THE CURIOSITY CUP

A Global SAS® Student Competition

World Energy Consumption and Population

Data Crusaders

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Data Source

World Energy Consumption Data:
https://www.kaggle.com/datasets/nirmalprasad/world-energy-consumption

World Population Data:
https://data.worldbank.org/indicator/SP.POP.TOTL

kaggle

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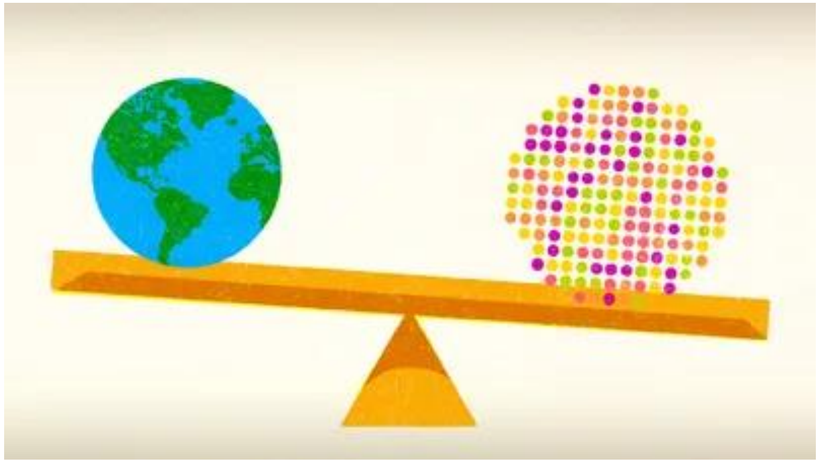
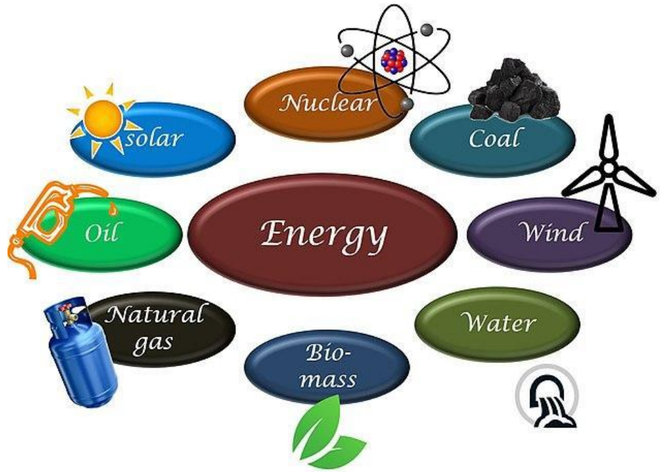
Problem Statements



- To investigate correlation between population size and energy consumption.



- To analyze per capita renewable and non-renewable energy consumption across countries.

Data Cleaning and Exploration

Summary Statistics for Population and Energy Consumption (Pre-Cleaned)

Summary Statistics Of Population

The MEANS Procedure

Year=1995

Analysis Variable : Total_Population Total Number of Population			
Country Name	**Mean**	**Minimum**	**Maximum**
Bangladesh	117793338	117793338	117793338
Brazil	163515328	163515328	163515328
China	1204855000	1204855000	1204855000
Congo, Dem. Rep.	43285791.00	43285791.00	43285791.00
Egypt, Arab Rep.	64166908.00	64166908.00	64166908.00
Ethiopia	57476536.00	57476536.00	57476536.00
Germany	81678051.00	81678051.00	81678051.00
India	964279129	964279129	964279129
Indonesia	198140162	198140162	198140162
Iran, Islamic Rep.	60794809.00	60794809.00	60794809.00
Japan	125472000	125472000	125472000
Mexico	89969572.00	89969572.00	89969572.00
Nigeria	108187610	108187610	108187610
Pakistan	133117476	133117476	133117476
Philippines	69250468.00	69250468.00	69250468.00
Russian Federation	148375787	148375787	148375787
Thailand	59424834.00	59424834.00	59424834.00
Turkiye	59305490.00	59305490.00	59305490.00
United States	266278000	266278000	266278000
Viet Nam	73759110.00	73759110.00	73759110.00

Summary Statistics of Energy Consumption

The MEANS Procedure

Year=1995

Analysis Variable : Energy Energy consumption (in Exajoules)					
Country	**Mean**	**Std Dev**	**Minimum**	**Maximum**	**Median**
Africa	0		0	0	0
Algeria	0.1890023	0.3595226	0	0.7279965	0.0140063
Argentina	0.2651853	0.3958473	0	0.9449199	0.0721796
Australia	0.5211382	0.7403783	0	1.7430000	0.1663945
Austria	0.1628888	0.1726923	0	0.3945866	0.1452191
Azerbaijan	0.0746737	0.1384398	0	0.2820054	0.0083447
Bangladesh	0.0650296	0.1185970	0	0.2427240	0.0086972
Belarus	0.1137504	0.2016634	0	0.4149372	0.0200323
Belgium	0.2489779	0.2273763	0	0.4482918	0.3705458
Brazil	0.7400664	1.1103653	0.0257317	2.7028597	0.2876153
Bulgaria	0.1779860	0.1210544	0.0246329	0.3204077	0.1834517
CIS	0		0	0	0
Canada	1.6864334	1.4457307	0	3.5561198	1.1024410
Central America	0.0308381	0.0607891	0	0.1220168	0.000667819
Chile	0.0925931	0.0808834	0	0.1960172	0.0871775
China	6.1312341	12.1692025	0	27.8526619	0.6436637
China Hong Kong SAR	0.0589097	0.1170910	0	0.2345445	0.000547105
Colombia	0.1281900	0.1404688	0	0.3405323	0.1493010
Croatia	0.0371988	0.0397342	0	0.0809820	0.0339067
Cyprus	0.0011200	0.0022399	0	0.0044799	0
Czech Republic	0.3505876	0.4334358	0.0213116	0.9818057	0.1996165
Denmark	0.1014245	0.1297823	0	0.2716563	0.0670208
Eastern Africa	0.0970654	0.1143721	0	0.2220783	0.0830917
Ecuador	0.0166471	0.0261075	0	0.0549349	0.0058268
Egypt	0.1461995	0.2001275	0	0.4365900	0.0741039
Estonia	0.0425542	0.0698029	0	0.1458286	0.0121941

- Created a new table ‘population’ that selects top 20 most populous countries, years, and total population from World Population dataset.

