgs) Emissions Without Land Use, Land-Use Change And Forestry (Lulucf), In Kilotonne Co2 Equivalent, Undata Greenhouse Gas (Ghgs) Emissions, Including Indirect Co2, Without Lulucf, In Kilotonne Co2 Equivalent, Undata Hydrofluorocarbons (Hfcs) Emissions, In Kilotonne Co2 Equivalent, Undata Methane (Ch4) Emissions Without Land Use, Land-Use Change And Forestry (Lulucf), In Kilotonne Co2 Equivalent, Undata Nitrogen Trifluoride (Nf3) Emissions, In Kilotonne Co2 Equivalent, Undata Nitrous Oxide (N2O) Emissions Without Land Use, Land-Use Change And Forestry (Lulucf), In Kilotonne Co2 Equivalent, Undata Perfluorocarbons (Pfcs) Emissions, In Kilotonne Co2 Equivalent, Undata Sulphur Hexafluoride (Sf6) Emissions, In Kilotonne Co2 Equivalent and Undata Unspecified Mix Of Hydrofluorocarbons (Hfcs) And Perfluorocarbons (Pfcs) Emissions, In Kilotonne Co2 Equivalent. The data is filtered on Country or Area, which keeps United States of America.

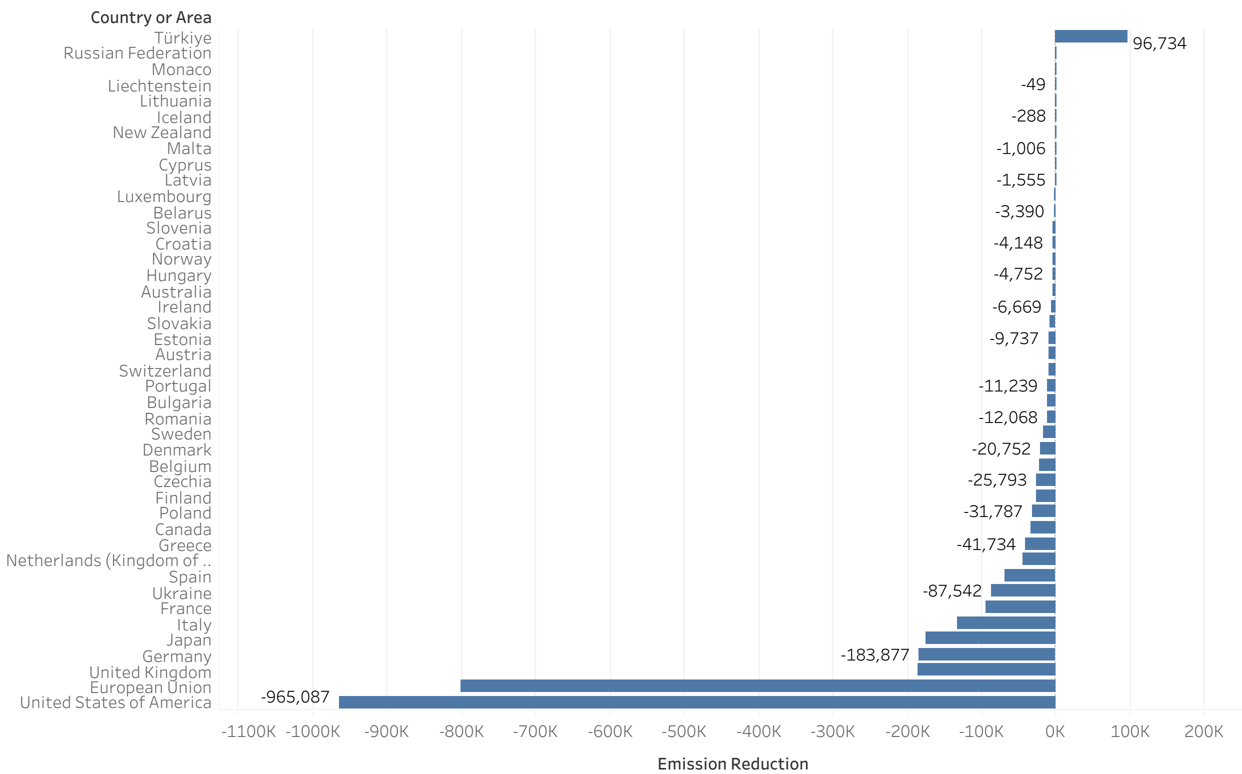
### Interpretation:

The overall greenhouse gas emissions in the U.S. peaked in 2005 at approximately 7.48 million kilotonnes of $CO_2$ equivalent and have since shown a gradual decline, reaching around 6.03 million kilotonnes by 2020. Carbon dioxide ($CO_2$) remains the dominant contributor, accounting for over 80% of total emissions, with methane ($CH_4$) and nitrous oxide ($N_2O$) being significant secondary contributors, at approximately 742,249 kilotonnes and 388,903 kilotonnes in 2020, respectively. High global warming potential gases like hydrofluorocarbons (HFCs) have steadily increased over the years, with emissions rising from about 38,783 kilotonnes in 1990 to 152,280 kilotonnes by 2020, highlighting the growing influence of industrial processes.

This trend aligns with research questions exploring the evolution of GHG emissions over time and their relationship with industrial and economic growth. The data underscores the importance of prioritizing $CO_2$ reductions through renewable energy adoption, as well as addressing methane and nitrous oxide emissions from agriculture and waste. Additionally, the rise in HFC emissions demands targeted regulation to mitigate their impact on climate and reduce public health risks associated with high-GWP gases.

7. **How have $CO_2$ emissions reductions varied across countries between 2010 and 2020, and which regions achieved the most significant declines?**

### Emission Reduction Comparison of CO2 (2010-2020)



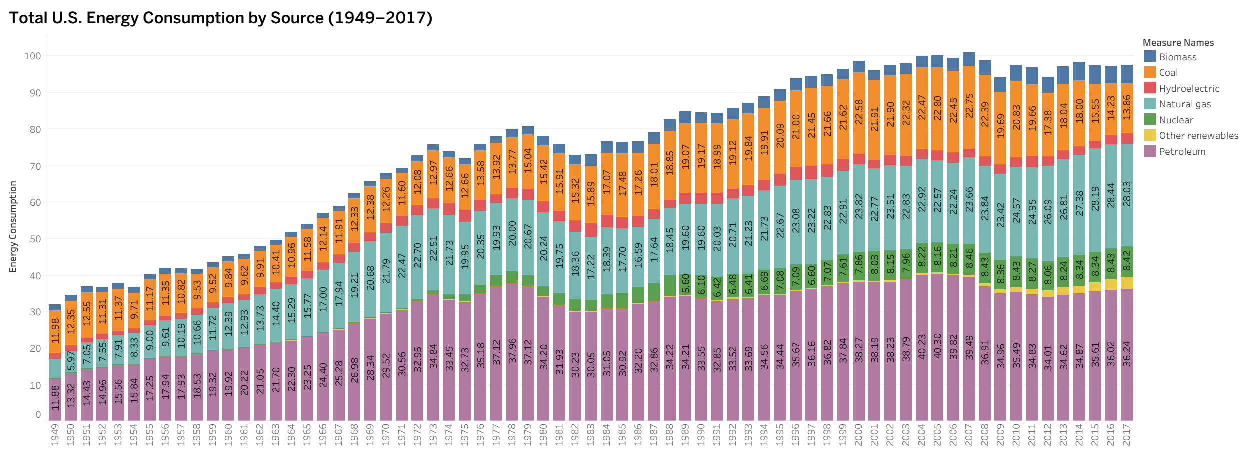

Emission Reduction for each Country or Area. The marks are labeled by Emission Reduction.

**Interpretation:**

The United States led the world in $CO_2$ emissions reductions between 2010 and 2020, with a substantial decrease of approximately 965,087 kilotonnes. This achievement aligns with the nation's increased focus on renewable energy adoption and efficiency improvements. The European Union also recorded a notable reduction of 802,170 kilotonnes, with Germany (-183,877 kilotonnes) and the United Kingdom (-186,679 kilotonnes) making the largest contributions within the bloc. These reductions underscore the impact of stringent environmental policies, advancements in clean energy, and shifts in industrial practices, reflecting progress toward global emissions targets.

