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INNOVATION. AUTOMATION. ANALYTICS

PROJECT ON

ENERGY CONSUMPTION ANALYSIS

Presented By:

N.Harshitha

Project Description :

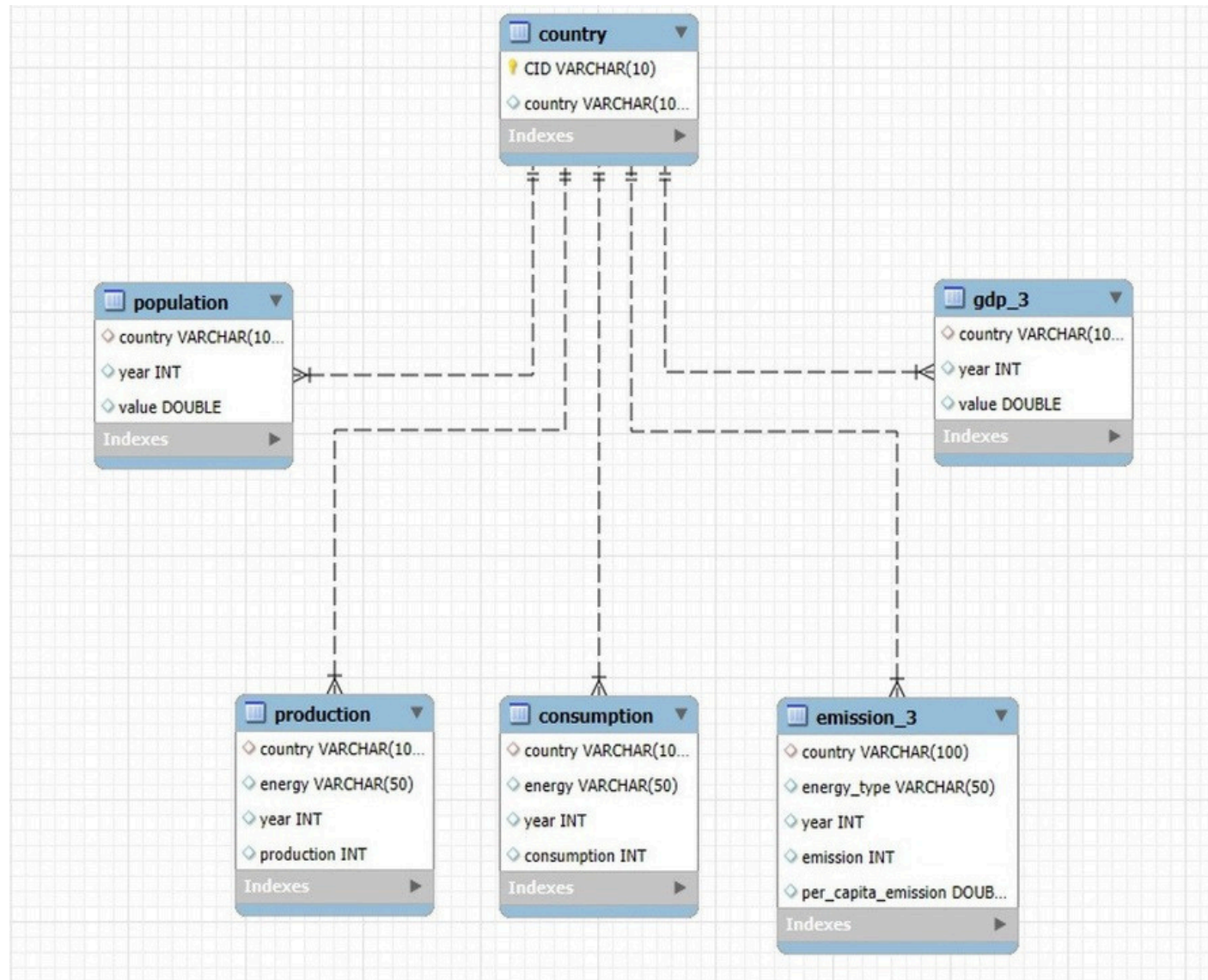## Energy Consumption, Production & Emission Analysis

This project focuses on analyzing global energy trends using structured datasets that include energy production, energy consumption, emissions, GDP, and population across different countries and years. The analysis was performed entirely using SQL, with optimized queries to uncover key insights about global energy sustainability, economic influence, and environmental impact.