- This table will later be merged with World Energy Consumption dataset.

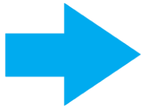
	Country_Name	Country_Code	Year	Indicator_Name	Indicator_Code	Total_Popu
1	India	IND	1995	Population, total	SP.POP.TOTL	9642
2	China	CHN	1995	Population, total	SP.POP.TOTL	12048
3	United States	USA	1995	Population, total	SP.POP.TOTL	2662
4	Indonesia	IDN	1995	Population, total	SP.POP.TOTL	1981
5	Pakistan	PAK	1995	Population, total	SP.POP.TOTL	1331
6	Nigeria	NGA	1995	Population, total	SP.POP.TOTL	1081
7	Brazil	BRA	1995	Population, total	SP.POP.TOTL	1635
8	Bangladesh	BGD	1995	Population, total	SP.POP.TOTL	1177
9	Russian Federation	RUS	1995	Population, total	SP.POP.TOTL	1483
10	Mexico	MEX	1995	Population, total	SP.POP.TOTL	899

	Country_Name	Year	Total_Population
1	India	1995	964279129
2	China	1995	1204855000
3	United States	1995	266278000
4	Indonesia	1995	198140162
5	Pakistan	1995	133117476
6	Brazil	1995	163515328
7	Bangladesh	1995	117793338
8	Russian Federation	1995	148375787
9	Mexico	1995	89969572
10	Japan	1995	125472000

- Standardized country names across both datasets to ensure consistency

- Removed 'Nigeria,' 'Ethiopia,' and 'Congo, Dem. Rep.' from the new 'population' table due to their absence in the World Energy Consumption dataset

14	Egypt, Arab Rep.	EGY	1995
15	Congo, Dem. Rep.	COD	1995
16	Viet Nam	VNM	1995
17	Iran, Islamic Rep.	IRN	1995
18	Turkiye	TUR	1995



12	Egypt	1995
13	Vietnam	1995
14	Iran	1995
15	Turkey	1995

- World Energy Consumption Data included the columns year, region, type of energy consumed and energy in exajoules.

- Replaced the 0's with null value for energy column of world_energy_consumption table to prevent their inclusion in average calculations.

	Country	Year	Region	Type	Energy
1	Canada	1990	North America	Biofuel	
2	Mexico	1990	North America	Biofuel	
3	United States	1990	North America	Biofuel	0.0602378626
4	Argentina	1990	S. & Cent. America	Biofuel	
5	Brazil	1990	S. & Cent. America	Biofuel	0.2451400996
6	Colombia	1990	S. & Cent. America	Biofuel	
7	Other S. & Cent. America	1990	S. & Cent. America	Biofuel	0.0577245804
8	Austria	1990	Europe	Biofuel	0.0002656031
9	Belgium	1990	Europe	Biofuel	

Summary Statistics for Population and Energy Consumption (Cleaned)

Summary Statistics of Population

The MEANS Procedure

Year=1995

Analysis Variable : Total_Population Total Number of Population				
Country Name	Mean	Minimum	Maximum	N Miss
Bangladesh	117793338	117793338	117793338	0
Brazil	163515328	163515328	163515328	0
China	1204855000	1204855000	1204855000	0
Egypt	64166908.00	64166908.00	64166908.00	0
Germany	81678051.00	81678051.00	81678051.00	0
India	964279129	964279129	964279129	0
Indonesia	198140162	198140162	198140162	0
Iran	60794809.00	60794809.00	60794809.00	0
Japan	125472000	125472000	125472000	0
Mexico	89969572.00	89969572.00	89969572.00	0
Pakistan	133117476	133117476	133117476	0
Philippines	69250468.00	69250468.00	69250468.00	0
Russian Federation	148375787	148375787	148375787	0
Thailand	59424834.00	59424834.00	59424834.00	0
Turkey	59305490.00	59305490.00	59305490.00	0
United States	266278000	266278000	266278000	0
Vietnam	73759110.00	73759110.00	73759110.00	0

Summary Statistics For Energy Consumption

The MEANS Procedure

Year=1995

Analysis Variable : Energy Energy consumption (in Exajoules)					
Country	Mean	Minimum	Maximum	N Miss	Median
Bangladesh	0.0963978	0.0039600	0.2427240	4	0.0694535
Brazil	0.9840704	0.0257317	3.1238782	2	0.2876153
China	4.6586964	0.000074516	27.8526619	1	0.3873768
Germany	1.5899180	0.000053226	5.8720663	0	0.2294671
India	1.3334031	0.000010753	5.8738083	1	0.3642928
Indonesia	0.6266045	0.0226043	1.7669534	4	0.2270789
Iran	0.9521497	0.0432180	2.5295334	4	0.6179238
Japan	2.6856779	0.000010215	11.8456271	0	1.5104987
Mexico	0.6335185	0.000053226	3.3069275	1	0.1479883
Pakistan	0.2956893	0.0053270	0.6695132	3	0.2421418
Philippines	0.1815485	0.000183503	0.7193759	3	0.0626694
Russian Federation	4.6212199	0.000639718	13.4080262	2	3.4371547
Thailand	0.4430513	0.0016391	1.4622755	4	0.3006838
Turkey	0.5116144	0.0034332	1.2497328	3	0.3783386
United States	9.7363661	0.0054766	34.5510978	0	3.3129851
Vietnam	0.1144374	0.0050547	0.2103976	4	0.1211488

Merging Energy Consumption and Population Tables

- Inner join of Energy Consumption and Population with Country name column was used for further analysis.

