World Wide Energy Consumption

Presented By :- Raj Shivade

INNOMATICS®
RESEARCH LABS

INNOVATION. AUTOMATION. ANALYTICS

ABOUT ME :-

Background: I have completed my B.Tech in Data Science and Engineering from G H Raisoni College of Engineering and Management.

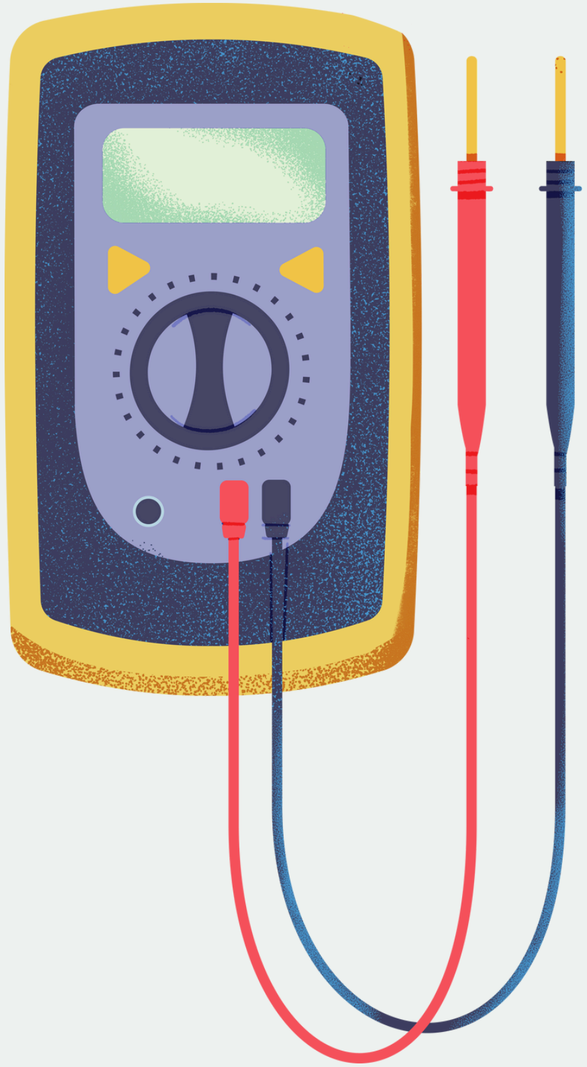
Why I want to learn Data Science: I'm passionate about solving real-world problems using data-driven insights. With a strong foundation in Data Science, I find data science an exciting intersection of statistics, programming, and domain knowledge. It allows me to uncover patterns, predict outcomes, and support decision-making processes.

LinkedIn Profile: LinkedIn
GitHub Profile: GitHub

INNOMATICS RESEARCH LABS

AGENDA :

- What is Energy and Sources of Energy.
- Objective of the Project or Problem Statement
- ER Diagram
- Key analysis questions on
  1. Production
  2. Consumption
  3. Emission
  4. GDP
- SQL query results with screenshots or summaries
- Conclusion.



INNOMATICS
RESEARCH LABS

ENERGY:

INNOMATICS RESEARCH LABS

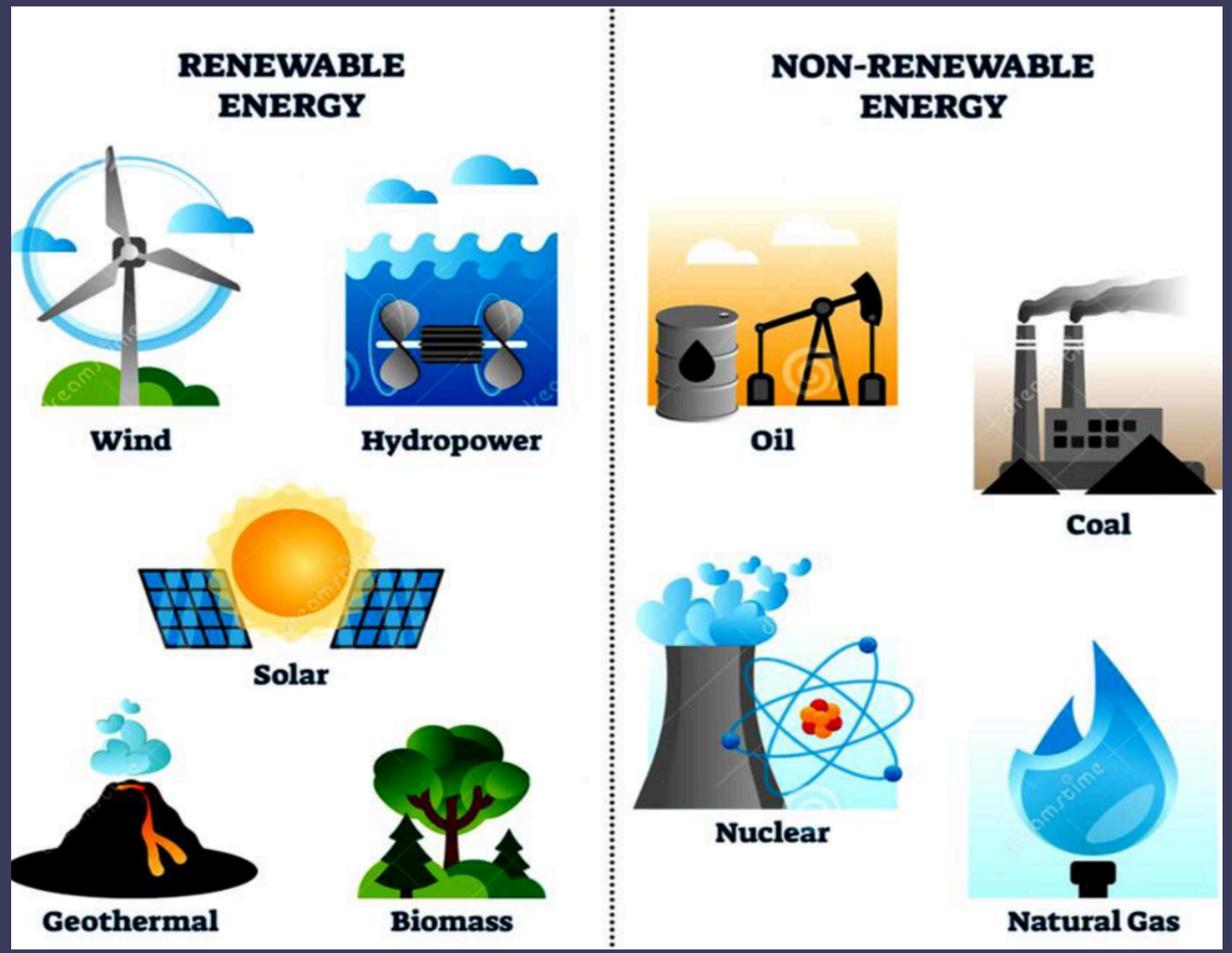
Energy is the capacity to do work. It exists in various forms, like heat, light, potential, and kinetic energy.