Objective:

The primary goal of this project was to analyze how countries consume and produce energy, how this relates to population and economic growth, and how these factors impact carbon emissions. This helps in understanding:

- Global & Country-level emission Patterns
- Energy Dependency and Imbalances
- Growth trends in GDP ,population & Energy usage

ER DIAGRAM & SCHEMA EXPLANATION

Data Information:

Consumption:

country	energy	year	consumption
▶ Afghanistan	Nuclear (quad Btu)	2020	0
Albania	Nuclear (quad Btu)	2020	0
Algeria	Nuclear (quad Btu)	2020	0
American Samoa	Nuclear (quad Btu)	2020	0
Angola	Nuclear (quad Btu)	2020	0
Antarctica	Nuclear (quad Btu)	2020	0
Antigua and Barbuda	Nuclear (quad Btu)	2020	0
Aruba	Nuclear (quad Btu)	2020	0
Australia	Nuclear (quad Btu)	2020	0

Production:

country	energy	year	production
Afghanistan	Nuclear (quad Btu)	2020	0
Albania	Nuclear (quad Btu)	2020	0
Algeria	Nuclear (quad Btu)	2020	0
American Samoa	Nuclear (quad Btu)	2020	0
Angola	Nuclear (quad Btu)	2020	0
Antarctica	Nuclear (quad Btu)	2020	0
Antigua and Barbuda	Nuclear (quad Btu)	2020	0
Aruba	Nuclear (quad Btu)	2020	0
Australia	Nuclear (quad Btu)	2020	0

Population:

countries	year	Value
Afghanistan	2024	42647.49
Albania	2024	2791.765
Algeria	2024	46814.31
Angola	2024	37885.85
Antigua and Barbuda	2024	93.772
Argentina	2024	45696.16
Armenia	2024	2973.84
Aruba	2024	108.066
Australia	2024	27236.21

Country:

Country	CID
Country	CID
Afghanistan	Af0
Albania	Al1
Algeria	Al2
American Samoa	Am3
Angola	An4
Antarctica	An5
Antigua and Barbuda	An6
Argentina	Ar7

GDP:

Country	year	Value
Afghanistan	2020	83.21645
Albania	2020	36.78752
Algeria	2020	531.9749
Angola	2020	215.9016
Antigua and Barbuda	2020	1.772876
Argentina	2020	866.9691
Armenia	2020	33.00228
Aruba	2020	2.584789
Australia	2020	1219.307

Emission:

country	energy_type	eyear	emission	per_capita_emission
American Samoa	Consumed natural gas (MMtonnes CO_2)	2020	0	0.007126096
Antarctica	Consumed natural gas (MMtonnes CO_2)	2020	0	0.007126096
Antigua and Barbuda	Consumed natural gas (MMtonnes CO_2)	2020	0	0.007126096
Aruba	Consumed natural gas (MMtonnes CO_2)	2020	0	0.007126096
Belize	Consumed natural gas (MMtonnes CO_2)	2020	0	0.007126096
Bermuda	Consumed natural gas (MMtonnes CO_2)	2020	0	0.007126096
Bhutan	Consumed natural gas (MMtonnes CO_2)	2020	0	0.007126096
Botswana	Consumed natural gas (MMtonnes CO_2)	2020	0	0.007126096
British Virgin Islands	Consumed natural gas (MMtonnes CO_2)	2020	0	0.007126096

General & Comparative Analysis

Query:

```sql
-- Q1. What is the total emission per country for the most recent year available?
select e.country,e.eyear,sum(e.emission) as Total_emission from emmission_3 e
where eyear= (select max(eyear) from emmission_3)
group by e.country,e.eyear
order by e.eyear;
```

Output:

countries	year	Value
Afghanistan	2024	42647.49
Albania	2024	2791.765
Algeria	2024	46814.31
Angola	2024	37885.85
Antigua and Barbuda	2024	93.772
Argentina	2024	45696.16
Armenia	2024	2973.84

Query:

```sql
-- Q2.What are the top 5 countries by GDP in the most recent year?
select Country ,value as Total_value from gdp_3
where year= (select max(year) from gdp_3)
order by Total_value desc limit 5;
```

Output:

Country	Total_value
China	28673.24
United States	22679.47
India	11660.21
Japan	5179.704
Germany	4463.949