- Added a column named Energy_Source and categorized type of energy by (Renewable/Non-Renewable)
  e.g Coal-NR and Wind-R

	Country	Year	Region	Type	Energy	Energy_source	Country_Name	Total_Population
1	China	2021	Asia Pacific	Coal	86.169817291	Non-Renewable	China	1412360000
2	China	2014	Asia Pacific	Coal	82.480215395	Non-Renewable	China	1371860000
3	China	2013	Asia Pacific	Coal	82.43068181	Non-Renewable	China	1363240000
4	China	2020	Asia Pacific	Coal	82.376123089	Non-Renewable	China	1411100000
5	China	2019	Asia Pacific	Coal	81.698552898	Non-Renewable	China	1407745000
6	China	2018	Asia Pacific	Coal	81.053223201	Non-Renewable	China	1402760000
7	China	2015	Asia Pacific	Coal	80.91794045	Non-Renewable	China	1379860000
8	China	2012	Asia Pacific	Coal	80.706561022	Non-Renewable	China	1354190000
9	China	2017	Asia Pacific	Coal	80.560382036	Non-Renewable	China	1396215000
10	China	2016	Asia Pacific	Coal	80.185852512	Non-Renewable	China	1387790000
11	China	2011	Asia Pacific	Coal	79.706312393	Non-Renewable	China	1345035000
12	China	2010	Asia Pacific	Coal	73.220806404	Non-Renewable	China	1337705000
13	China	2009	Asia Pacific	Coal	70.578071174	Non-Renewable	China	1331260000
14	China	2008	Asia Pacific	Coal	67.377314245	Non-Renewable	China	1324655000
15	China	2007	Asia Pacific	Coal	66.326086566	Non-Renewable	China	1317885000
16	China	2006	Asia Pacific	Coal	60.90617426	Non-Renewable	China	1311020000
17	China	2005	Asia Pacific	Coal	55.45838066	Non-Renewable	China	1303720000
18	China	2004	Asia Pacific	Coal	47.359006934	Non-Renewable	China	1296075000
19	China	2003	Asia Pacific	Coal	40.619010882	Non-Renewable	China	1288400000

DATA ANALYSIS

Summary Table For Total

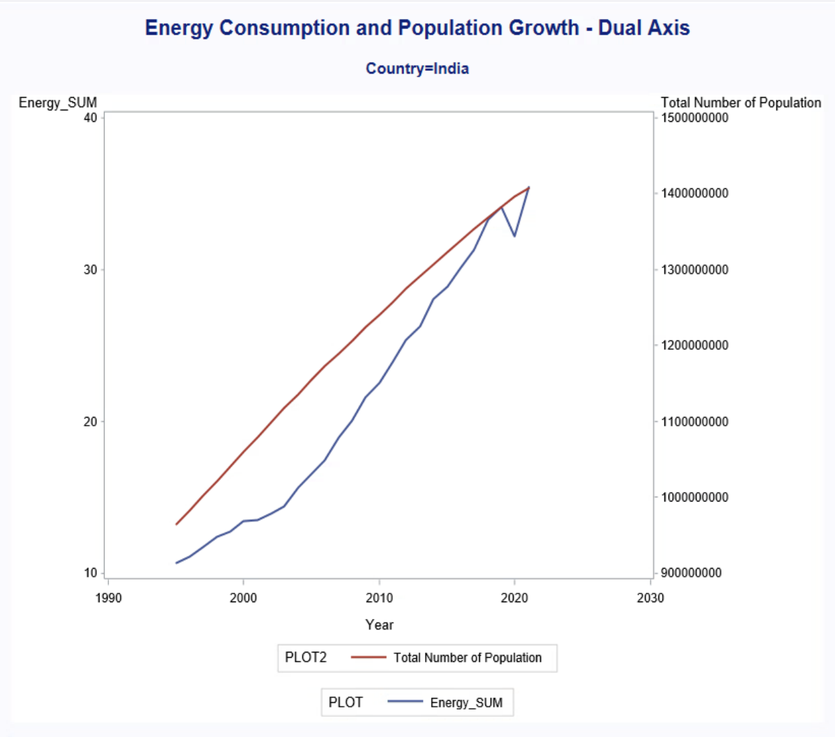
Total Energy Consumption by Country and Type

