RECHAUFFEMENT CLIMATIQUE

Debut et introduction

Depuis quelques années, la prise de conscience de la protection de la planete s'est généralisée. On entend souvent le sujet du rechauffement climatique et les emissions de CO2. On veut donc savoir si a-t-il un impact significatif.

Nous avons analysé nos principales problématiques:

> 1). Y a-t-il une augmentation de la température en France et EU? | Arisoy Ivan Can
>
> 2). Y a-t-il une augmentation de la température en France? (visualisation cartographique du problème) | Axel Carot
>
> 3). L'augmentation de la température est-elle corrélée à notre émission de CO2? | Axel Carot
>
> 4). Comment le réchauffement climatique impacte notre consommation d'énergies renouvelables? | Arisoy Ivan Can

Arisoy Ivan Can, Axel Carot

In [ ]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import geopandas as gpd
import seaborn as sb
```

In [ ]:
```
## 1) AUGMENTATION DE LA TEMPERATURE EN FRANCE ET EU (DISTRIBUTION DU CHANGEMENT DE LA TEMPERATURE AU FUR DES ANNEES)
df_1 = pd.read_csv('FAOSTAT_data_en_11-23-2022.csv', sep= ",", header=0,encoding="UTF-8")


## 2) AUGMENTATION DE LA TEMPERATURE MOYENNE EN FRANCE (REPRESANTATION CARTOGRAPHIQUE)
df_2 = pd.read_csv("donnees-synop-essentielles-omm.csv", sep= ";", header=0,encoding="UTF-8")
df_france_geo_regions = gpd.read_file("https://raw.githubusercontent.com/gregoiredavid/france-geojson/master/regions.geojson")