In contrast, Turkey saw a net increase of 96,734 kilotonnes, emphasizing disparities in emissions trends between developed and developing nations. Countries like Italy (-133,253 kilotonnes) and Japan (-174,912 kilotonnes) also demonstrated significant reductions, highlighting the role of economic restructuring and energy transitions in cutting emissions. These findings are critical for understanding the global distribution of mitigation efforts and their alignment with research questions on the relationship between economic development, renewable energy adoption, and greenhouse gas emissions.

8. **How has the composition of U.S. energy consumption by source evolved from 1949 to 2017, and what trends are evident in renewable energy adoption?**



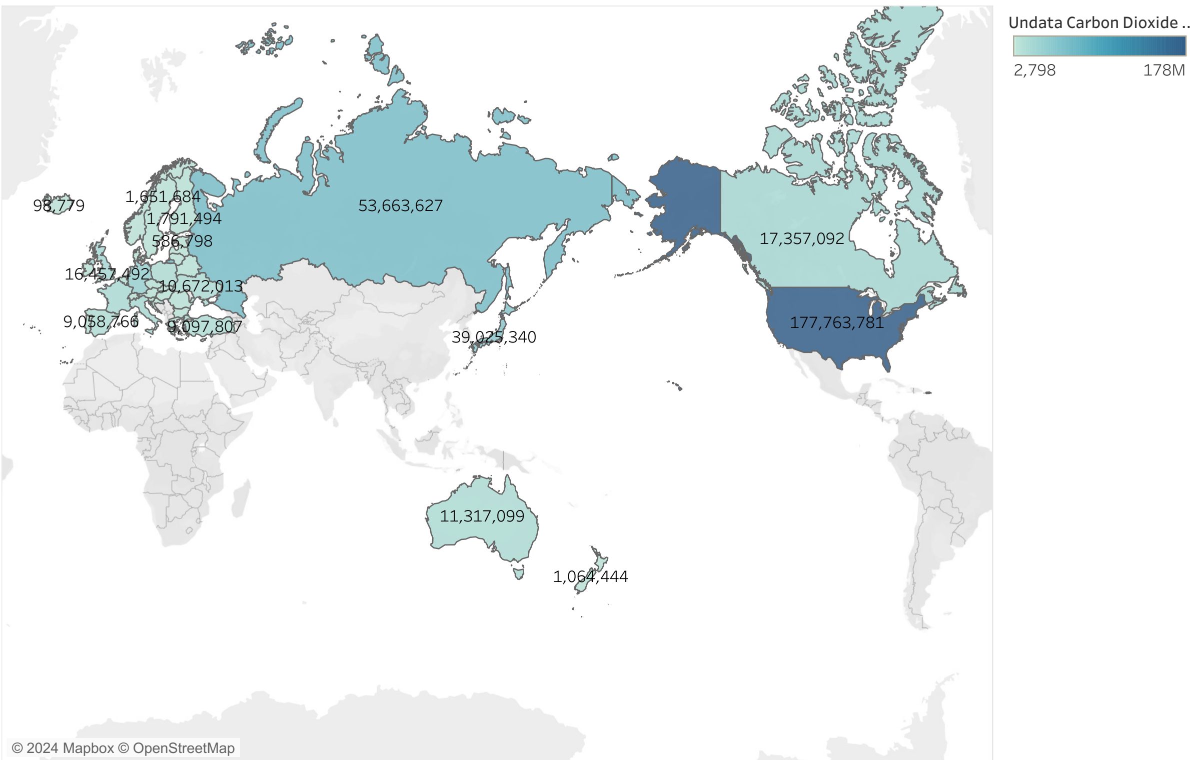

Biomass, Coal, Hydroelectric, Natural gas, Nuclear, Other renewables and Petroleum for each Year ( Total U.S. energy consumption by source, 1949-2017.csv). Color shows details about Biomass, Coal, Hydroelectric, Natural gas, Nuclear, Other renewables and Petroleum. The marks are labeled by Biomass, Coal, Hydroelectric, Natural gas, Nuclear, Other renewables and Petroleum. Details are shown for Biomass, Coal, Hydroelectric, Natural gas, Nuclear, Other renewables and Petroleum.

