Memory

An explanation of the EDA

Original tables:

- **add_val_ind_EU27 (added value by industry and country in the EU 27)**
    - **Columns:**
        - **units (Current prices, million euro)**
        - **nace_r2 (industry types)**
        - **na_item (gross value added, Compensation of employees , Operating surplus and mixed income, net)**
        - **geo (countries)**
        - **TIME_PERIOD (in years)**
        - **OBS_VALUE (values)**
- **Co2_eu27 (emission by industry and country in EU 27)**
    - **Columns:**
        - **airpol (type of emissions)**
        - **nace_r2 (industry types)**
        - **unit (tonnes)**
        - **geo (countries)**
        - **TIME_PERIOD (in years)**
        - **OBS_VALUE (values)**
- **Eu_27_GDP (GDP by country in EU 27)**
    - **Columns:**
        - **units (Current prices, million euro)**
        - **na_item (CP_MEUR Current prices, million euro)**
        - **geo (countries)**

        - **TIME_PERIOD (in years)**
        - **OBS_VALUE (values)**

- **EU27_ener_ind (Energy consumtion by industry and country)**
    - **Columns:**
        - **nrg_bal (industry types, in bigger groups)**
        - **siec (energy type, only total energy)**
        - **units (Gigawatt hour)**
        - **geo (countries)**
        - **TIME_PERIOD (in years)**
        - **OBS_VALUE (values)**

Bridge Tables:

- **country_table:**
    - **columns:**
        - **country_code (original code)**
        - **country_name (name country)**
- **energy_industry_table:**
    - **columns:**
        - **sectors_code**
        - **sectors_name**
        - **small_name (shorter name version for visuals)**
- **industry_table:**
    - **columns:**
        - **industry_code**
        - **industry**

Tables in Power BI:

Code in Dax:

```
gas_name = DISTINCT(SELECTCOLUMNS(Co2_eu27,"gas",Co2_eu27[airpol]))

gas emissions = if(gas_name[gas]=="CO2", "CO2","CH4_EQU")
```

- **gas_name:**
    - **gas_name**
    - **gas_emission**

Code in Dax:

```
Time_Table = DISTINCT(ALLSELECTED(add_val_ind_EU27[TIME_PERIOD]))
```

- **Time_Table:**
    - **columns:**
        - **TIME_PERIOD**

TIME PREDICTION TABLE

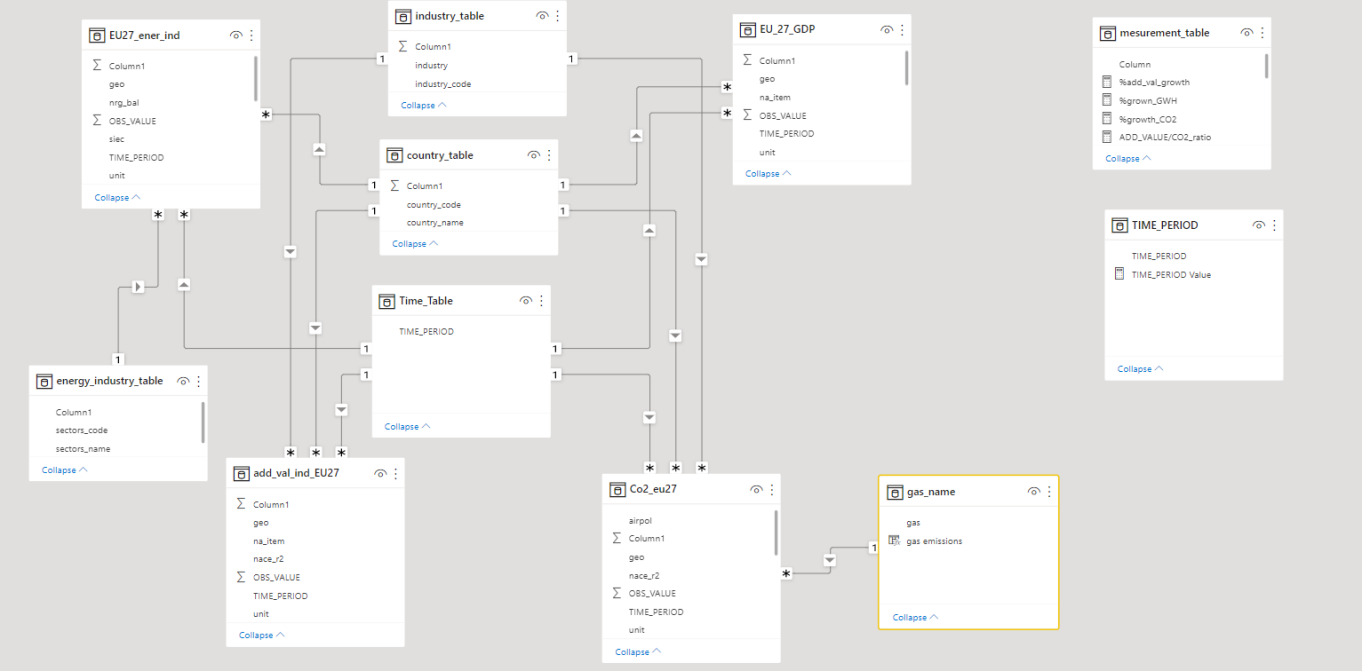
Code in Dax:

```
TIME_PERIOD = GENERATESERIES(1980, 2050, 1)
```

- **TIME_PERIOD:**
    - **columns:**
        - **TIME_PERIOD**

Model:

Now that we know what tables we will be working with we can take a look at the model:



As we can see the bridge tables, country_table and time_table, are connected with all tables as all tables have those variables.
The industry_table is only connected with add_val_ind_EU27 and Co2_eu27.
And both gas_name and energy_industry_table are only connected to one each, Co2_eu27 and EU27_ener_ind respectably.
All created table are in a one to many relation in a single direction to avoid recursivity.