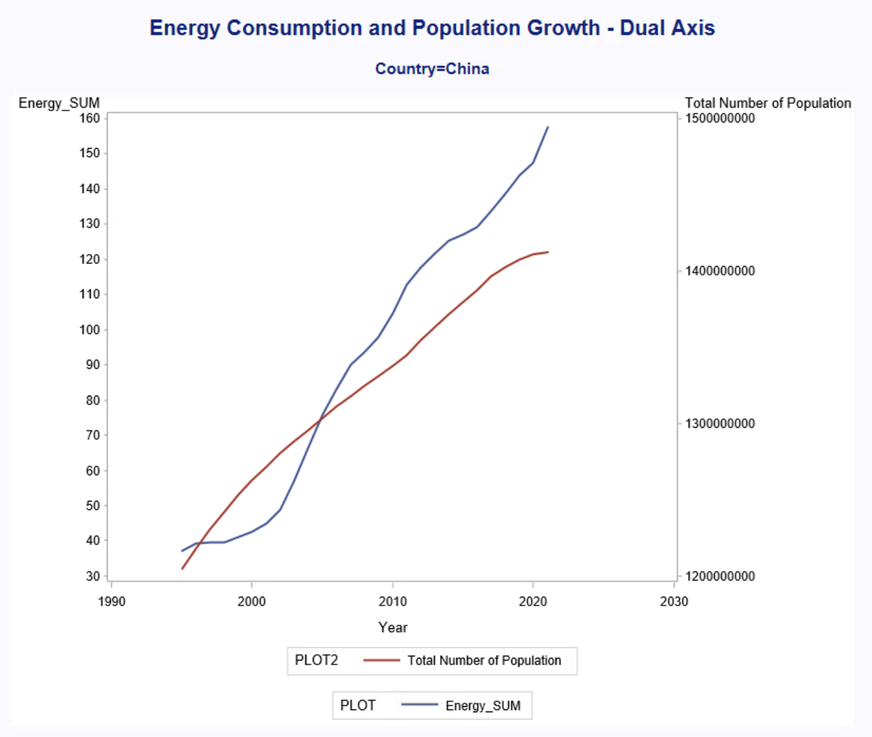
	Biofuel	Coal	Hydro-electric	Natural gas	Nuclear energy	Oil	Other renewables	Solar	Wind	Energy Consumption per Country
Bangladesh		1.28	0.21	17.01		5.83	0.00	0.03	0.00	**24.35**
Brazil	13.17	15.98	94.07	23.07	3.08	113.35	8.52	0.37	3.47	**275.08**
China	1.52	1617.91	174.45	119.18	28.77	461.27	10.99	11.90	30.71	**2456.70**
Germany	2.09	88.38	5.54	83.03	34.25	138.10	8.36	4.25	12.50	**376.50**
India	0.98	314.40	29.71	39.82	6.39	172.26	4.15	2.48	5.73	**575.92**
Indonesia	1.33	40.82	3.65	37.32		70.92	2.75	0.01	0.02	**156.81**
Iran		1.59	3.27	123.81	0.46	85.67	0.00	0.02	0.06	**214.89**
Japan		122.34	22.21	91.91	51.48	260.13	6.70	4.72	0.83	**560.32**
Mexico	0.12	11.37	8.16	58.47	2.63	98.35	1.91	0.32	1.14	**182.45**
Pakistan		5.95	7.46	29.65	0.96	23.11	0.11	0.07	0.15	**67.46**
Philippines		8.87	2.26	2.45		19.33	2.67	0.07	0.08	**35.73**
Russian Federation		108.90	47.34	394.95	41.91	159.67	0.10	0.07	0.05	**752.98**
Thailand	0.86	15.19	1.67	34.58		53.56	1.33	0.33	0.14	**107.66**
Turkey		32.91	12.88	30.16		40.69	0.94	0.43	1.68	**119.69**
United States	20.71	510.06	76.27	652.38	211.50	991.31	22.11	7.13	28.68	**2520.14**
Vietnam		18.98	9.97	5.79		17.68	0.02	0.40	0.05	**52.88**
Energy Consumption per Type	**40.78**	**2914.93**	**499.10**	**1743.58**	**381.42**	**2711.22**	**70.66**	**32.58**	**85.29**	**8479.55**

Correlation Of Energy Consumption and Population

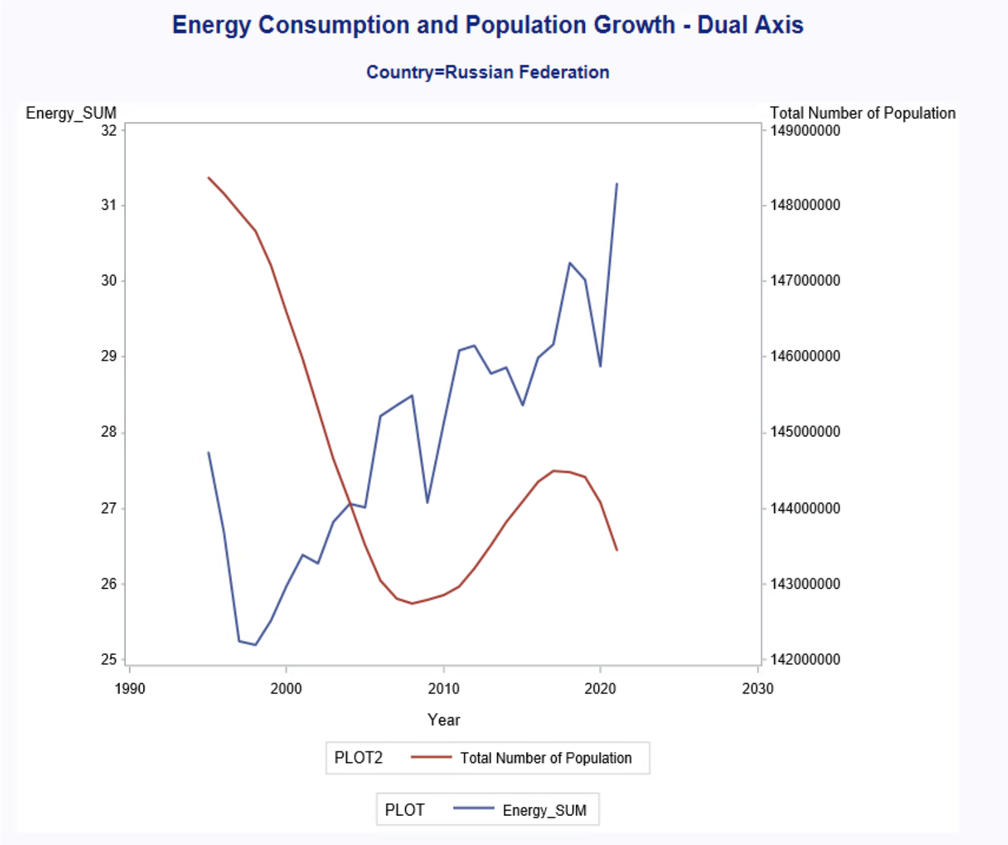
- Population and energy consumption were correlated for 13 countries i.e., 76.47% of the data.