SOURCES OF ENERGY:-

- Renewable Energy Sources
- Non-Renewable Energy Sources

1.Renewable Energy Sources:
These are naturally replenished and sustainable.
- o Solar Energy
- o Wind Energy
- o Hydropower (Hydroelectric Energy)
- o Biomass Energy
- o Geothermal Energy

2.Non-Renewable Energy Sources:
These are limited and will eventually run out.
- o Coal
- o Crude Oil (Petroleum)
- o Natural Gas
- o Nuclear Energy (Uranium)



Objective of the Analysis

The primary objective of this analysis is to gain comprehensive insights into global energy usage, production, emissions, population growth, and economic performance (GDP) across different countries and over time.

The key goals are as follows:

1.Analyze the relationship between energy production/consumption and emissions to understand how different energy sources contribute to environmental impact.

2.Identify top contributors to greenhouse gas emissions and study emission trends over the years to track progress or setbacks.

3.Evaluate the impact of GDP and population growth on energy demand and emissions, helping to understand development-related pressures.

4.Compare per capita metrics to examine how energy use and emissions scale with population in both developing and developed nations.

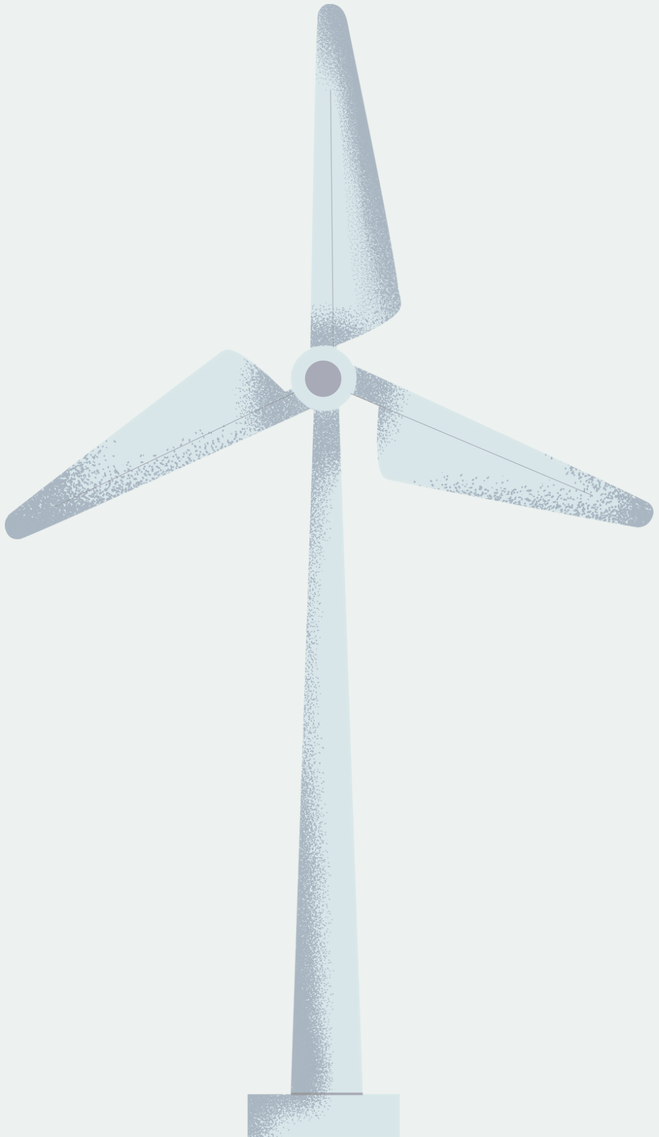
5.Measure energy efficiency by assessing how effectively countries convert energy into economic output (GDP).