Measures in Power BI:

%add_val_growth (this measure give the % of growth of value added from the first year to the last, used in the table in the GDP_val_add page):

```
var tab_1 =
SUMMARIZE(add_val_ind_EU27,add_val_ind_EU27[TIME_PERIOD],"sum",sum(add_val_ind_EU2
7[OBS_VALUE]))
var
tab_2=FILTER(tab_1,add_val_ind_EU27[TIME_PERIOD]==min(add_val_ind_EU27[TIME_PERIOD
]))
var max_1=maxx(tab_2,[sum])
var
tab_3=filter(tab_1,add_val_ind_EU27[TIME_PERIOD]==max(add_val_ind_EU27[TIME_PERIOD
]))
var min_1=maxx(tab_3,[sum])
var cal= (min_1-max_1)/max_1*100
return
cal
```

last_add_val (this calculates the value added of the last year, used in the table in the GDP_val_add page):

```
last_add_val =
CALCULATE(sum(add_val_ind_EU27[OBS_VALUE]),add_val_ind_EU27[TIME_PERIOD]=max(add_v
al_ind_EU27[TIME_PERIOD]))
```

%grown_GWH (this measure give the % of growth of GWH from the first year to the last, used in the table in GWH_consumption page):

```
%grown_GWH =
var
first=CALCULATE(sum(EU27_ener_ind[OBS_VALUE]),EU27_ener_ind[TIME_PERIOD]==MIN(EU27
_ener_ind[TIME_PERIOD]))
var growth=([last_gwh]-first)/first*100
return
growth
```

last_gwh (this calculates the consumption of energy in GWH of the last year, used in the table in the GWH_consumption page):

```
last_gwh =
CALCULATE(sum(EU27_ener_ind[OBS_VALUE]),EU27_ener_ind[TIME_PERIOD]==max(EU27_ener_
ind[TIME_PERIOD]))
```

%growth_CO2 (this measure give the % of growth of CO2 and CH4 equivalent emission from the first year to the last, used in the table in CO2_by country page):

```
%growth_CO2 =
var
first=calculate(sum(Co2_eu27[OBS_VALUE]),Co2_eu27[TIME_PERIOD]==MIN(Co2_eu27[TIME_
PERIOD]))
var growth=([last_CO2]-first)/first*100
return
growth
```

last_CO2 (this calculates the CO2 and CH4 equivalent emission of the last year, used in the table in the CO2_by country page):

```
last_CO2 =
calculate(sum(Co2_eu27[OBS_VALUE]),Co2_eu27[TIME_PERIOD]==max(Co2_eu27[TIME_PERIOD
]))
```

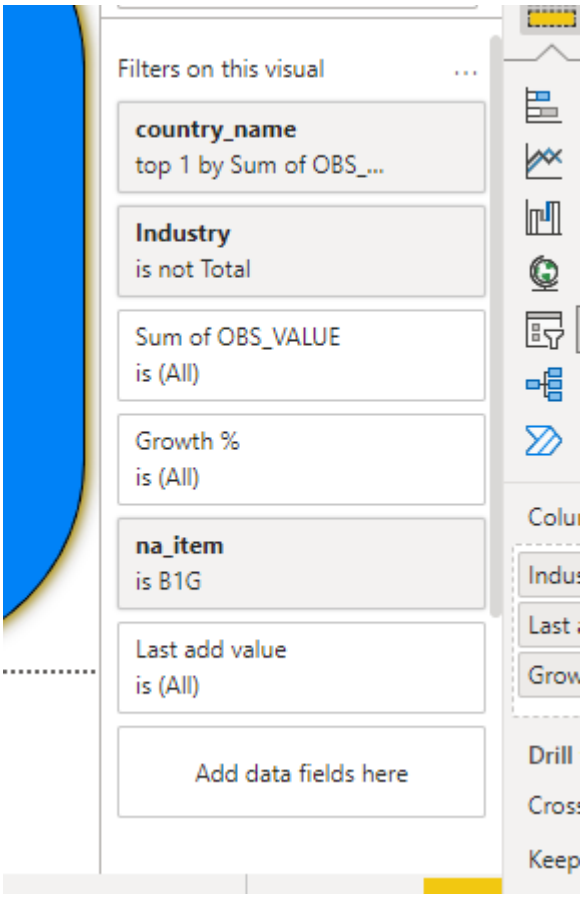
ADD_VALUE/CO2_ratio (this calculates the ratio of value added per CO2 emission, and can be seen in the page Value_added_by industry in both graphs):

```
ADD_VALUE/CO2_ratio =
var cal_1=CALCULATE(sum(Co2_eu27[OBS_VALUE]))
var cal_2=CALCULATE(sum(add_val_ind_EU27[OBS_VALUE]))
var ratio=cal_2/cal_1
return
if (or(cal_1==0,cal_2==0),0 ,ratio*1000000)
```

country_name_slice (this is use for the first 3 pages to give a title to all the tables):

```
country_name_slice =
if(SELECTEDVALUE(country_table[country_name])==BLANK(),"Euro27",SELECTEDVALUE(coun
try_table[country_name]))
```

because there are several ways of measuring the same thing in particular in economic variable I use Power BI's filter side bar for this purpose:



as we can see in this image the na_item is B1G, this is value added, that way the measures would work as intended

Linear Regressions

To make linear regressions in Power BI is important to truly understand this calculation, because one need to calculate each value:
The formula for a line goes like so: y = mx + b
Where:

y is what we want to predict

m is the slope i.e. the change in y divided by change in x represented this way:

$$\frac{n(\sum xy)-(\sum x)(\sum y)}{n(\sum x^2)-(\sum x)^2}$$

x is the value we give in theses cases will be years

b is the value of y when x is 0 calculated like so:

$$=\frac{(\sum y)(\sum x^2)-(\sum x)(\sum xy)}{n(\sum x^2)-(\sum x)^2}$$

As we can see we will need 2 values that are not in the original data:

- X^2
- XY

Create X^2 column for EU_27_GDP, Co2_eu27 and EU27_ener_ind

```
X^2 = tables_name[TIME_PERIOD]^2
```

Create XY column for EU_27_GDP, Co2_eu27 and EU27_ener_ind

```
XY = tables_name[TIME_PERIOD]*tables_name[OBS_VALUE]
```

now that we have the X^2 and XY we need measurements to calculate the sum of:

- X
- Y
- XY
- X^2

Measurements

SUMX

```
SUMX = sum(tables_name[TIME_PERIOD])
```

SUMY

```
SUMX = sum(tables_name[OBS_VALUE])
```

SUMXY

```
SUMX = sum(tables_name[XY])
```

SUMX^2

```
SUMX = sum(tables_name[X^2])
```

we also need n, this is the number of observation

N

```
N=countrows(tables_name)
```

now that we have all the components we can make m and b as measurements as well:

M

```
M = DIVIDE([N]*[SUMXY]-[SUMX]*[SUMY],[N]*[SUMX^2]-[SUMX]^2,0)
```

B

```
B = DIVIDE([SUMY]*[SUMX^2]-[SUMX]*[SUMXY],[N]*[SUMX^2]-[SUMX]^2,0)
```

And finally we group all of this measurements to make a line equation:

LINEAR_REGRESSION

```
LINEAR_REGRESSION = [M]*(TIME_PERIOD[TIME_PERIOD Value])+[B]
```

because TIME_PERIOD table has years up to 2050 we can make future prediction uo to 2050.

Extra Measurements

2050 predicted value for GDP GWH and CO2

```
choosen_value_2050 = [M]*(2050)+[B]
```

growth for 2050 for GDP GWH and CO2

```
%_growth =
var
first=CALCULATE(sum(tables_name[OBS_VALUE]),tables_name[TIME_PERIOD]==min(tables_n
ame[TIME_PERIOD]))
var cal=(tables_name[choosen_value_2050]-first)/first
return
cal
```

total emissions by 2050

```
emission_2050 =
VAR
co2=CALCULATE([CO2_2050],and(Co2_eu27[airpol]=="CO2",Co2_eu27[nace_r2]=="TOTAL"))
VAR
ch4=CALCULATE([CO2_2050],and(Co2_eu27[airpol]=="CH4_CO2E",Co2_eu27[nace_r2]=="TOTA
L"))
RETURN
co2+ch4
```

ratio Measurements

GDP/CO2_2050

```
GDP/CO2_2050 = [GDP_2050]/[emission_2050]*1000000
```

GDP/GWH_2050

```
GDP/GWH_2050 = [GDP_2050]/[GWH_2050]
```

GWH/CO2_2050

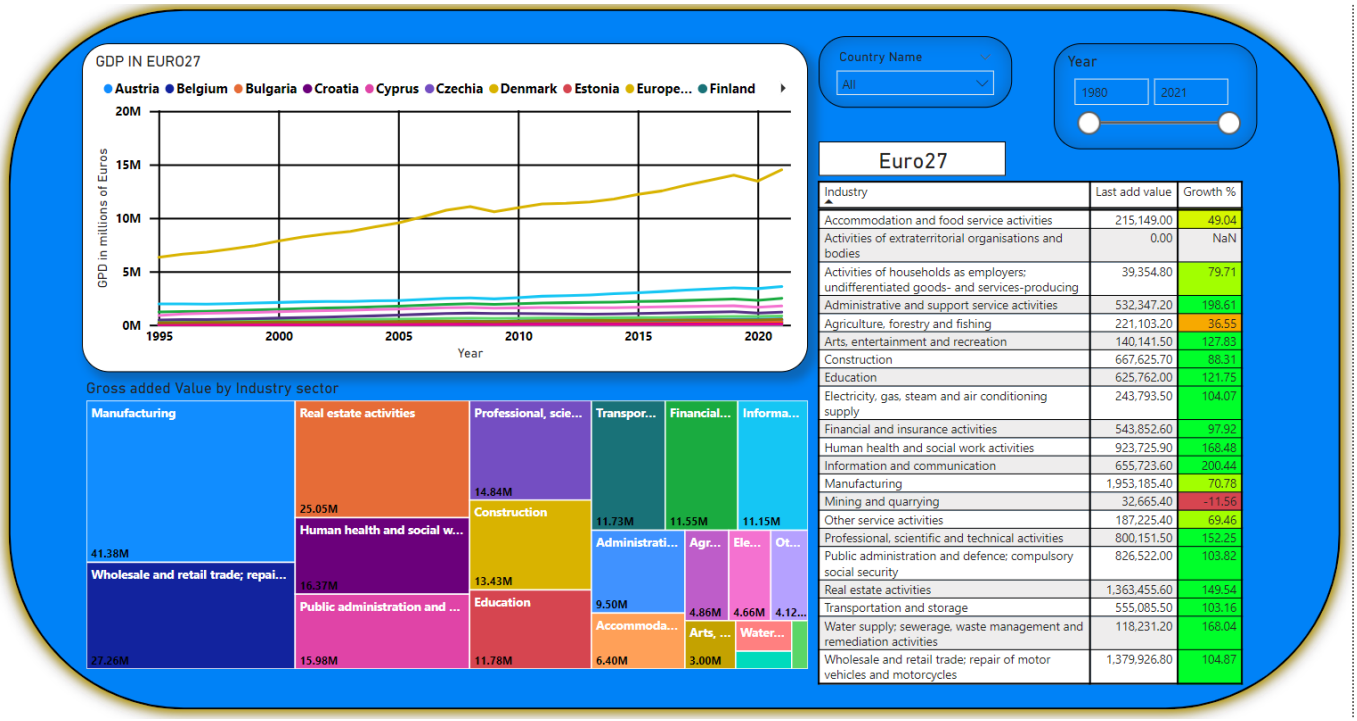
```
GWH/CO2_2050 = [GWH_2050]/[emission_2050]
```

Analysis

first we will check the progression over time of all the individual variable:

GDP

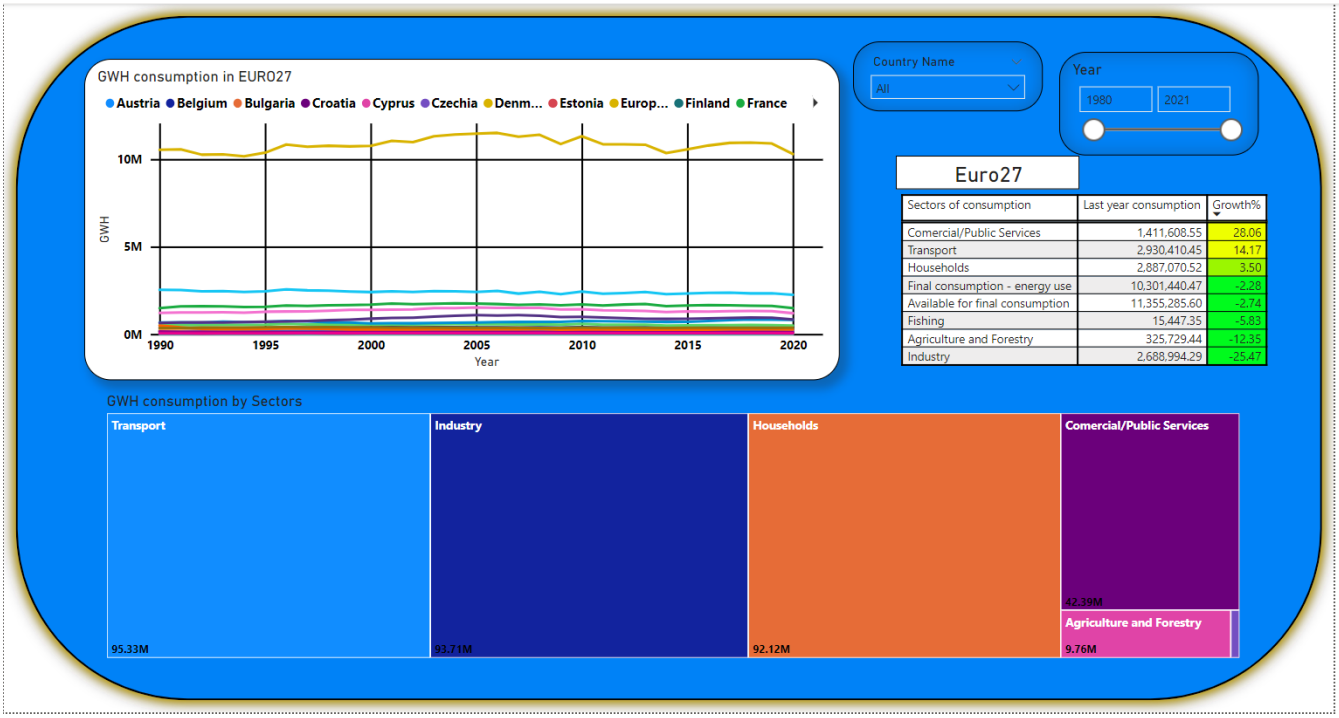
lets check the overall report page of GDP and added value for each industry:



Here we can conclude that GDP in EU as increase since 1995 to 2021, from about 6 billion € (american trillion) to 14 billion €.
The industry that had the biggest growth, in added value, is the Information and communication industry with a 200% growth in that period of time. And finally the top 3 industries are Manufacturing, Wholesale and retail trade and real estate.