## 3) CO2 EMISSiONS
df_3 = pd.read_csv('annual-co2-emissions-per-country.csv', sep= ",", header=0,encoding="UTF-8")


## 4) ENERGY CONSUMPTION
df_a = pd.read_csv('per-capita-renewables.csv', sep= ",", header=0,encoding="UTF-8") # https://ourworldindata.org/grapher/per-capita-renewables?tab=chart
df_b = pd.read_csv('per-capita-hydro.csv', sep= ",", header=0,encoding="UTF-8") # https://ourworldindata.org/grapher/per-capita-hydro?tab=chart
df_c = pd.read_csv('per-capita-solar.csv', sep= ",", header=0,encoding="UTF-8") # https://ourworldindata.org/grapher/per-capita-solar?tab=chart
df_d = pd.read_csv('per-capita-wind.csv', sep= ",", header=0,encoding="UTF-8") # https://ourworldindata.org/grapher/per-capita-wind?tab=chart
```

1) AUGMENTATION DE LA TEMPERATURE EN FRANCE ET EU

DISTRIBUTION DU CHANGEMENT DE LA TEMPERATURE AU FUR DES ANNEES

https://www.fao.org/faostat/en/#data/ET

In [ ]:
```
df_1.head(3)
```

Out[ ]:

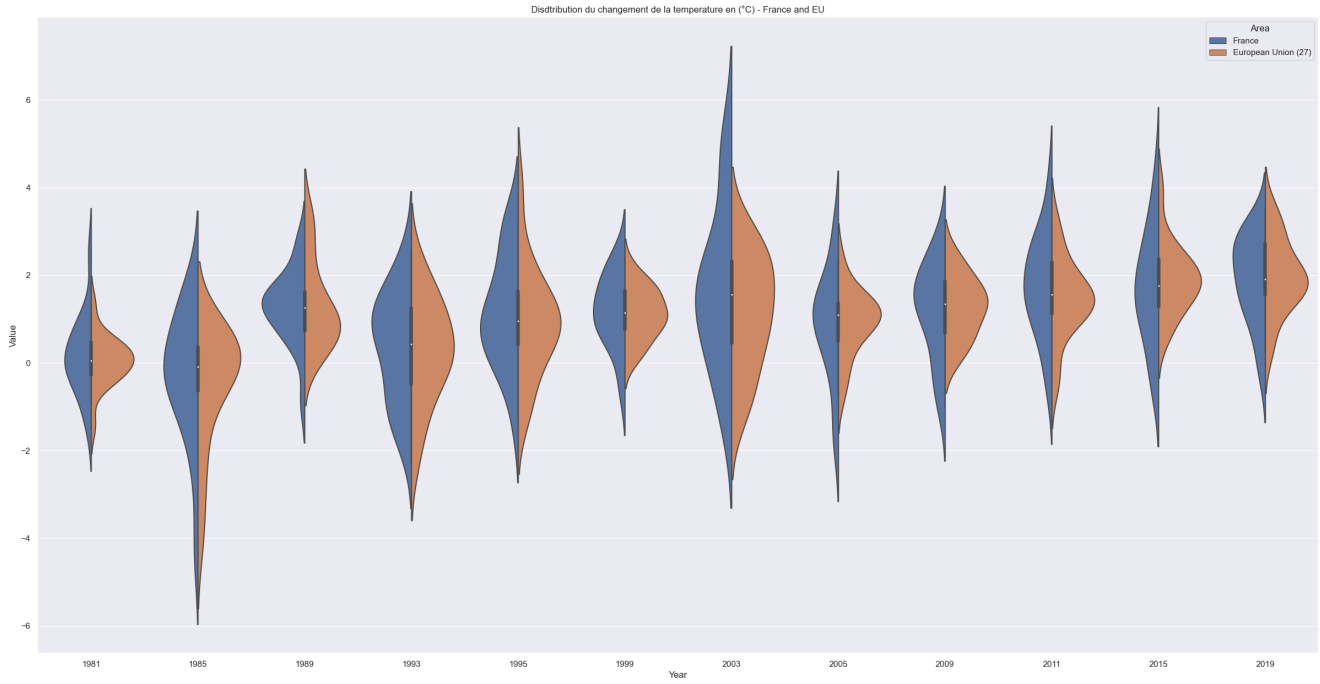
	Domain Code	Domain	Area Code (M49)	Area	Element Code	Element	Months Code	Months	Year Code	Year	Unit	Value	Flag	Flag Description
0	ET	Temperature change	250	France	7271	Temperature change	7001	January	1961	1961	°C	0.104	E	Estimated value
1	ET	Temperature change	250	France	7271	Temperature change	7001	January	1962	1962	°C	1.604	E	Estimated value
2	ET	Temperature change	250	France	7271	Temperature change	7001	January	1963	1963	°C	-4.598	E	Estimated value

In [ ]:
```
print(df_1.isnull().sum())
```

```
Domain Code         0
Domain              0
Area Code (M49)     0
Area                0
Element Code        0
Element             0
Months Code         0
Months              0
Year Code           0
Year                0
Unit                0
Value               0
Flag                0
Flag Description    0
dtype: int64
```

In [ ]:
```
#Filtrage des annees
df_1_years = df_1[(df_1["Year"]== 1981) | (df_1["Year"]== 1985) | (df_1["Year"]== 1989) | (df_1["Year"]== 1993) | (df_1["Year"]== 1995) | (df_1["Year"]== 1999) | (df_1[
```

In [ ]:
```
#Visualisation en violionplot
sb.set(rc={'figure.figsize':(30,15)})

sb.violinplot(x='Year', # variable x-axis
              y='Value',  # variable y-axis
              data=df_1_years[(df_1_years["Area"]!='World')],
              split = True,
              hue = 'Area',
              ).set(title = "Disdtribution du changement de la temperature en (°C) - France and EU")