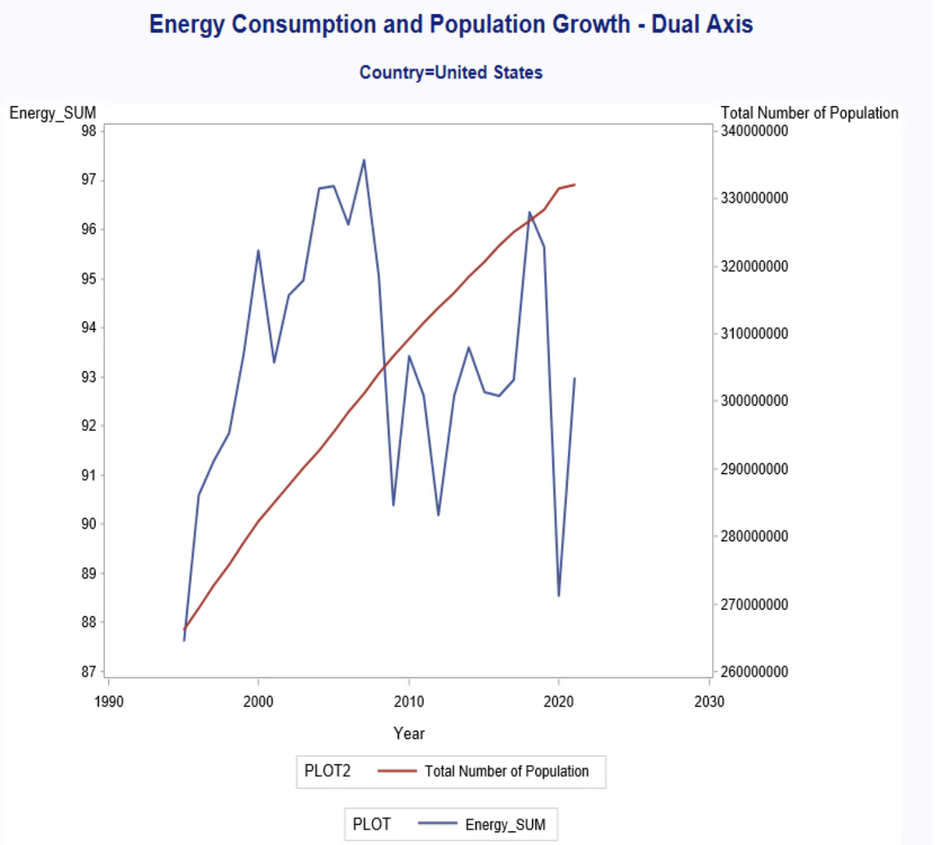
- Time Series graphs indicate the same.