Energy consumption

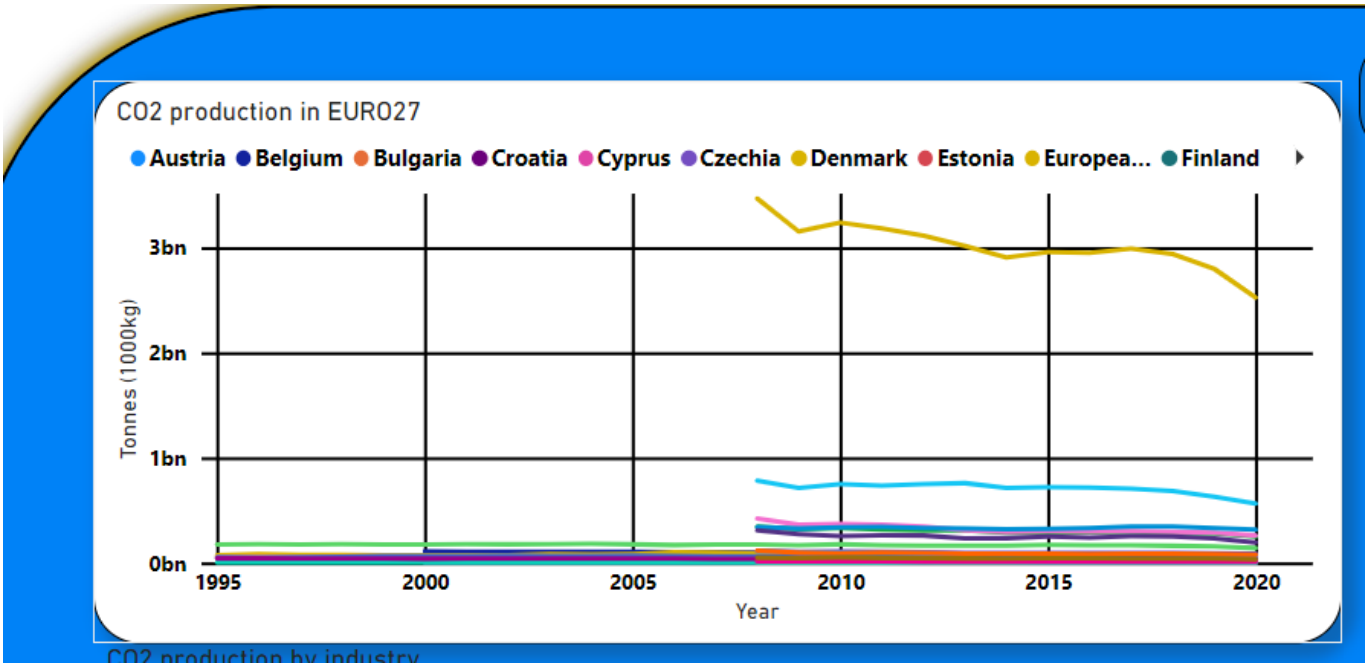
lets check the energy consumption



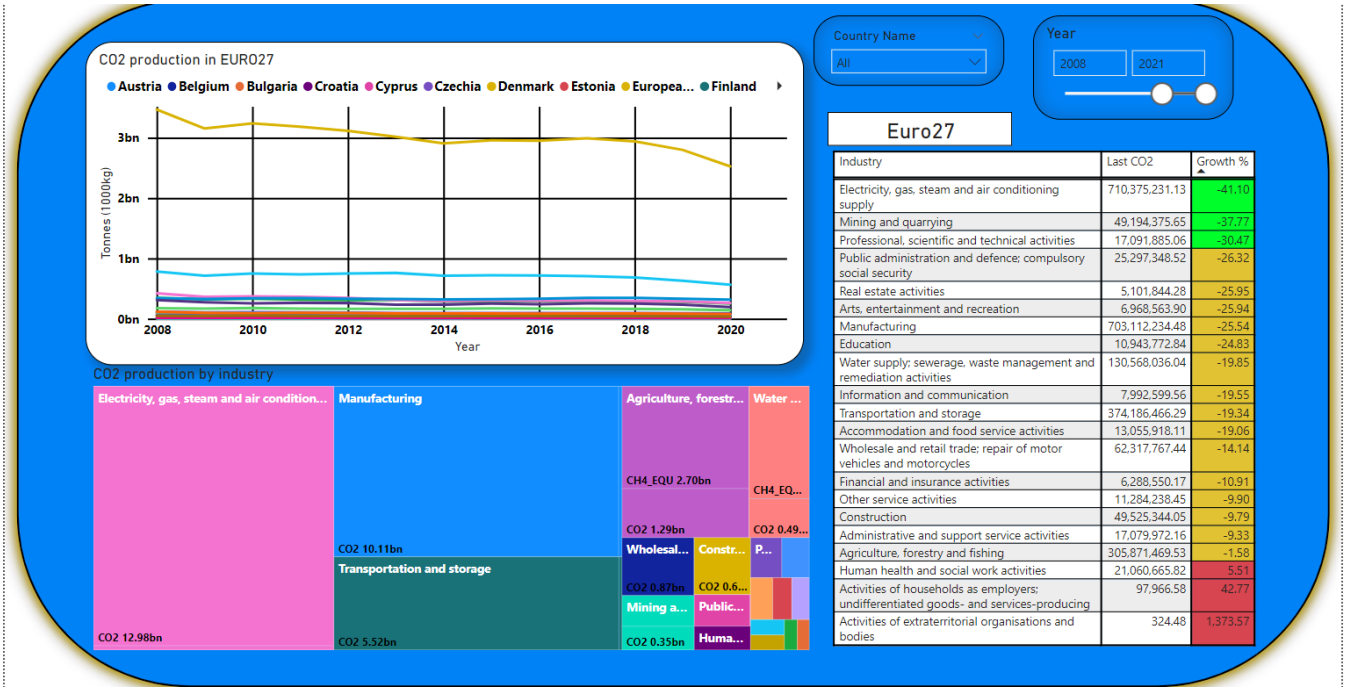
One thing to notice is that energy consumption has not increase even though as we previously notice GDP has, there are several reasons for this.
For one the GDP is not adjusted for inflation, this means that GDP will grow due to inflation even if the union does not increase wealth.
The other reason we can see here, this energy consumption by sectors table and added value table of the previous page. We can see that Industry, sector that has many types of enterprises, have reduce their energy consumption by 25% since 1990. And energy heavy sectors, like Manufacturing and Mining, have had either a small or negative growth in added value.
This shows that the EU's economy as shifted in theses last few years. This is identify also by the growth in energy consumption in the Comercial/Public Services by 28% since 1990.

Emission

now for emission



To notice that not all countries measure emission at the same time, lets check since 2008 when EU started to be consisted in measuring.



Here we can notice that the EU as decrease their emission, both CO2 and CH4 equivalent to CO2, by about 1.000 million (1 billion american) tonnes (1000 kg) since 2008 to 2020.
To have in mind that 2020 was a different year.
The biggest decrease was in the Electricity industry, 41 % decrease, yet it is still the most polluting industry. And considering all other industries use energy it is necessary to reduce it further. The second biggest drop was in Mining with 37% followed by Professional, scientific and technical activities with 30%. Theses 2 activities have different reasons for their drop in emission, because mining has drop their added value by 11% since 1995, while the later has increase their added value by 152%. So in the case of mining their emission are reducing due to reduce economic activity, while in the case of Professional, scientific and technical activities, one can assume this is due to improvements made in their sector.
Besides this all other sectors have reduce their emissions with 3 notable exceptions, Human heath and social work activities being the most notable due to their sizeable emission.