plt.show()
```



2) AUGMENTATION DE LA TEMPERATURE MOYENNE EN FRANCE

REPRESANTATION CARTOGRAPHIQUE

https://public.opendatasoft.com/explore/dataset/donnees-synop-essentielles-omm/information/?sort=date&dataChart=eyJxdWVyaWVzIjpbeyJjaGFydHMiOlt7InR5cGUiOiJjb2x1bW4iLCJmdW5jIjoiQVZHIiwieUF4aXMiOiJ0bjEyYyIsInNjaWVudGlr

In [ ]:
```
#dataframe geojson des regions
df_france_geo_regions.head(3)
```

Out[ ]:

	code	nom	geometry
0	11	Île-de-France	POLYGON ((2.59052 49.07965, 2.59602 49.08171, ...
1	24	Centre-Val de Loire	POLYGON ((2.87463 47.52042, 2.87984 47.51671, ...
2	27	Bourgogne-Franche-Comté	POLYGON ((3.62942 46.74946, 3.62655 46.75228, ...

In [ ]:
```
#Garder le colonne souhatees
df_2_filtred = df_2[["Date",
             'Température (°C)',
            'communes (name)',
            'region (name)',
            'department (name)',
            'Latitude',
            'Longitude']]

#Modification de la colonne 'Date' par un regex
df_2_filtred['Date'] = df_2_filtred['Date'].str.replace('T',' ')
df_2_filtred['Date'] = df_2_filtred['Date'].str.replace('\+[0-9]+:[0-9]+',' ')

#Transformer la colonne 'Date' en formate Date
df_2_filtred['Date']= pd.to_datetime(df_2_filtred['Date'])
```

In [ ]:
```
## Traitement des donees nules
df_2_filtred = df_2_filtred.dropna()
print(df_2_filtred.isnull().sum())
```

```
Date                0
Température (°C)    0
communes (name)     0
region (name)       0
department (name)   0
Latitude            0
Longitude           0
dtype: int64
```

In [ ]:
```
#Rejoindre le fichier geojson avec la dataframe
merged_inner_geo_france = pd.merge(left=df_france_geo_regions, right=df_2_filtred, left_on='nom', right_on='region (name)')
merged_inner_geo_france['year'] = merged_inner_geo_france.Date.dt.year

merged_inner_geo_france.head(3)
```

Out[ ]:

	code	nom	geometry	Date	Température (°C)	communes (name)	region (name)	department (name)	Latitude	Longitude	year
0	11	Île-de-France	POLYGON ((2.59052 49.07965, 2.59602 49.08171, ...	2010-01-05 16:00:00	-0.5	Athis-Mons	Île-de-France	Essonne	48.716833	2.384333	2010
1	11	Île-de-France	POLYGON ((2.59052 49.07965, 2.59602 49.08171, ...	2010-01-06 01:00:00	-4.4	Athis-Mons	Île-de-France	Essonne	48.716833	2.384333	2010
2	11	Île-de-France	POLYGON ((2.59052 49.07965, 2.59602 49.08171, ...	2010-01-05 01:00:00	-5.6	Athis-Mons	Île-de-France	Essonne	48.716833	2.384333	2010

In [ ]:
```
#Regrouper les moyennes pour chaque region: annee 2010
merged_inner_geo_france_2010 = merged_inner_geo_france[(merged_inner_geo_france["year"] == 2010)].groupby(
    ["nom"]).mean()
```

In [ ]:
```
#Regrouper les moyennes pour chaque region: annee 2022
merged_inner_geo_france_2021 = merged_inner_geo_france[(merged_inner_geo_france["year"] ==2021)].groupby(
    ["nom"]).mean()
```

In [ ]:
```
#Rejoindre le fichier geojson avec la dataframe ???
merged_inner_geo_mean_temp_2010 = pd.merge(
    left=df_france_geo_regions,
    right=merged_inner_geo_france_2010,
    left_on='nom',
    right_on='nom')