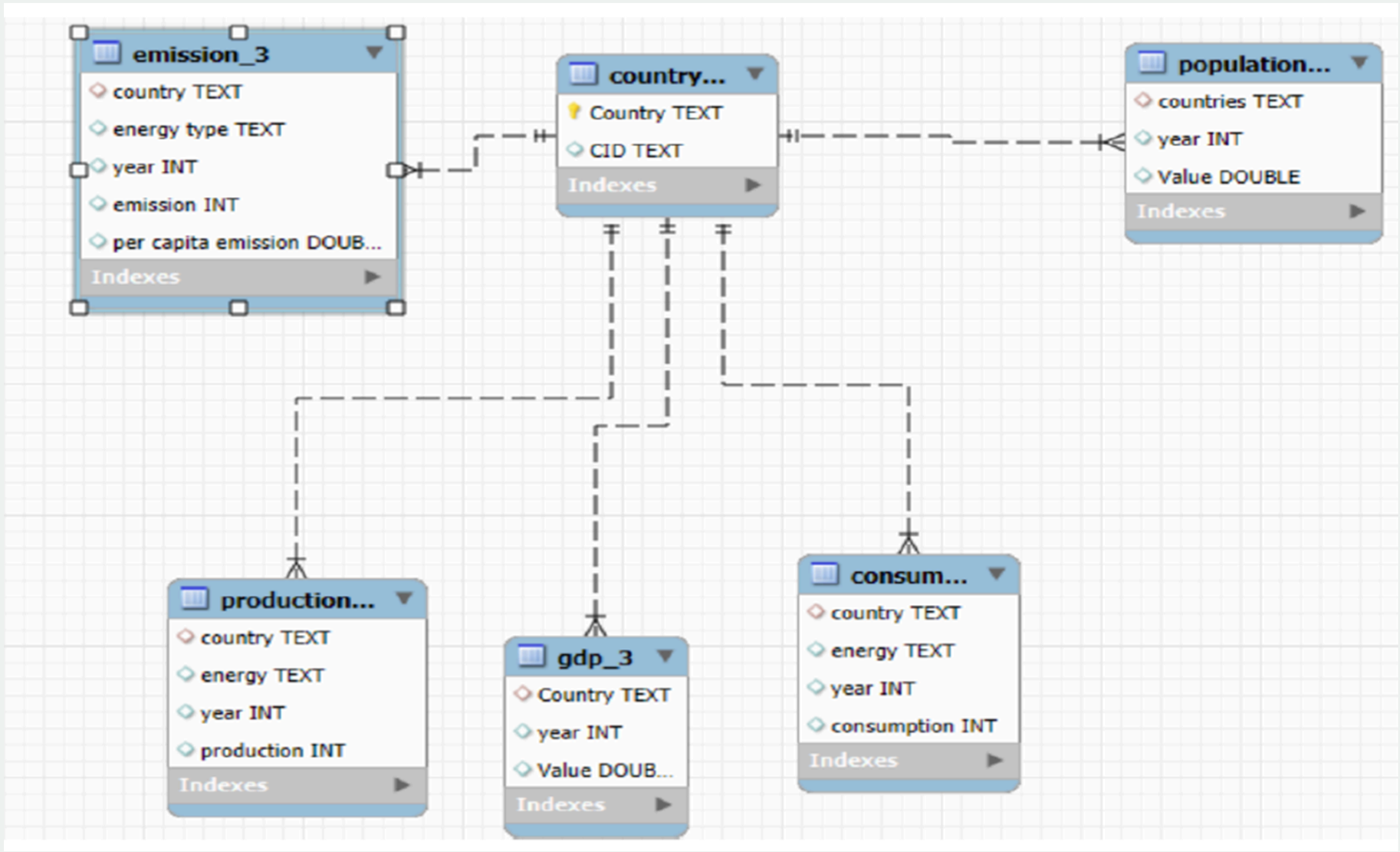
6.Highlight global emission shares, and distinguish countries showing positive trends (reducing emissions) versus those with negative trends (increasing emissions).

7.Support sustainable energy policies by providing data-driven insights that can guide governmental and international decision-making.

ER DIAGRAM :

- All the tables are connected with Country Table.
- One to Many relationship exist between Country, Population, Consumption, Emission, Production and GDP.
- Country is the Parent Table and all the remaining tables Child Table.





Q1. Total Energy Production by Country ?

```
select country, sum(production) as Total_Production
from production_3
group by country
order by Total_Production desc;
```

country	Total_Production
China	546
United States	452
Russia	257
Saudi Arabia	110
Canada	95
India	84
Australia	70
Indonesia	70
Iran	69
Brazil	54
United Arab ...	41
Norway	40
Qatar	40

- **Key Insights:**
- China is the top producer with 546 units.
- USA is second with 452, and Russia is third with 257.
- There's a big drop after the top 3 countries.
- Australia and Indonesia produce the same amount (70).
- Norway and Qatar also have equal production (40).
- Countries like India, Canada, and Saudi Arabia are in the middle range.
- The lowest producers in this list are Qatar and Norway.

Q2. Total Energy Production by Energy Type ?

```
select energy, sum(production) as Total_Production
from production_3
group by energy
order by Total_Production desc;
```

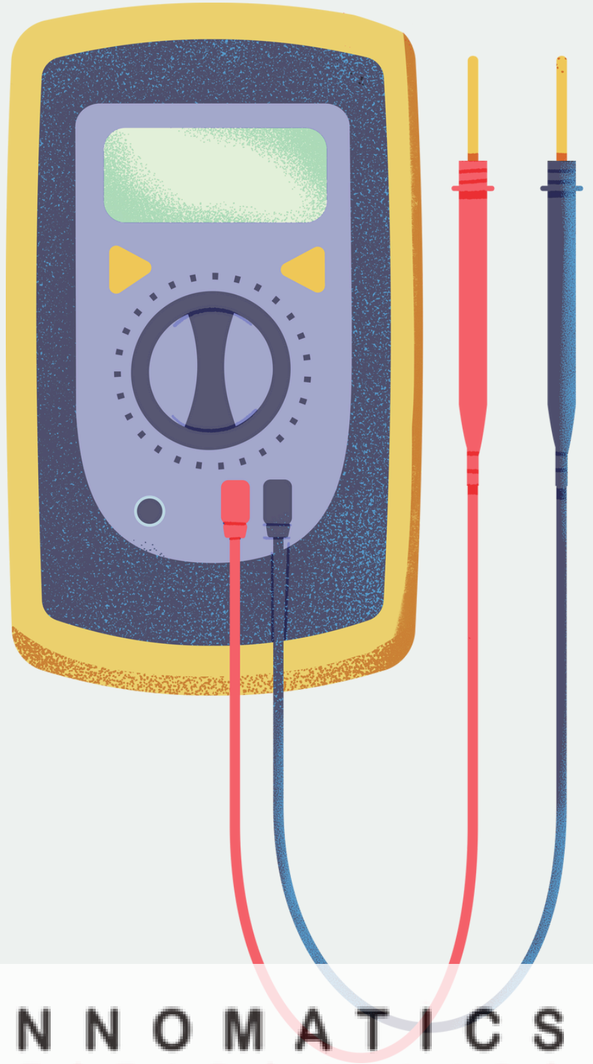
energy	Total_Production
Petroleum and other liqui...	719
Coal (quad Btu)	682
Natural gas (quad Btu)	592
Nuclear, renewables, an...	229
Renewables and other (...	128
Nuclear (quad Btu)	98