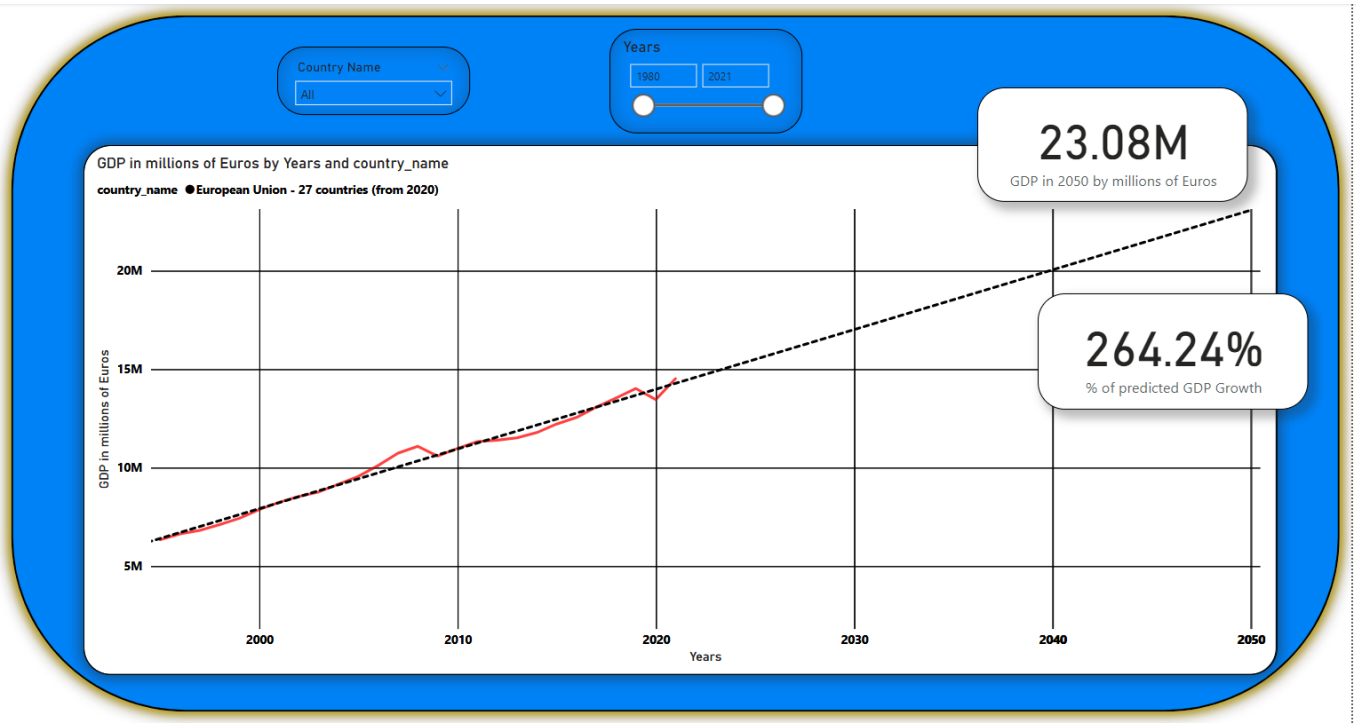
Conclusion of current data

We can say with this data that yes, the EU is reducion their emission. However alot of factors clearly make this picture a bit more complicated.
For one the reason the emission have gone down while GDP as gone up is due to a change of EU's industry sectors, manufacturing indutries an heavy emittor and energy consumer has not grown as much in added value in comparison to other industries like information and communication, that are lower emittor and lower energy consuming industries. Yet this does not mean that EU citizens, goverments and industries have reduce their consumption in manufacture goods, what is most likely happening is that EU is buy these goods from other countries, that may or may not have the same standards when it come to emission. More over the reduction may not be has high as it should be, but this we will see with the prediction.

Predictions

GDP 2050

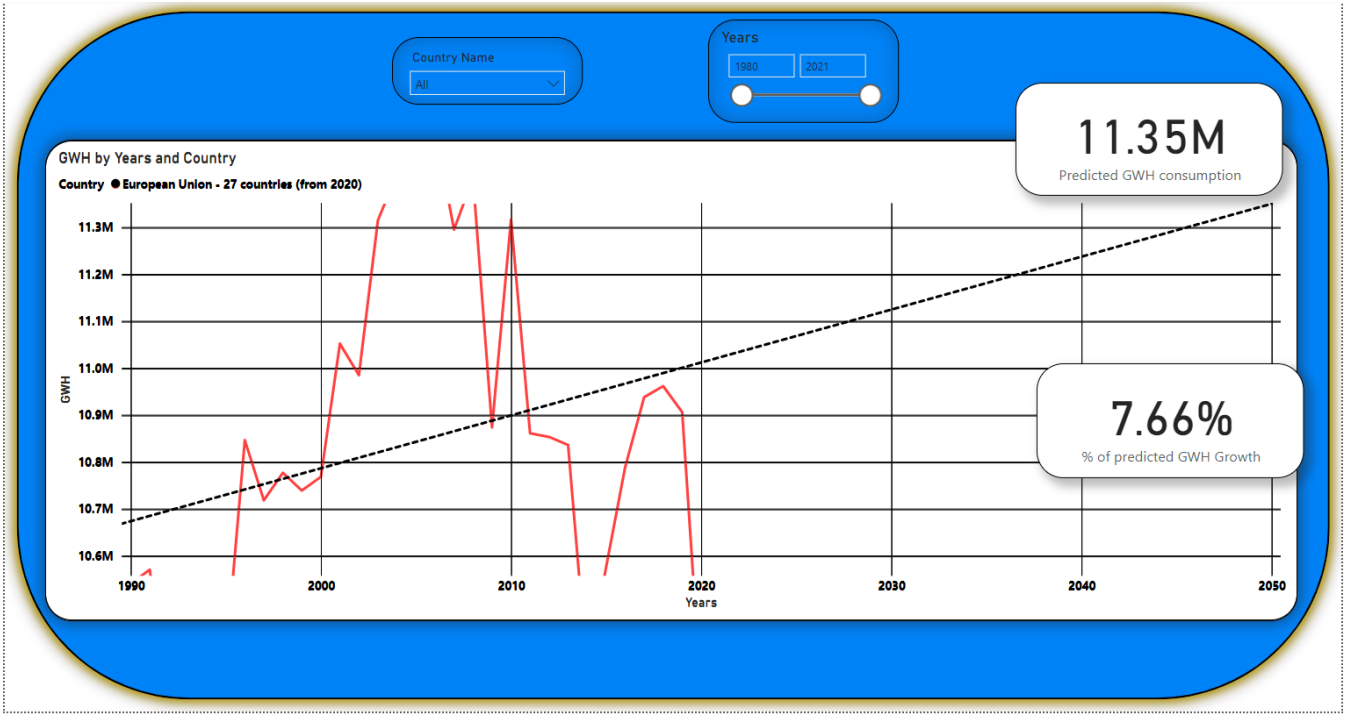
lets check how the EU's GDP in 2050



Doing a linear regressions I predict that the EU's GDP will grow 264% to 23 billions (23 trillions) € in 2050 since 1995.