merged_inner_geo_mean_temp_2010.head(3)
```

Out[ ]:

	code	nom	geometry	Température (°C)	Latitude	Longitude	year
0	11	Île-de-France	POLYGON ((2.59052 49.07965, 2.59602 49.08171, ...	10.714045	48.716833	2.384333	2010.0
1	24	Centre-Val de Loire	POLYGON ((2.87463 47.52042, 2.87984 47.51671, ...	10.965458	47.250569	1.548940	2010.0
2	27	Bourgogne-Franche-Comté	POLYGON ((3.62942 46.74946, 3.62655 46.75228, ...	10.008969	47.267833	5.088333	2010.0

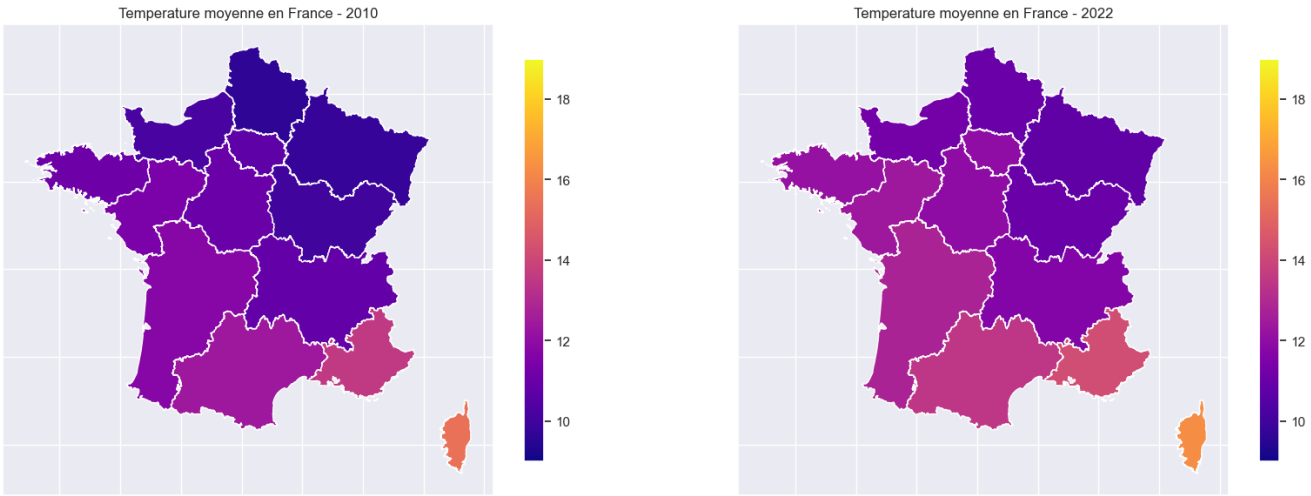
In [ ]:
```
#Rejoindre le fichier geojson avec la dataframe
merged_inner_geo_mean_temp_2021 = pd.merge(
    left=df_france_geo_regions,
    right=merged_inner_geo_france_2021,
    left_on='nom',
    right_on='nom')

merged_inner_geo_mean_temp_2021.head(3)
```

Out[ ]:

	code	nom	geometry	Température (°C)	Latitude	Longitude	year
0	11	Île-de-France	POLYGON ((2.59052 49.07965, 2.59602 49.08171, ...	12.005729	48.716833	2.384333	2021.0
1	24	Centre-Val de Loire	POLYGON ((2.87463 47.52042, 2.87984 47.51671, ...	11.936013	47.251767	1.543863	2021.0
2	27	Bourgogne-Franche-Comté	POLYGON ((3.62942 46.74946, 3.62655 46.75228, ...	11.030992	47.267833	5.088333	2021.0

In [ ]:
```
#Creation de 2 subplots
fig, (ax1, ax2) = plt.subplots(ncols=2,figsize=(20, 20))

#Enlever les valeurs sur les axes pour les 2 subplots
ax1.set_yticklabels([])
ax1.set_xticklabels([])

ax2.set_yticklabels([])
ax2.set_xticklabels([])

#min et max pour la barre
norm = plt.Normalize(vmin=9, vmax=19)

#plot de 2010
merged_inner_geo_mean_temp_2010.plot(column = 'Température (°C)', # colonne
                ax=ax1, # function axes
                cmap = 'plasma', # couleur de la barre
                legend = True,
                legend_kwds={'shrink': 0.3},norm = norm).set(title = "Temperature moyenne en France - 2010")