- **Key Insights**
- Petroleum and other liquids are the most produced energy source (719 units).
- Coal is the second most used (682 units).
- Natural gas comes next with 592 units.
- Nuclear, renewables, and others combined produce 229 units.
- Renewables alone contribute 128 units.
- Nuclear alone produces 98 units.

Q3. Compare Energy Production And Consumption By Country And Year ?

```sql
SELECT
p.country,
p.year,
p.energy,
c.consumption,
p.production
FROM production_3 p
JOIN consum_3 c ON p.country = c.country
AND p.year = c.year
AND p.energy = c.energy
ORDER BY
p.production DESC;
```

country	year	energy	consumption	production
China	2023	Coal (quad Btu)	100	94
China	2021	Coal (quad Btu)	95	93
China	2022	Coal (quad Btu)	96	93
China	2020	Coal (quad Btu)	92	90
United States	2023	Natural gas (quad Btu)	34	39
United States	2022	Natural gas (quad Btu)	33	38
United States	2021	Natural gas (quad Btu)	32	36
United States	2020	Natural gas (quad Btu)	32	35
United States	2023	Petroleum and other liqui...	37	35
United States	2022	Petroleum and other liqui...	37	33
United States	2021	Petroleum and other liqui...	37	31
United States	2020	Petroleum and other liqui...	34	30
Russia	2021	Natural gas (quad Btu)	18	28



INNOMATICS RESEARCH LABS

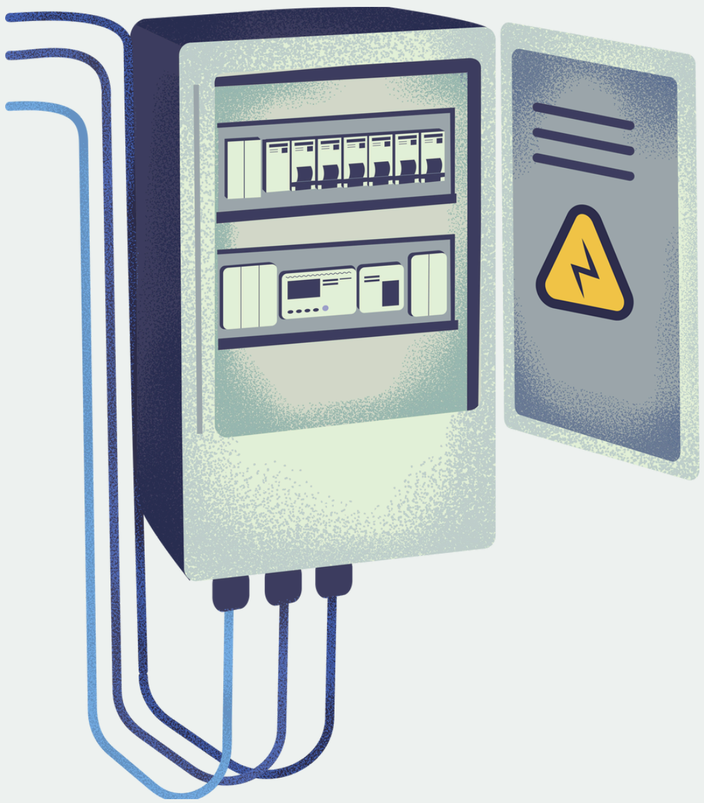
INNOMATICS RESEARCH LABS

Q4. How Does Energy Production Per Capita Vary Across Countries ?

```sql
SELECT p.countries,
ROUND(SUM(p1.production) / SUM(p.value), 4) AS production_percapita
FROM population_3 p
JOIN production_3 p1
ON p.countries = p1.country
AND p.year = p1.year
GROUP BY p.countries
ORDER BY production_percapita DESC;
```

countries	production_percapita
Qatar	0.0006
Kuwait	0.0003
Norway	0.0003
United Arab Emirates	0.0002
Australia	0.0001
Bahrain	0.0001
Kazakhstan	0.0001
Libya	0.0001
Mongolia	0.0001
Oman	0.0001
Saudi Arabia	0.0001
Trinidad and Tobago	0.0001
Turkmenistan	0.0001

- **Key Insights:**
- Qatar has the highest per capita production (0.0006), meaning each person contributes a large share of the country's total energy production.
- Kuwait and Norway follow, both with high production per person (0.0003).
- UAE also ranks high (0.0002), showing strong energy output compared to its population.
- Most countries in the list are small population countries with rich energy resources (especially oil and gas).
- Countries like Australia, Saudi Arabia, and Kazakhstan also appear, showing they produce a significant amount of energy per citizen, even if they have larger populations.