Query:

```sql
-- Q3.Compare energy production and consumption by country and year.
select p.country,p.year,sum(p.production) as  Energy_Production ,
sum(c.consumption)  as Energy_consumption from production_3 p
 join consum_3 c on
p.country = c.country and
p.year = c.yearS
group by p.country,p.year
order by p.country,p.year;
```

Output:

country	year	Energy_Production	Energy_consumption
Afghanistan	2020	0	0
Afghanistan	2021	0	0
Afghanistan	2022	0	0
Afghanistan	2023	0	0
Albania	2020	0	0
Albania	2021	0	0
Albania	2022	0	0
Albania	2023	0	0
Algeria	2020	36	18

Query:

```sql
-- Q4.Which energy types contribute most to emissions across all countries?
select energy_type,sum(emission) as Total_Emissions from emmission_3
group by energy_type
order by  Total_Emissions desc ;
```

Output:

energy_type	Total_Emissions
CO2 emissions (MMtonnes CO2)	142723
Coal and coke (MMtonnes CO2)	63945
Petroleum and other liquids (MMtonnes CO2)	47297
Consumed natural gas (MMtonnes CO2)	31469

Trend Analysis

Query :

```
-- Q5.How have global emissions changed year over year?
select eyear,sum(emission) as Total_Emissions from emmission_3
group by eyear
order by eyear;
```

Output :

eyear	Total_Emissions
2020	67852
2021	70976
2022	72445
2023	74161

Query :

```
-- Q6.What is the trend in GDP for each country over the given years?
select Country,value,year  from gdp_3  order by Country,year desc;
```

Output :

Country	value	year
Afghanistan	57.83112	2024
Afghanistan	58.90645	2023
Afghanistan	61.84236	2022
Afghanistan	65.95827	2021
Afghanistan	83.21645	2020
Albania	45.2091	2024
Albania	43.63172	2023
Albania	41.99279	2022

Query :

```sql
-- Q7.How has population growth affected total emissions in each country?
select p.countries,p.year,p.value as Polpulation ,
sum(e.emission ) as Total_Emissions
from population_3 p
join emmission_3 e on
e.country =p.countries and
e.eyear= p.year
group by p.countries,p.year,p.value
order by p.countries,p.year;
```

Output:

countries	year	Polpulation	Total_Emissions
Afghanistan	2020	39068.98	18
Afghanistan	2021	40000.41	20
Afghanistan	2022	40578.84	18
Afghanistan	2023	41454.76	16
Albania	2020	2871.954	6
Albania	2021	2849.635	8
Albania	2022	2827.608	9
Albania	2023	2811.655	7
Algeria	2020	44042.09	284

Query :

```sql
-- Q8. Has energy consumption increased or decreased over the years for major economies?
select c.country,c.year,sum(c.consumption) as Total_Consumption
from consum_3 c
join (select country from gdp_3
where year =(select max(year) from gdp_3)
order by value desc
limit 5
) top_countries on c.country = top_countries.country
group by c.country ,c.year
order by c.country ,c.year;
```

Output:

country	year	Total_Consumption
China	2020	156
China	2021	165
China	2022	168
China	2023	177
Germany	2020	13
Germany	2021	13
Germany	2022	11
Germany	2023	11
India	2020	32

Ratio & Per Capita

Query :

```
-- Q10.What is the emission-to-GDP ratio for each country by year?
select e.country,e.eyear,sum(emission)/sum(value) as Emission_to_GDP_Ratio from emmission_3 e
join gdp_3 g on
e.country =g.country and
e.eyear =g.year
group by e.eyear,e.country
order by e.eyear,e.country;
```

Output :

country	eyear	Emission_to_GDP_Ratio
Afghanistan	2020	0.0540758467826 9742
Albania	2020	0.0407746975061 1077
Algeria	2020	0.133649435527879
Angola	2020	0.0335801124215846 44
Antigua and Barbuda	2020	0.28202762065705667
Argentina	2020	0.09919615358840356
Armenia	2020	0.10605327874316563
Aruba	2020	0.19343938712 2121
Australia	2020	0.1543909778259 2898

Query :

```sql
-- Q11.How does energy production per capita vary across countries?
select pro.country,pro.year,sum(pro.production)/sum(p.value) as Production_per_capita
from production_3 pro
join population_3 p on
pro.country=p.countries and pro.year =p.year
group by pro.country,pro.year
order by pro.country,pro.year;
```