Energy consumption

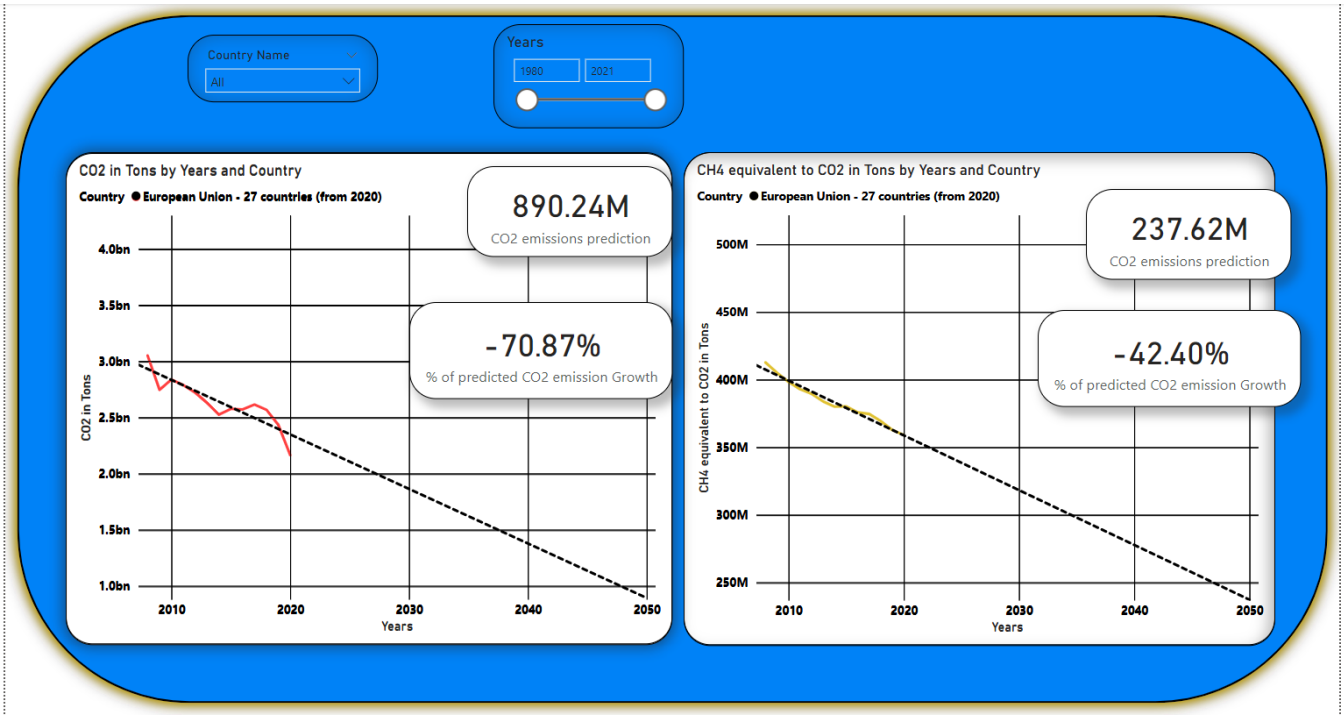
now the energy consumption in GWH



In this case we can see that using a linear regression is not very usefull, but as we have notice before the energy consumption has not change much since 1995, being about 10 million GWH. Still using this model we can predict a small increase at about 7% since 1990.

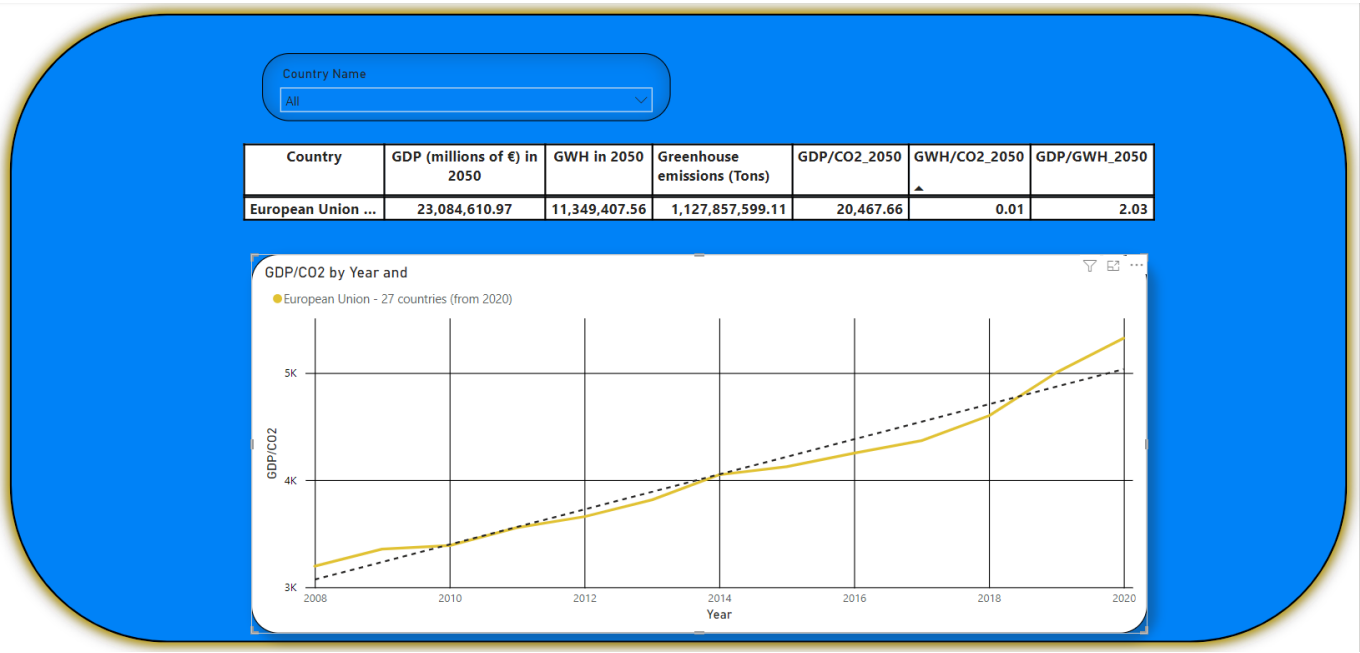
Emission

now lets check emissions



Here we can see that using a linear regression that emissions will be reduce by 70% since 2008 for CO2, to 890 million tonnes, and 42% for CH4 equivalent to CO2, to 237 million tonnes.
We can see here that using this method can be resonable but knowing that development in tecnologies, geopolitics and enviroment will affect theses values in the coming years.