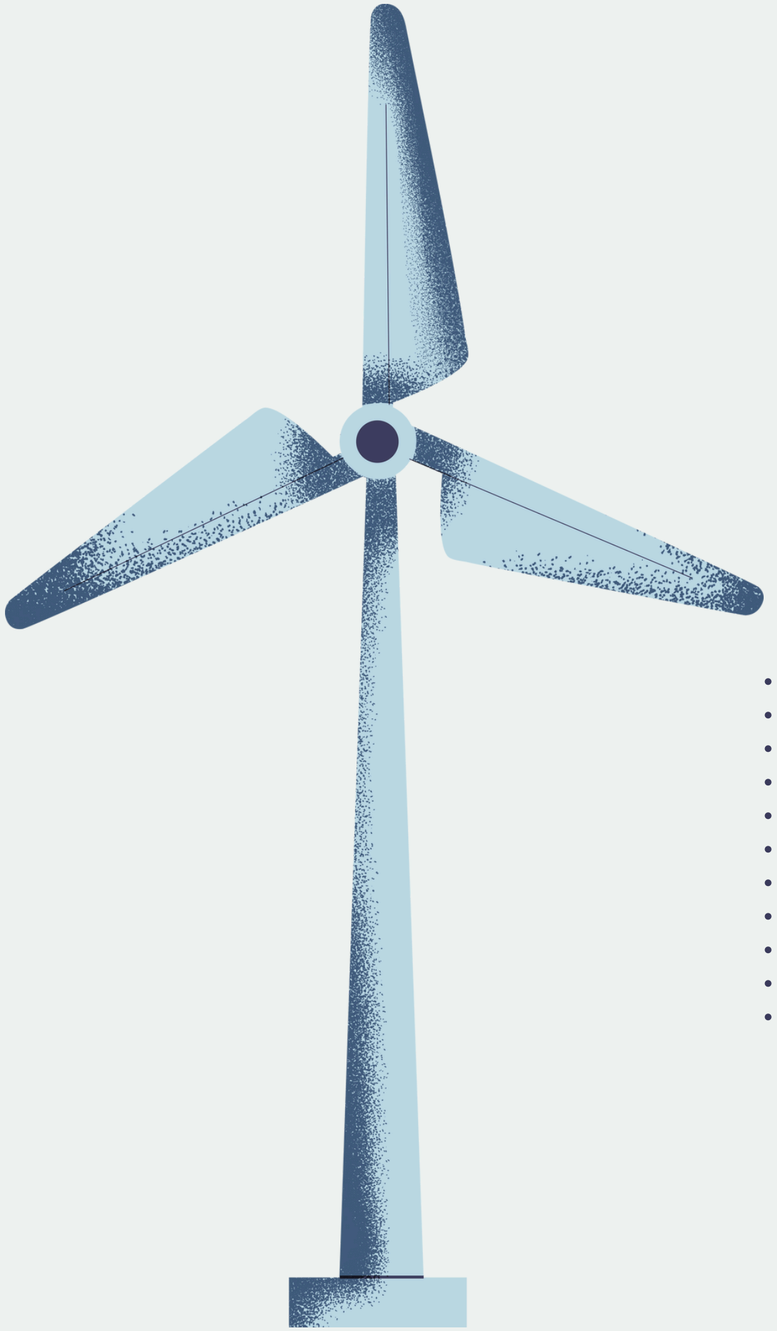
Q5. Has Energy Consumption Increased Or Decreased Over The Years For Major Economies ?

```sql
SELECT major_economies.country , c.year, SUM(c.consumption) as Total_Consumption
FROM consum_3 c
JOIN (SELECT country, SUM(value) as Total_gdp
FROM gdp_3
GROUP BY country
ORDER bY Total_gdp DESC LIMIT 5) as major_economies
ON c.country = major_economies.country
GROUP BY c.year, major_economies.country
ORDER BY c.year DESC, major_economies.country;
```

country	year	Total_Consumption
China	2023	177
Germany	2023	11
India	2023	38
Japan	2023	19
United States	2023	111
China	2022	168
Germany	2022	11
India	2022	36
Japan	2022	19
United States	2022	112
China	2021	165
Germany	2021	13
India	2021	33

- **Key Insights:**
- Top 5 GDP countries in the data:
- China, United States, India, Japan, Germany.
- China has the highest energy consumption every year:
- 2023: 177, 2022: 168, 2021: 165
- → Shows consistently high and rising demand for energy.
- India shows a noticeable increase:
- 2021: 19 → 2022: 36 → 2023: 38
- → Reflects growing energy needs, likely due to industrialization and population growth.
- United States has high but slightly declining or stable consumption:
- 2021: 112 → 2022: 113 → 2023: 123
- Japan and Germany have lower and steady consumption levels compared to others:
- Japan: Stays around 19 units.
- Germany: Around 11–13 units.

INNOMATICS RESEARCH LABS



Q6. What is the total Energy consumption country wise ?

```
SELECT country, sum(consumption) as Total_Consumption
FROM consum_3
GRoup By country
ORDER BY Total_Consumption;
```

country	Total_Consumption
Indonesia	32
Saudi Arabia	44
France	47
Germany	48
Brazil	49
Iran	53
Canada	54
South Korea	54
Japan	76
India	139
Russia	140
United States	441
China	666

- **Key Insights**
- Top Energy Consumers:
- China has the highest total consumption: 666 units.
- United States is second with 441 units.
- These two countries are major global energy users, likely due to large populations and heavy industries.
- Moderate Consumers:
- Russia (140) and India (139) are also high, but significantly below China/US.
- Countries like Japan, South Korea, and Canada fall into the mid-range.
- Low Energy Consumers:
- Indonesia (32) and Saudi Arabia (44) consume the least among the listed countries.
- This could be due to smaller populations, lower industrial demand, or efficient energy use.