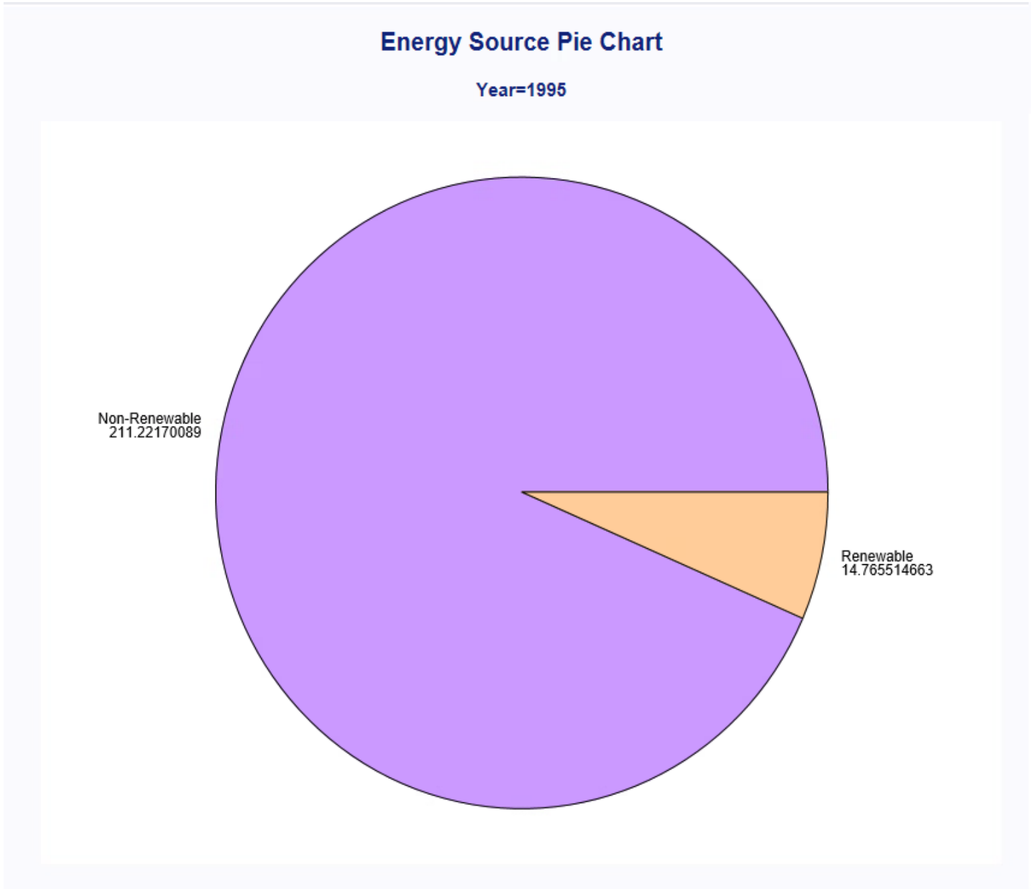


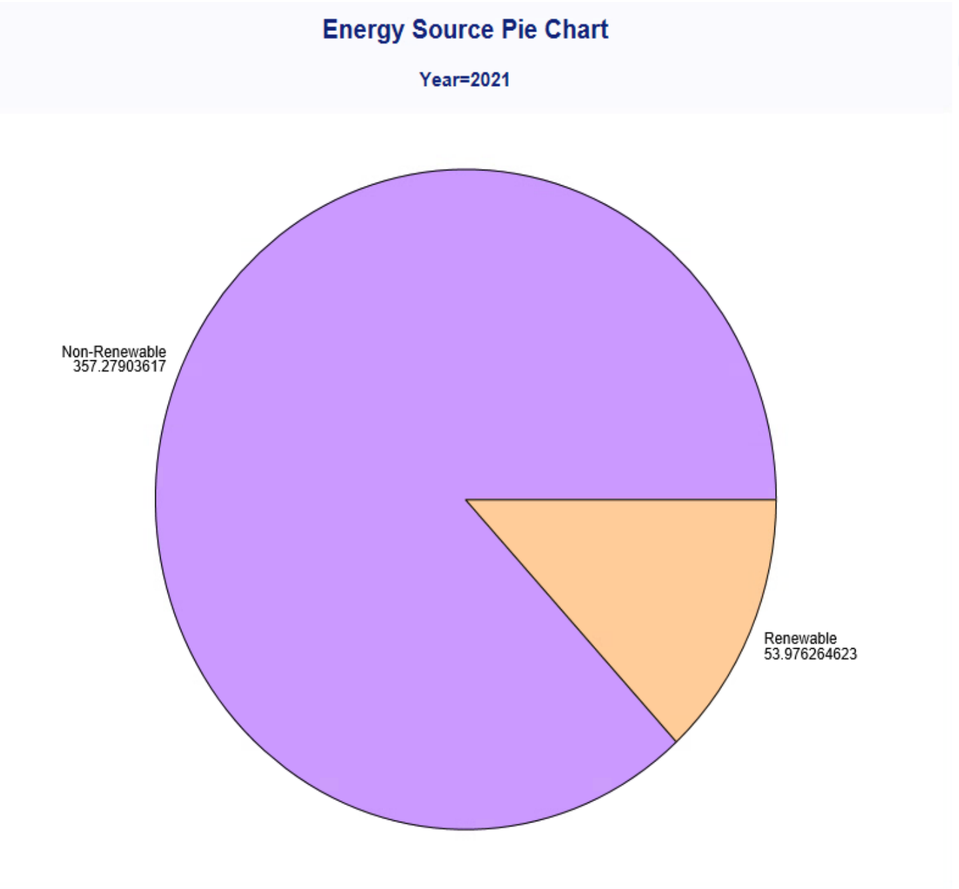
No correlation found between population and energy consumption for 4 countries i.e., 23.5% of the data.





Gradual Increase Of Renewable Energy Consumption From 1995 - 2021





Countries Above Total Temporal Average Energy Consumption

- Output shows countries with years that surpass average energy usage (renewable and nonrenewable)

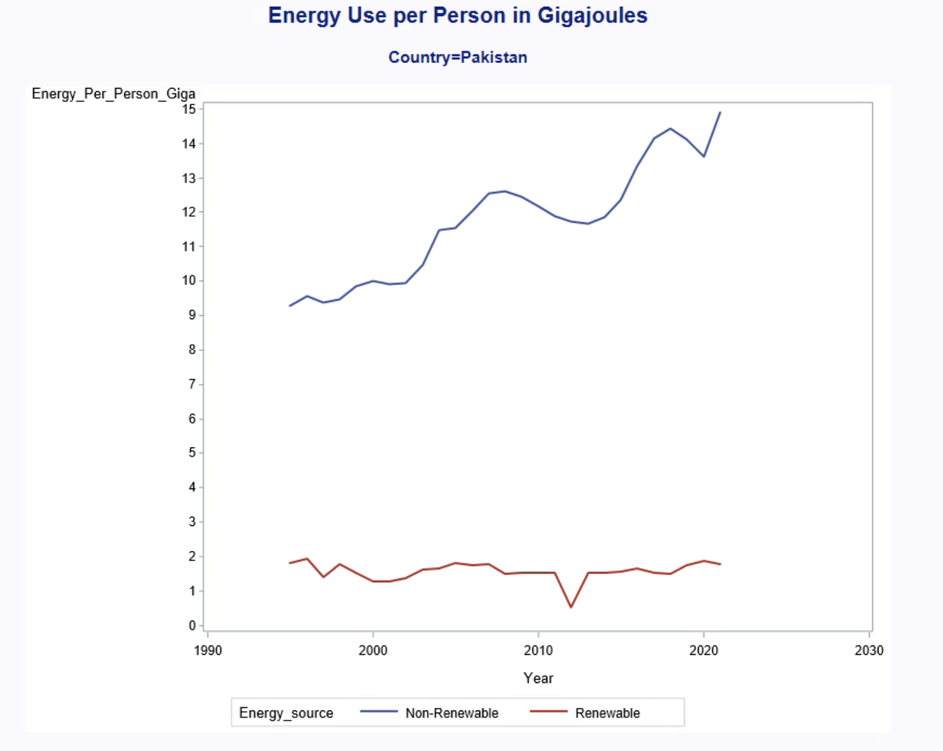
- Used inline view.