#plot de 2022
merged_inner_geo_mean_temp_2021.plot(column = 'Température (°C)',
                ax=ax2,
                cmap = 'plasma',
                legend = True,
                legend_kwds={'shrink': 0.3}, norm =norm).set(title = "Temperature moyenne en France - 2022")
```

Out[ ]:
```
[Text(0.5, 1.0, 'Temperature moyenne en France - 2022')]
```



3) CORRELATION AVEC LE CO2

CORRELATION ENTRE LE CHANGEMENT DE LA TEMPERATURE ET L'EMISISON DU CO2

https://ourworldindata.org/co2/country/france?country=FRA~OWID_WRL

In [ ]:
```
##CO2 Emissions
df_3.head(3)
```

Out[ ]:

	Entity	Code	Year	Annual CO_2 emissions
0	Afghanistan	AFG	1949	14656.0
1	Afghanistan	AFG	1950	84272.0
2	Afghanistan	AFG	1951	91600.0

In [ ]:
```
#Emission mondiale
df_3_world = df_3[(df_3["Entity"] == "World")]

#Pour la temperature on utilise la premiere dataframe
df_a_years_meteorological_years_world  = df_1[(df_1["Months"] == "Meteorological year") & (df_1["Area"] == "World")]

df_a_years_meteorological_years_world.head(3)
```

Out[ ]:

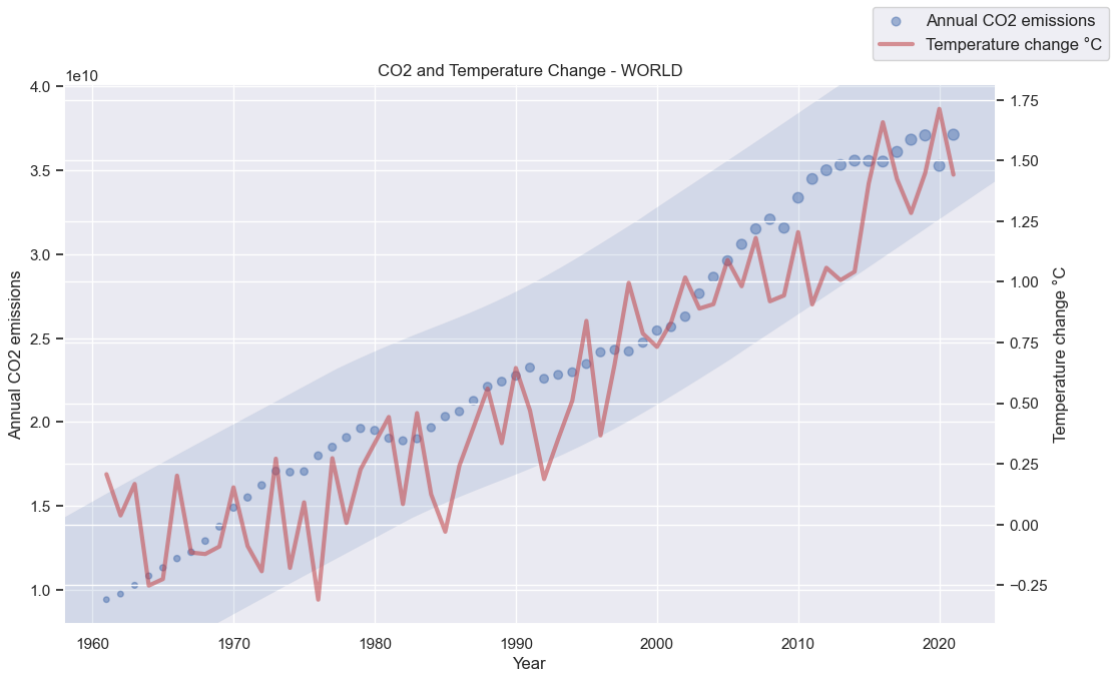
	Domain Code	Domain	Area Code (M49)	Area	Element Code	Element	Months Code	Months	Year Code	Year	Unit	Value	Flag	Flag Description
2013	ET	Temperature change	1	World	7271	Temperature change	7020	Meteorological year	1961	1961	°C	0.207	E	Estimated value
2014	ET	Temperature change	1	World	7271	Temperature change	7020	Meteorological year	1962	1962	°C	0.037	E	Estimated value
2015	ET	Temperature change	1	World	7271	Temperature change	7020	Meteorological year	1963	1963	°C	0.167	E	Estimated value

In [ ]:
```
#Tout est ok
print(df_3_world .isnull().sum())
```