INNOMATICS RESEARCH LABS

Q7 . Which Country Have Highest energy Consumption relative to GDP ?

```sql
SELECT c.country,
ROUND(SUM(consumption) / SUM(g.value), 4) AS relative_consumption_for_gdp
FROM  consum_3 c
JOIN  gdp_3 g
ON c.country = g.country
AND c.year = g.year
GROUP BY country
ORDER BY relative_consumption_for_gdp DESC;
```

country	relative_consumption_for_gdp
Trinidad and Tobago	0.0051
North Korea	0.0045
Turkmenistan	0.0034
Bahrain	0.0022
Kuwait	0.0017
Iran	0.0017
Qatar	0.0015
Russia	0.0015
Kazakhstan	0.0014
Ukraine	0.0014
Iraq	0.0013
Canada	0.0012
United Arab Emirates	0.0012
Oman	0.0011
Saudi Arabia	0.0011

- **Key Insights:**
- Top Countries with Highest Energy Use per GDP Unit:
- Trinidad and Tobago has the highest ratio (0.0051), meaning it uses a lot of energy compared to the size of its economy.
- North Korea (0.0045) and Turkmenistan (0.0034) also have very high ratios.
- This often suggests low economic efficiency — high energy consumption but relatively low GDP output.
- Oil-Rich and Resource-Heavy Economies:
- Countries like Bahrain, Kuwait, Iran, Qatar, and Saudi Arabia appear on the list.
- These nations often have energy-intensive industries (like oil refining and extraction), which explains their higher ratios.
- Developed Nations Lower on the List:
- Canada and United Arab Emirates are the only more developed nations in this high-consumption list.
- Their presence could relate to climate demands (heating/cooling) and industrial energy use.

Q8. How has population growth affected total emissions in each country ?

```sql
SELECT p.countries,
p.year,SUM(e.emission) AS total_emission,
p.value AS population
FROM  population_3 p
JOIN  emission_3 e
ON p.countries = e.country
AND p.year = e.year
GROUP BY p.countries , p.year , p.value
ORDER BY countries , year;
```

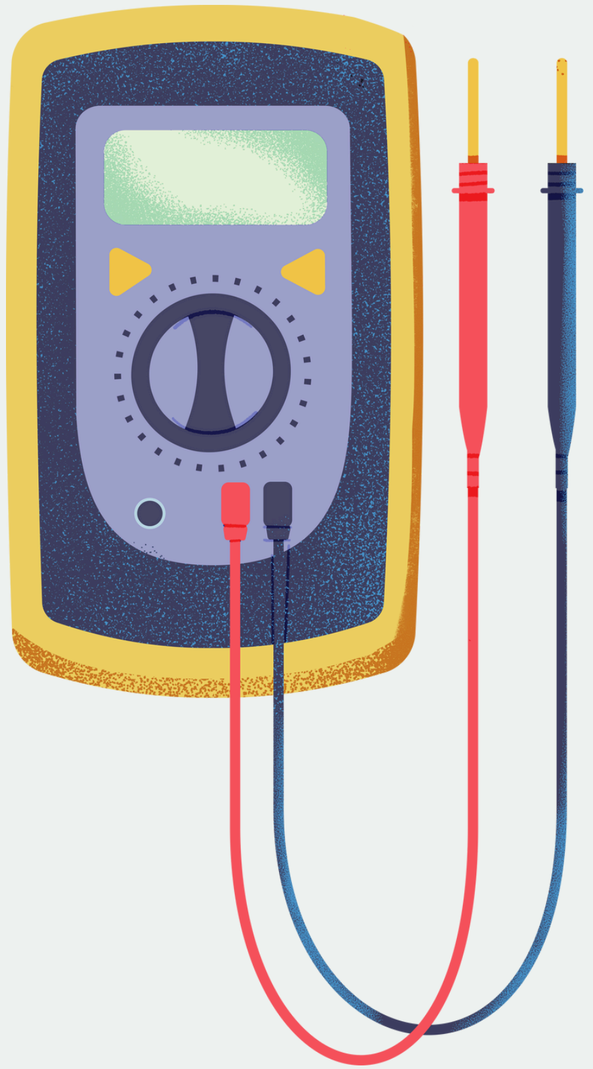
- India: Emissions rose from 5022 (2021) to 5642 (2023); population also increasing rapidly.
- Indonesia: Emissions rising faster than population; from 1028 (2020) to 1569 (2023).
- Iran: Strong emission growth (1354 to 1824); steady population rise.
- Iraq: Emissions jumped ~57% in 4 years; moderate population growth.
- Ireland: Emissions and population stable; likely strong environmental controls.

countries	year	total_emission	population
India	2022	5158	1425423
India	2023	5642	1438070
Indonesia	2020	1028	274814.9
Indonesia	2021	1130	276758.1
Indonesia	2022	1496	278830.6
Indonesia	2023	1659	281190.1
Iran	2020	1354	87723.45
Iran	2021	1424	88455.48
Iran	2022	1542	89524.24
Iran	2023	1646	90608.7
Iraq	2020	282	42116.61

Q9.What is the total emission per country for the most recent year available ?

```sql
SELECT country, SUM(emission) AS total_emission
FROM emission_3
WHERE year =
(SELECT MAX(year) AS recent_year
FROM emission_3)
GROUP BY country
ORDER BY total_emission DESC;
```

country	total_emission
China	24392
United States	9590
India	5642
Russia	3688
Japan	1920
Indonesia	1659
Iran	1646
Saudi Arabia	1313
South Korea	1288
Germany	1200
Canada	1171
South Africa	894
Mexico	882
Brazil	876
Turkiye	798
Australia	789