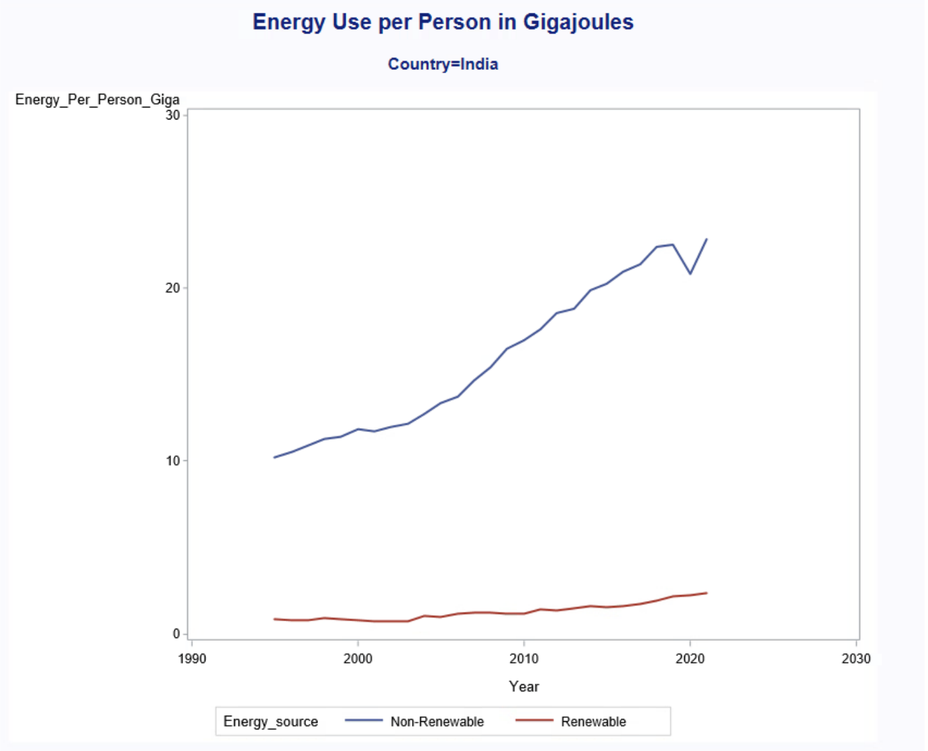
Country	Year	Type	Energy consumption (in Exajoules)
China	2021	Coal	86.169817291
China	2014	Coal	82.480215395
China	2013	Coal	82.43068181
China	2020	Coal	82.376123089
China	2019	Coal	81.698552898
China	2018	Coal	81.053223201
China	2015	Coal	80.91794045
China	2012	Coal	80.706561022
China	2017	Coal	80.560382036
China	2016	Coal	80.185852512
China	2011	Coal	79.706312393
China	2010	Coal	73.220806404
China	2009	Coal	70.578071174
China	2008	Coal	67.377314245
China	2007	Coal	66.326086566
China	2006	Coal	60.90617426
China	2005	Coal	55.45838066
China	2004	Coal	47.359006934
China	2003	Coal	40.619010882
United States	2005	Oil	40.370681647
United States	2004	Oil	40.312320973
United States	2006	Oil	39.855272504
United States	2007	Oil	39.606319882
United States	2003	Oil	38.893256845
United States	2000	Oil	38.354880513
United States	2002	Oil	38.312687366
United States	2001	Oil	38.292654327
United States	1999	Oil	37.933534408

Country	Year	Type	Energy consumption (in Exajoules)
China	2020	Hydro-electric	12.496284381
China	2021	Hydro-electric	12.246048092
China	2019	Hydro-electric	12.075750116
China	2018	Hydro-electric	11.418940696
China	2017	Hydro-electric	11.162074355
China	2016	Hydro-electric	11.114425668
China	2015	Hydro-electric	10.804893059
China	2014	Hydro-electric	10.334910647
China	2013	Hydro-electric	8.9246645324
China	2012	Hydro-electric	8.5166128277
China	2010	Hydro-electric	7.1082000274
China	2011	Hydro-electric	6.833082622
China	2008	Hydro-electric	6.4436205971
China	2009	Hydro-electric	6.1895391398
China	2021	Wind	6.1757762531
China	2007	Hydro-electric	4.9397135806
China	2006	Hydro-electric	4.4639551917
China	2020	Wind	4.4105901251
Brazil	2011	Hydro-electric	4.2538412912
Brazil	2012	Hydro-electric	4.0998292158
China	2005	Hydro-electric	4.0925660127
Brazil	2010	Hydro-electric	4.0297056544
Brazil	2009	Hydro-electric	3.9309015137
China	2019	Wind	3.8460945937
Brazil	2013	Hydro-electric	3.8362197407
Brazil	2007	Hydro-electric	3.8072628003
United States	1997	Hydro-electric	3.7893912903
Brazil	2019	Hydro-electric	3.7756545681

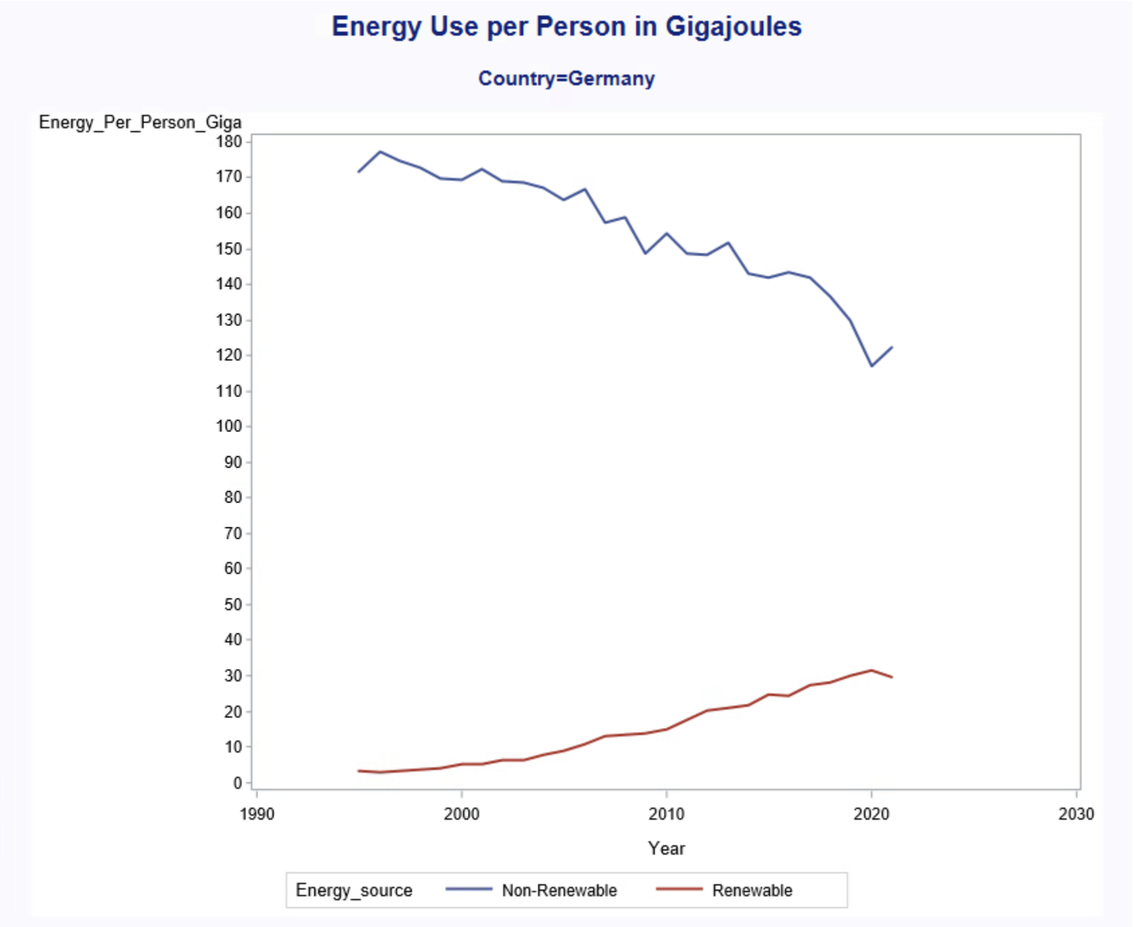
Per Capita Usage of Non-Renewable And Renewable Energy