**Interpretation:**
From 1949 to 2017, the U.S. saw significant shifts in energy consumption patterns. Petroleum consistently dominated energy consumption, peaking at 40.3 quadrillion BTU in 2005 before gradually stabilizing at 36.2 quadrillion BTU in 2017. Meanwhile, natural gas consumption grew substantially, reaching 28.03 quadrillion BTU in 2017, reflecting its increasing role in displacing coal. Coal usage declined markedly after peaking at 22.79 quadrillion BTU in 2005 to just 13.86 quadrillion BTU in 2017, highlighting the shift toward cleaner energy sources.

Renewable energy sources, including biomass and "other renewables" (such as wind and solar), showed steady growth. Biomass increased from 1.54 quadrillion BTU in 1949 to 4.91 quadrillion BTU in 2017, while "other renewables" rose from nearly zero in the 1980s to 3.33 quadrillion BTU in 2017. These trends align with research questions exploring the relationship between renewable energy adoption and greenhouse gas emissions. The growth in renewables has contributed to the decline in coal use and has implications for reducing GHG emissions, addressing air pollution, and improving public health outcomes.

9. **How do CO2 emissions vary across countries, and what insights can be drawn regarding regional contributions to global emissions?**

Global CO2 Emissions by Country



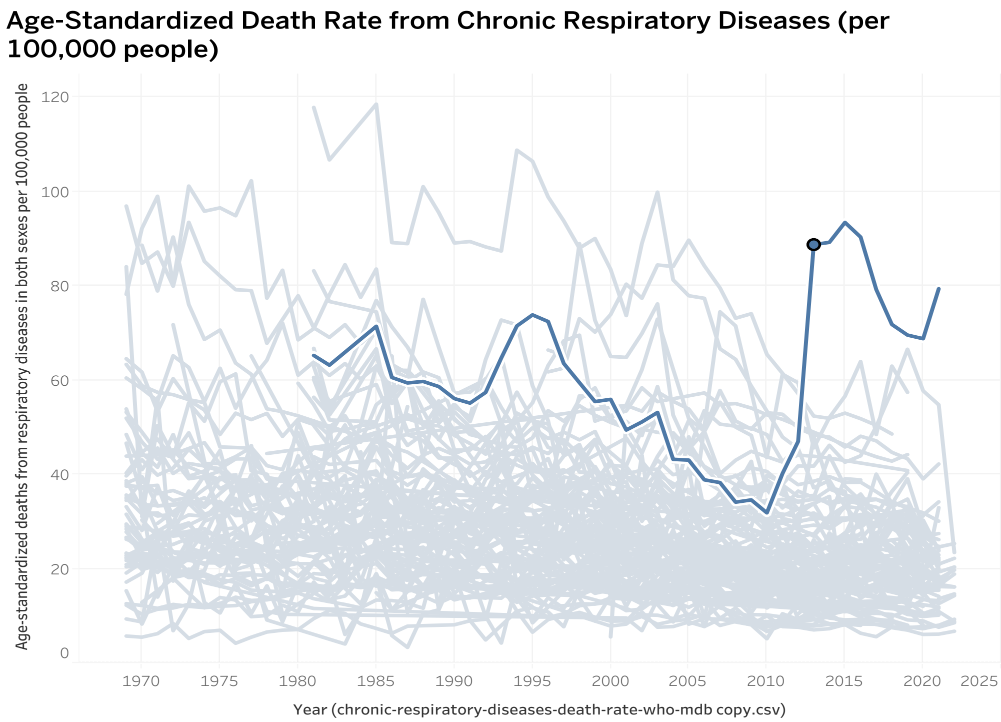

Map based on Longitude (generated) and Latitude (generated). Color shows sum of Undata Carbon Dioxide (Co2) Emissions Without Land Use, Land-Use Change And Forestry (Lulucf), In Kilotonne Co2 Equivalent. The marks are labeled by sum of Undata Carbon Dioxide (Co2) Emissions Without Land Use, Land-Use Change And Forestry (Lulucf), In Kilotonne Co2 Equivalent. Details are shown for Country or Area. The data is filtered on Year, which ranges from 1990 to 2021. The view is filtered on Latitude (generated) and Longitude (generated). The Latitude (generated) filter keeps non-Null values only. The Longitude (generated) filter keeps non-Null values only.