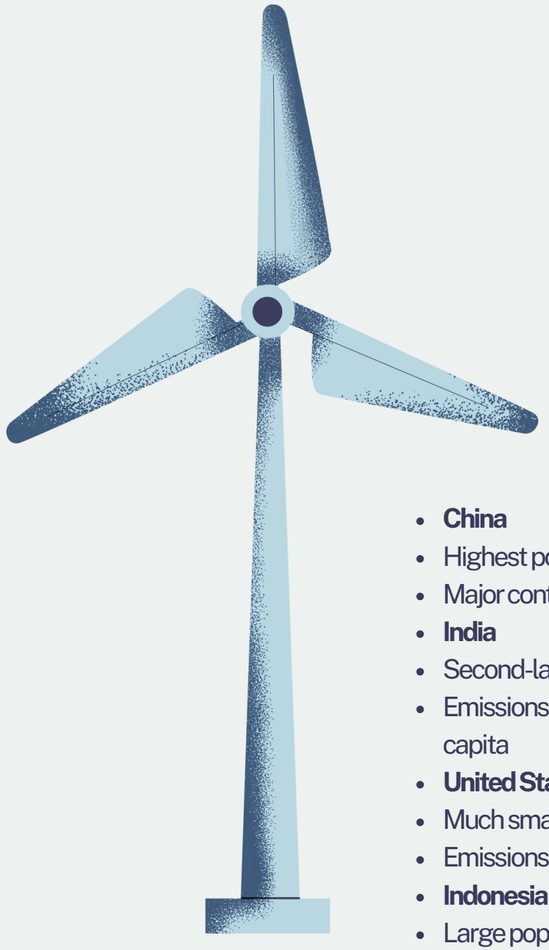


Q10. What are the top 10 countries by population and how do their emissions compare?

```sql
SELECT p.countries,
SUM(p.value) AS total_population,
SUM(e.emission) AS total_emission
FROM population_3 p
JOIN emission_3 e
ON p.countries = e.country
AND p.year = e.year
GROUP BY p.countries
ORDER BY total_population DESC
LIMIT 10;
```

countries	total_population	total_emission
China	22801232	92338
India	22721260	20223
United States	5334912.8	38453
Indonesia	4446374.8	5313
Pakistan	3862739.1999999997	1640
Nigeria	3534237.1999999997	874
Brazil	3358632.7999999993	3405
Bangladesh	2699235.1999999997	894
Russia	2332911.5999999996	14481
Mexico	2051199.9999999998	3416

- China: Largest population (~2.28B), highest emissions (92,338) — major global emitter.
- India: 2nd largest population, emissions at 20,223 — significantly lower than China.
- US: Smaller population than India/China, but high emissions (38,453) — very high per capita.
- Indonesia: Large population (4.4M), moderate emissions (5,313).
- Russia: Emissions (14,481) high compared to population — suggests energy-heavy economy.
- Nigeria & Bangladesh: High population but low emissions — low industrial carbon footprint.
- Pakistan & Brazil: Moderate emissions despite large populations — controlled output.
- Mexico: Moderate emissions (3,416) for its population size.

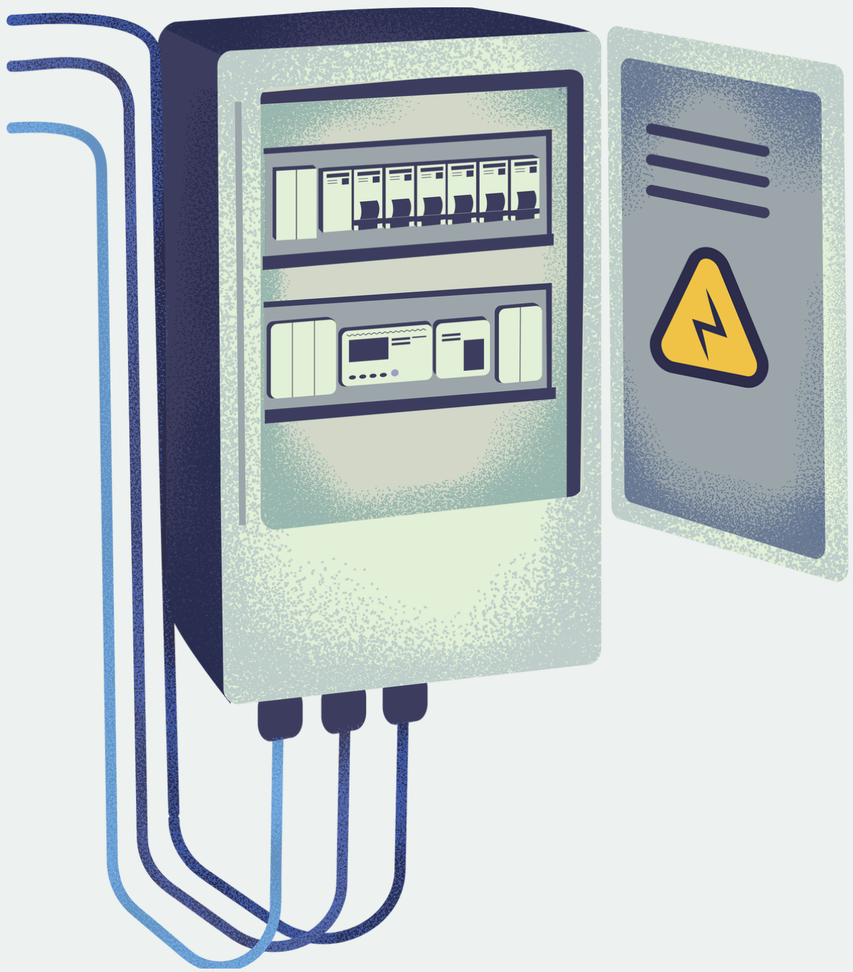


Q11.Which energy types contribute most to emissions across all countries?

```sql
SELECT
energy_type, SUM(emission_3) AS total_emission
FROM emission_3
GROUP BY energy_type
ORDER BY total_emission DESC;
```