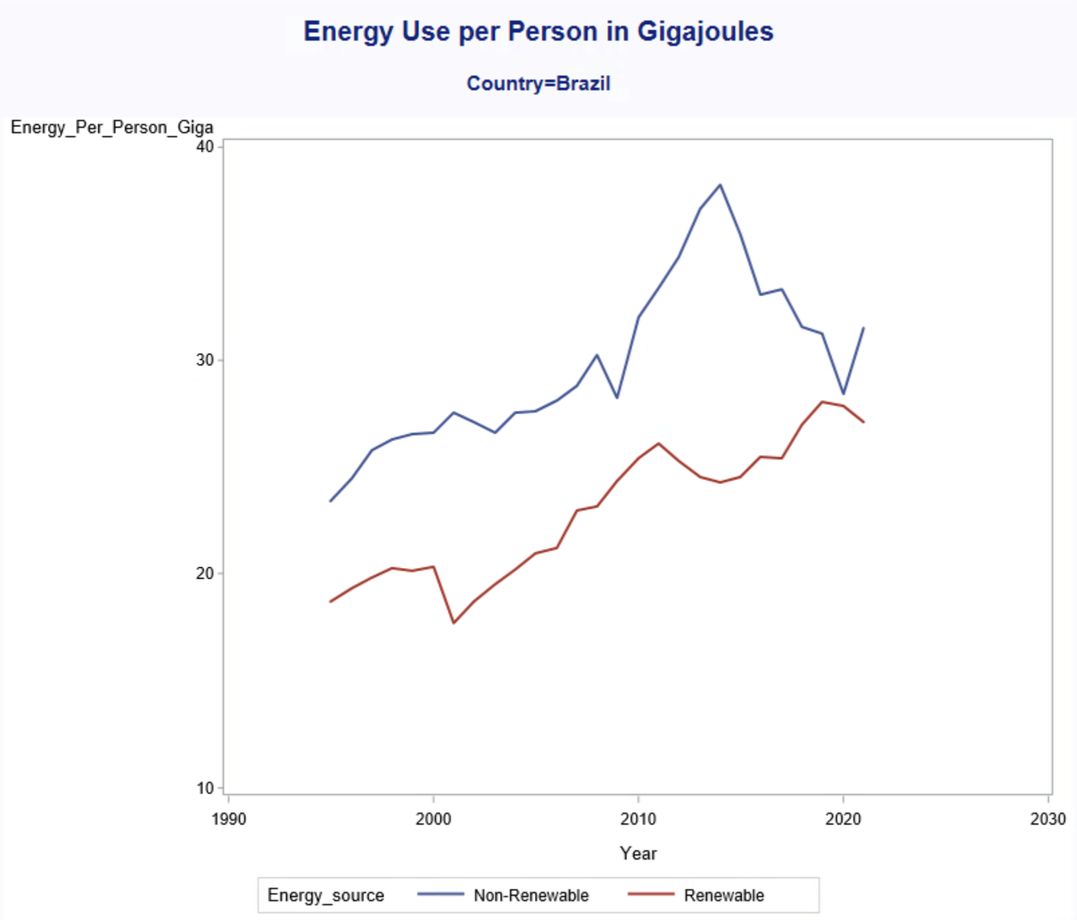
- An increase in non-renewable energy is seen but very slow to no growth in renewable per-person energy usage.
- This trend is observed for 13 countries i.e; 76.47% of overall data.





A gradual decrease in non-renewable resource usage while renewable resource usage is increasing.
This trend is observed for 4 countries i.e; 23.53% of overall data.





Conclusion

➢ Correlation between population size and energy consumption.

- 76.47% indicates correlation.
- 23.53% indicates lack of correlation.

➢ Per capita renewable and non-renewable energy consumption across countries.

- 76.47% indicates increasing non-renewable energy usage while renewable energy usage runs constant.
- 23.53% indicates declining non-renewable energy usage while renewable energy usage increases.

Recommendations

- For more in-depth research, all countries can be considered from both datasets instead of just 17 countries
- New variable for clean energy can be added (renewable energy does not always mean clean energy)
- Considering the climate is also crucial, as it influences energy consumption patterns.
- Population density, with variations between sparse and densely populated countries.
- A country's reliance on industry or agriculture is likely to impact its energy consumption trends.

Thank you!

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