Total predictions and ratios



In the EU in 2050, I predict using linear regression:

- the EU's GDP will be 23 billion €
- the emission will be about 1.000 tonnes of CO2 equivalent

- the energy consumption will be about 11 million GWH
- Each ton of CO2 equivalent emission is related to about 20.000 € in GDP
- Each ton of CO2 equivalent emission is related to about 0.01 GWH
- Each GWH will be related to about 2 million €

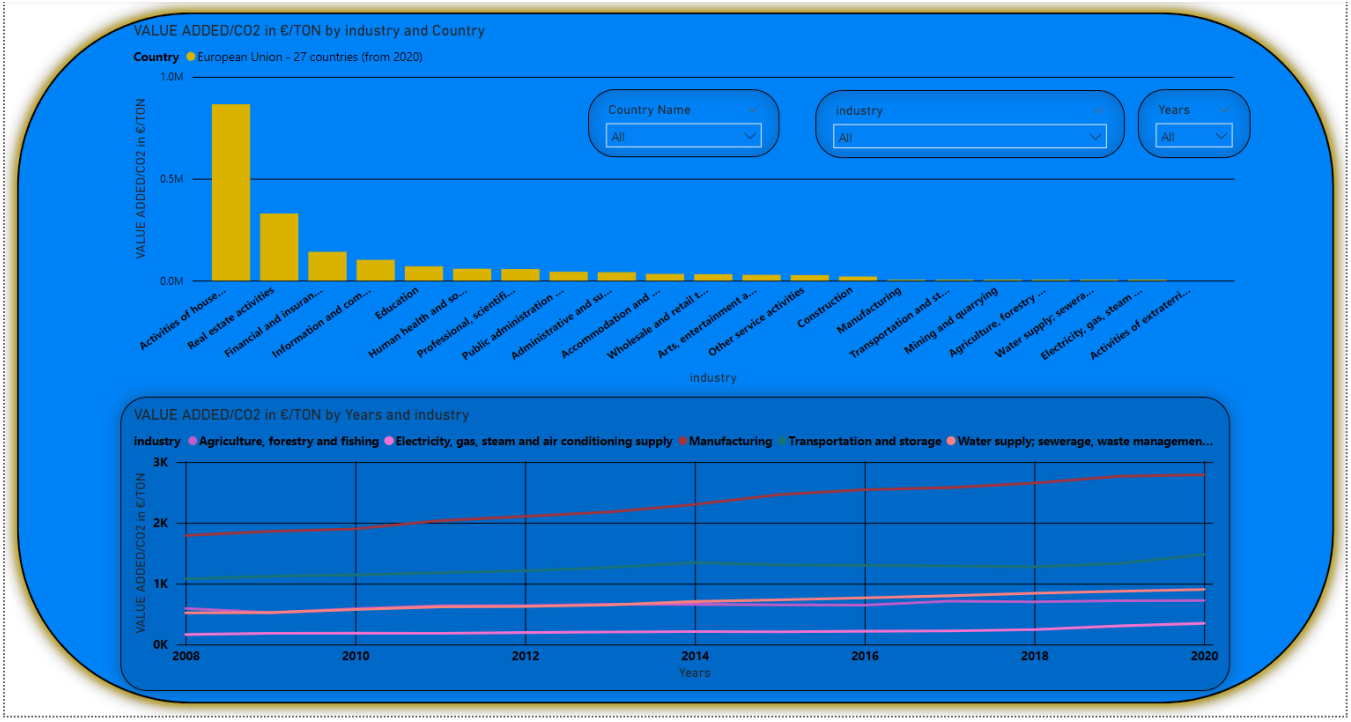
In the graph we see that currently the relation between GDP and emission is about 5.000 € per ton of CO2. still alot to go.

Conclusion of predictions

The EU is on the path of reducing their emission. However, if theses predictions are correct, by the time it reaches 2050 their will still be about 1.000 tonnes of equivalent CO2 emitted every year, to offset theses emission is going to be expensive both economic and energetic.
Currently it the cost to offset 1 ton of emission is between $10 and $1200. climate.mit The cheapest offsets tend to be unreliable and there is a cap of how much they can be done, as they rely on tree planting, while the most expensive rely on air or ocean capture that are very expensive both economic and energetic. We are doing something but there is alot more to do.

Possible Solucions

Most CO2 emission are done in the private sector, yet it is this same private sector that enables our corrent way of life. Because the market can't regulate it's self when it come to CO2 emission, it would be important to understand what industries have a higher value added per ton of CO2 and what is this value over time of the most polluting industries.



In the bar chart we see value added per ton of CO2 for each industry, those that have the higher value have a higher economic output per ton of CO2.
Not suprising the industries that have the highest values are Activities in households as employers, Real estate (it's not construction so they don't get the emission of that), Finance and IT, this last one having a average value, since 2008 till 2020, of about 100.000 € per ton of CO2, to note that for each year this value is always below that, this means that the industry as improve their output throughout the years, becoming more

effecient.
As for the most polluting industries and their development of this ratio throughtout time, presented in the line graph, we see that the top 5 are manufacturing, transport and storage, water supply(sewerage, waste managent), Agriculture foresty and fishing and at the last place has most polluting, using this ratio, Electricity.

To reduce our emission it is a complicated task, ultimatly our current globalise economy creates a complex and confusing web of interrelations. However if EU wishes to be affective in curving said emissions, making the top 5 most polluting industries more effective in their wealth generation per ton of CO2, would be an important step.
To do this my meagre recomendation would be:

- Decarbonize the electricity, by using of renewable and nuclear energy.
- Improve EU grid interconnection.
- Incentivate reducing meat consumption, in partiular from ruminants animals.
- Improve resource utilization by farms.
- Improve and fully electrify the EU's rail network.
- Encourage the manufactory sector to improve their value add per ton of CO2 ratio, by developing long lasting and fixable goods.

I understand that these solucions might seem farfetch, but ultimatly the improvement of the previously mention ratios should be our goal. At least now we have the means to measure it.
And in the imortal words of Peter Drucker, **"if you can't measure it, you can't improve it"** .
Now we can.