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

- **China**
- Highest population and total emissions
- Major contributor to global emissions due to industrial scale
- **India**
- Second-largest population
- Emissions significantly lower than China — more efficient or lower industrial activity per capita
- **United States**
- Much smaller population than China/India
- Emissions very high — indicates high per capita emission
- **Indonesia**
- Large population, moderate emissions
- Possibly developing industrially but still under China/US levels
- **Pakistan, Nigeria, Bangladesh**
- High populations but very low emissions
- May indicate limited industrialization or cleaner practices
- **Russia**
- Relatively smaller population, high emissions
- Suggests heavy fossil fuel usage or energy export-oriented economy
- **Brazil & Mexico**
- Moderate population and emissions — more balanced industrial activity



Q12. How have global emissions changed year over year?

```
SELECT
year,
SUM(emission) AS total_global_emissions,
SUM(emission) - LAG(SUM(emission)) OVER (ORDER BY year) AS yoy_change
FROM emission_3
GROUP BY year
ORDER BY
year;
```

year	total_global_emissions	yoy_change
2020	67852	NULL
2021	70976	3124
2022	72445	1469
2023	74161	1716

INNOMATICS RESEARCH LABS

13. What is the emission-to-GDP ratio for each country by year?

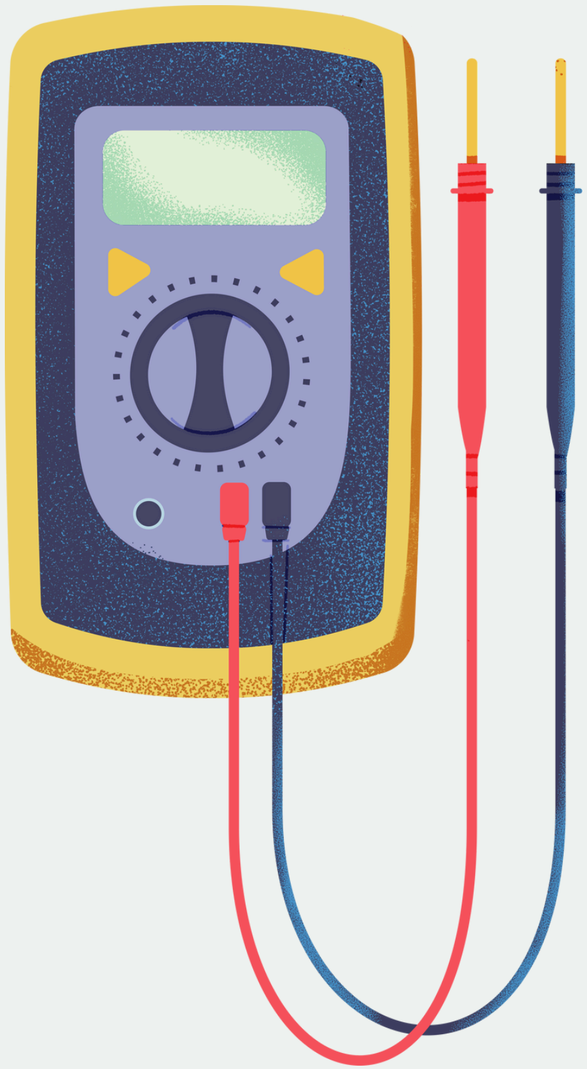
```sql
SELECT e.country, e.year,
ROUND((SUM(e.emission) / SUM(g.value)), 4) AS emission_gdp_ratio
FROM  emission_3 e
JOIN  gdp_3 g
ON e.country = g.country
AND e.year = g.year
GROUP BY country , year
ORDER BY country , year;
```

country	year	emission_gdp_ratio
Iceland	2020	0.0697
Iceland	2021	0.0662
Iceland	2022	0.0851
Iceland	2023	0.0694
India	2020	0.1358
India	2021	0.1269
India	2022	0.1283
India	2023	0.129
Indonesia	2020	0.0854
Indonesia	2021	0.0905
Indonesia	2022	0.1138
Indonesia	2023	0.1202
Iran	2020	0.2761
Iran	2021	0.2773

Q14.What are the top 5 countries by GDP in the most recent year?

```
SELECT country, value
FROM gdp_3
WHERE year = (SELECT MAX(year)
FROM gdp_3)
ORDER BY value DESC
LIMIT 5;
```

country	value
China	28673.24
United States	22679.47
India	11660.21
Japan	5179.704
Germany	4463.949



Q15. What Is The Global Average GDP, Emission, And Population By Year?

```sql
SELECT e.year,
ROUND(AVG(g.value), 5) AS avg_gdp,
ROUND(AVG(e.emission), 5) AS avg_emission,
ROUND(AVG(p.value), 5) AS avg_population
FROM emission_3 e
JOIN gdp_3 g ON e.country = g.country
AND e.year = g.year
JOIN population_3 p ON p.countries = e.country
AND p.year = e.year
GROUP BY e.year
ORDER BY e.year;
```

year	avg_gdp	avg_emission	avg_population
2020	629.0275	85.3955	39656.20232
2021	671.04251	89.4439	39986.56866
2022	694.60013	91.2926	40345.80628
2023	717.92553	93.4552	40711.65565

CONCLUSION

- China, the USA, and India are the top emitters due to large populations and high energy use.
- Fossil fuels like coal and oil are the biggest sources of global emissions.
- Some countries have low per capita emissions despite high totals; others have high per capita rates but are improving.
- Some nations produce and consume a lot of energy, while others rely on imports.
- Countries with low emissions and energy use per GDP are more energy-efficient.
- A few countries cause most emissions, holding key responsibility for climate action.
- Population growth raises emissions, but clean energy investment can break this link.
- Global trends show rising GDP and energy demand, but mixed changes in per capita emissions.

Thank you very much!