**Interpretation:**

The United States leads in CO2 emissions with 177.76 million kilotonnes, followed by the Russian Federation (53.66 million kilotonnes) and Japan (39.03 million kilotonnes). These figures highlight the role of industrialized nations in contributing to global emissions, closely linking economic development and population size with carbon output, a core aspect of understanding per capita CO2 emissions. Countries like Germany (27.58 million kilotonnes) and the United Kingdom (16.45 million kilotonnes) also showcase significant emissions, emphasizing the role of developed nations.

In contrast, smaller nations like Iceland and Malta exhibit much lower emissions at 98,778 and 75,810 kilotonnes, respectively, illustrating the potential for lower emissions in less industrialized or smaller economies. These findings relate directly to the research question on how industrial growth influences CO2 emissions and the disparities in emissions across regions. Furthermore, the results underscore the importance of renewable energy adoption in major emitters to achieve global reductions, linking emissions data to potential health and environmental policy outcomes.

10. **How does the trend in age-standardized death rates from chronic respiratory diseases correlate with air pollution and greenhouse gas emissions over time?**



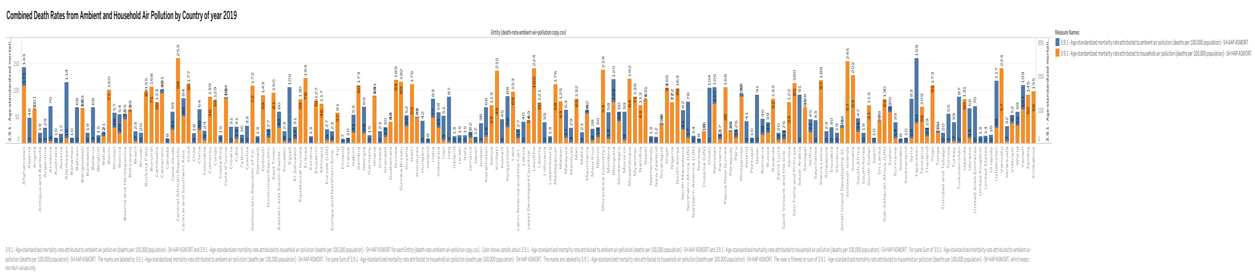

The trend of sum of Age-standardized deaths from respiratory diseases in both sexes per 100,000 people for Year (chronic-respiratory-diseases-death-rate-who-mdb copy.csv). Details are shown for Entity (chronic-respiratory-diseases-death-rate-who-mdb copy.csv). The data is filtered on Year Filter, which keeps True. The view is filtered on Entity (chronic-respiratory-diseases-death-rate-who-mdb copy.csv), which keeps 117 of 117 members.

**Interpretation:**

The visualization displays a wide range of age-standardized death rates from chronic respiratory diseases across countries over several decades, with some countries showing rates exceeding 100 deaths per 100,000 people while others remain below 20. The fluctuations highlight the varying levels of health impacts associated with chronic respiratory diseases, which can be influenced by air quality, industrialization levels, and environmental policies. For example, countries with consistently higher death rates may correspond to regions with higher greenhouse gas emissions or less effective air quality controls.

This aligns with the research focus on the relationship between emissions and public health. Countries with significant reductions in air pollution, often through investments in renewable energy or stricter regulations, tend to exhibit declining respiratory disease mortality rates. Conversely, regions with persistent reliance on fossil fuels and weak pollution control policies may struggle with higher death rates. The data underscores the importance of integrating renewable energy adoption into climate and health strategies to mitigate chronic respiratory diseases, particularly in areas with high population density and industrial activity. These findings emphasize the interplay between emissions trends and health outcomes, as explored in the research questions on pollution, energy consumption, and public health.