Output:

country	year	Production_per_capita
Albania	2023	0
Algeria	2020	0.00002270555280187657
Algeria	2021	0.0000260642983900045525
Algeria	2022	0.00002565377923413061
Algeria	2023	0.000025272097452673665
Angola	2020	0.000014947178167075373
Angola	2021	0.0000096527621522369045
Angola	2022	0.0000140311373373873663
Angola	2023	0.0000090703169976011716

Query:

```sql
-- Q12.Which countries have the highest energy consumption relative to GDP
select c.country,c.year,
sum(c.consumption)/sum(g.value) as Consumption_to_GDP_Ratio
from consum_3 c
join gdp_3 g
on c.country =g.country and c.year =g.year
group by c.country, c.year
order by Consumption_to_GDP_Ratio desc;
```

Output:

country	year	Consumption_to_GDP_Ratio
Trinidad and Tobago	2021	0.005188443758463001
Trinidad and Tobago	2020	0.00513461945281 3873
Trinidad and Tobago	2022	0.00511 2664202158014
Trinidad and Tobago	2023	0.004969233981649414
North Korea	2022	0.004535334976213075
North Korea	2021	0.00452844652366557
North Korea	2020	0.0045259391 07472135
North Korea	2023	0.00440086066751 9026
Turkmenistan	2020	0.003552778 13572001746

Global Comaprisons

Query :

```
-- Q13.What are the top 10 countries by population and how do their emissions comp
select p.countries,p.year,sum(p.value) as Population,sum(e.emission) as Emission
from population_3 p
join emmission_3 e on
e.country =p.countries
group by p.countries ,p.year
order by population desc limit 10;
```

Output :

countries	year	Population	Emission
India	2024	23214976	20223
India	2023	23009120	20223
China	2021	22822992	92338
China	2020	22817696	92338
India	2022	22806768	20223
China	2022	22802880	92338
China	2023	22761360	92338
China	2024	22709136	92338
India	2021	22627264	20223

Query :

```sql
-- Q14. What is the global share (%) of emissions by country?
select e.country,sum(e.emission) as Total_Emission,
(sum(e.emission)/(select sum(emission) from emmission_3)*100) as Global_Share_Percent
from emmission_3 e
group by e.country
order by Global_Share_Percent desc;
```

Output :

country	Total_Emission	Global_Share_Percent
China	92338	32.3500
United States	38453	13.4718
India	20223	7.0850
Russia	14481	5.0733
Japan	8137	2.8507
Iran	5966	2.0902
Indonesia	5313	1.8614
Germany	5159	1.8074
South Korea	5065	1.7745

Query :

```
-- Q15.What is the global average GDP, emission, and population by year?
select p.year,avg(g.value) as avg_gdp,
            avg(e.emission) as avg_emission,
            avg(p.value) as avg_population
from gdp_3 g
join emmission_3 e on
g.year=e.eyear and g.country = e.country
join population_3 p on
e.eyear= p.year and e.country =p.countries
group by p.year
order by p.year;
```

Output :

year	avg_gdp	avg_emission	avg_population
2020	629.0274965879088	85.3955	39656.20231536521
2021	671.0425053881461	89.4439	39986.56866078184
2022	694.6001345356871	91.2926	40345.80627994949
2023	717.9255333412349	93.4552	40711.65565397222

Key Insights

- Countries like India & China have the highest energy demand due to large population bases.

- Coal and oil are still the main contributors to emissions, showing reliance on fossil fuels.

- Several countries have reduced per-capita emissions, indicating positive sustainability efforts.

- Energy imbalance exists — some countries produce much more than they consume and vice versa.

- Renewable energy is growing, but fossil fuel dependency still dominates.

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CHALLENGES

Data Quality Problems–Missingvalues, duplicaterecords,and inconsistent year formats made data cleaning essential before analysis.

Complex Relationships –Managing joins across multiple tables while ensuring accuracy in insights like emission-to-GDP ratio or energy per capita.

Visualization Limitations –Translating raw SQL outputs into meaningful visuals for presentation required extra effort.

Conclusion

- Countries with rapid GDP growth also show higher energy consumption, which directly increases pressure on natural resources.

- As energy demand increases, emissions also rise, making it challenging for developing countries to balance growth and sustainability.

- Coal, oil, and natural gas remain the biggest contributors to emissions, indicating slow transition to fully sustainable energy sources.

- Countries with large populations (India, China) naturally drive global energy consumption and emissions.

THANK YOU