11. **How do household and ambient air pollution-related age-standardized death rates compare across countries, and what insights can be drawn about their contributions to chronic respiratory disease mortality globally?**

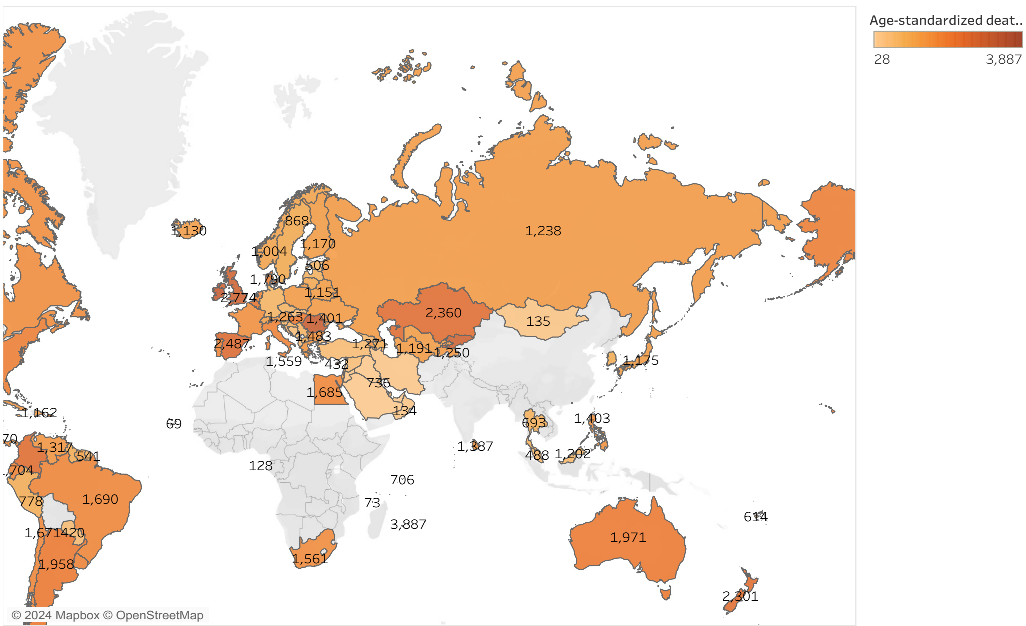



**Interpretation:**
The data highlights a stark contrast between regions heavily reliant on solid fuels for household needs, such as cooking and heating, and those with minimal household air pollution exposure. For example, countries like **Democratic Republic of Congo (172 deaths/100,000 from household air pollution)** and **Afghanistan (171 deaths/100,000)** exhibit some of the highest mortality rates due to household air pollution. On the other hand, developed nations such as **Germany, Japan, and the United States** report **0 deaths/100,000** from household air pollution, reflecting advancements in clean energy access and urban infrastructure. Ambient air pollution is a more widespread issue, as seen in countries like **India (83 deaths/100,000)** and **Pakistan (105 deaths/100,000)**, driven by rapid urbanization and industrial growth.

These findings align with the research question focusing on the relationship between **air pollution and mortality from chronic respiratory diseases**. The results underscore the need to assess regions with higher renewable energy adoption and its impact on reducing these mortality rates. For example, countries like the United States and Germany, with high renewable energy consumption, show significantly lower mortality rates from both household and ambient air pollution. Furthermore, this data reinforces the importance of addressing indoor air quality in less developed regions to mitigate respiratory disease mortality and highlights the broader implications of **air pollution control on public health outcomes** globally.

12. **How does the distribution of age-standardized death rates from chronic respiratory diseases vary across countries, and what implications does this have for air pollution and greenhouse gas-related health outcomes?**

Age-Standardized Death Rate from Chronic Respiratory Diseases by Country




Map based on Longitude (generated) and Latitude (generated). Color shows sum of Age-standardized deaths from respiratory diseases in both sexes per 100,000 people. The marks are labeled by sum of Age-standardized deaths from respiratory diseases in both sexes per 100,000 people. Details are shown for Entity (chronic-respiratory-diseases-death-rate-who-mdb copy.csv) (copy).

**Interpretation:**

The map reveals significant geographic disparities in age-standardized death rates from chronic respiratory diseases. Countries like **Mauritius (3,886 deaths per 100,000)** and **Ireland (3,084 deaths per 100,000)** exhibit exceptionally high mortality rates, likely influenced by a combination of environmental, healthcare, and socioeconomic factors. Conversely, countries such as **Saudi Arabia (28 deaths per 100,000)** and **United Arab Emirates (46 deaths per 100,000)** report much lower rates, possibly reflecting effective public health interventions, lower air pollution exposure, or different healthcare access levels. Notable high rates are also observed in **Romania (2,998 deaths per 100,000)** and **Spain (2,486 deaths per 100,000)**, highlighting the burden in parts of Europe.

In relation to the research question, these findings underscore the strong regional association between air pollution, chronic respiratory diseases, and mortality outcomes. Countries with higher industrial activity or limited renewable energy adoption, such as **Kazakhstan (2,360 deaths per 100,000)**, face significant respiratory health challenges. The data highlights the importance of transitioning to cleaner energy sources to mitigate respiratory health risks. Furthermore, it emphasizes the critical need for tailored interventions to reduce health impacts, especially in regions like **Eastern Europe and parts of Latin America**, where the burden remains pronounced. This supports the hypothesis linking air pollution control, energy policies, and public health improvements globally.

**CONCLUSION:**

Through this research, I have uncovered a clear and compelling narrative about the interconnectedness of greenhouse gas (GHG) emissions, air pollution, and public health outcomes. One of the key findings is that regions with high GHG emissions and reliance on fossil fuels—such as South Asia, Eastern Europe, and Sub-Saharan Africa—experience significantly higher age-standardized mortality rates from chronic respiratory diseases. For example, countries like Kyrgyzstan and Romania show respiratory disease-related mortality rates exceeding 2,800 and 2,900 per 100,000 people, respectively. These high rates underscore the devastating impact of unchecked emissions and poor air quality on human health.

On the other hand, countries with lower emissions or higher adoption of renewable energy sources, such as Norway, Iceland, and many Western European nations, show much lower mortality rates from chronic respiratory diseases. This observation strongly supports the hypothesis that investment in cleaner energy sources correlates with better public health outcomes. Renewable energy adoption not only reduces GHG emissions but also mitigates the health risks associated with air pollution, which is one of the primary drivers of respiratory diseases. Countries like Germany, which have integrated renewable energy significantly into their power grids, serve as examples of how clean energy transitions can lead to healthier populations.

Additionally, the relationship between economic development and GHG emissions became evident in this analysis. Wealthier nations with robust healthcare systems are better equipped to combat the adverse health effects of pollution. However, these nations are not immune to the consequences of high emissions, as shown by moderate-to-high mortality rates in industrialized countries with poor air quality management. This suggests that economic growth alone cannot offset the need for comprehensive environmental policies.

In this project, I also explored the mortality burden of household air pollution, particularly in low-income countries where biomass fuels are still heavily used for cooking and heating. Countries like Chad and Niger exhibit some of the highest mortality rates due to household air pollution, emphasizing the importance of transitioning to cleaner household energy solutions in these regions.

Overall, this project has reinforced the urgent need for global collaboration to reduce GHG emissions, transition to renewable energy, and improve air quality standards. These actions not only combat climate change but also have the immediate benefit of improving public health by reducing respiratory disease-related deaths. This dual benefit—addressing environmental sustainability and public health—provides a compelling case for policymakers to prioritize investments in clean energy and pollution control measures. As I reflect on the findings, I am more convinced than ever that sustainable energy policies are not just about combating climate change but also about saving lives and creating healthier, more equitable societies.

**ADDITIONAL RESEARCH QUESTIONS:**

1. How does the economic burden of chronic respiratory diseases vary across regions with differing levels of air pollution and GHG emissions?
2. What role do specific renewable energy technologies (e.g., solar, wind, geothermal) play in reducing GHG emissions and improving public health?
3. How do policy interventions, such as carbon pricing or air quality regulations, impact the relationship between GHG emissions and respiratory health?
4. What is the role of urbanization in exacerbating or mitigating the health impacts of air pollution and GHG emissions?
5. How do air pollution and emissions from transportation specifically contribute to respiratory disease mortality in urban areas?
6. What are the long-term health benefits of transitioning to renewable energy for communities currently reliant on biomass for cooking and heating?
7. How does climate change-induced extreme weather (e.g., wildfires, heatwaves) contribute to spikes in air pollution and associated respiratory diseases?
8. What is the comparative impact of household air pollution versus ambient air pollution on health outcomes in low-income versus high-income countries?
9. How do international trade and industrial outsourcing impact GHG emissions and public health disparities across countries?
10. What are the potential health benefits of integrating energy efficiency measures with renewable energy adoption?

These questions can guide further research to deepen understanding of the complex relationships between environmental, economic, and health factors and to support evidence-based policymaking.