```
Entity                  0
Code                    0
Year                    0
Annual CO₂ emissions    0
dtype: int64
```

In [ ]:
```
#fusionner les 2 dataframe sans perdre les valeurs
df_merged_world = pd.merge(left = df_3_world,
                    right =  df_a_years_meteorological_years_world,
                    left_on = 'Year' ,
                    right_on = 'Year')
df_merged_world.rename(columns={"Value":'Temperature change °C', "Annual CO₂ emissions": "Annual CO2 emissions"},inplace = True)
```

In [ ]:
```
p = plt.figure(figsize=(12,7))

#Premier plot
ax = sb.regplot(data=df_merged_world, x='Year', y="Annual CO2 emissions", fit_reg=True, lowess=True, scatter_kws={'s': df_merged_world['Annual CO2 emissions']/600000000

#fusionner les 2 plots
ax2 = ax.twinx()

#Deuxieme plot
df_merged_world.plot(x="Year", y="Temperature change °C", ylabel="Temperature change °C", ax=ax2, linewidth=3, alpha = 0.6, legend=False, color="r").set(title = "CO2 and
ax.figure.legend(fontsize="medium")

plt.show()
```



4) ANALYSE DE LA CONSOMMATION D'ÉNERGIE RENOUVELABLES ANNUELLES (EN %)

Consommations d'énergies renouvelables annuelles (en %)

https://ourworldindata.org/renewable-energy

In [ ]:
```
#La colonne 'Renewables per capita (kWh - equivalent)' est en effet en MWh
#On devra multiplier la colonne par 1000 pour avoir des valeurs en kWh
df_a.head(3)
```

Out[ ]:

	Entity	Code	Year	Renewables per capita (kWh - equivalent)
0	Africa	NaN	1965	0.128437
1	Africa	NaN	1966	0.139717
2	Africa	NaN	1967	0.142220

In [ ]:
```
#Les pays souhaitées
top_renew_country = ['China','United States',
                     'Brazil','Canada','India','Germany',
                     'Russia','Japan','Norway','Italy']

#La fonction pour garder les donnees de 2010 jusqu'a 2021
def country_df(df):
    dfn = df[(df.Year >= 2010) & (df.Year < 2021)]
    dfn = dfn[dfn.Entity.isin(top_renew_country)]
    dfn.reset_index(drop=True, inplace=True)
    dfn.dropna()
    return dfn
```

In [ ]:
```
renewables = country_df(df_a)
hydro = country_df(df_b)
solar = country_df(df_c)
wind = country_df(df_d)

#fusionnement des 4 dataframes
result = renewables.merge(hydro,on=['Entity', 'Code', 'Year']).merge(solar,on=['Entity', 'Code', 'Year']).merge(wind,on=['Entity', 'Code', 'Year'])

result.head(3)
```

Out[ ]:

	Entity	Code	Year	Renewables per capita (kWh - equivalent)	Hydro per capita (kWh - equivalent)	Solar per capita (kWh - equivalent)	Wind per capita (kWh - equivalent)
0	Brazil	BRA	2010	7.085883	5719.390137	0.000000	30.867586
1	Brazil	BRA	2011	7.284781	5982.458496	0.000000	37.777081
2	Brazil	BRA	2012	7.048717	5714.571289	0.013479	69.481461

In [ ]:
```
r_pct = {'hydro_pct':'Hydro per capita (kWh - equivalent)',\
         'solar_pct':'Solar per capita (kWh - equivalent)',\
         'wind_pct':'Wind per capita (kWh - equivalent)'}
```

```
#ajoute les colonnes des pourcentages de consommation
for pct, cons in r_pct.items():
  result[pct] = result[cons]/(result['Renewables per capita (kWh - equivalent)']*1000)*100     #MWH en kWH

result.head(3)
```

Out[ ]:

	Entity	Code	Year	Renewables per capita (kWh - equivalent)	Hydro per capita (kWh - equivalent)	Solar per capita (kWh - equivalent)	Wind per capita (kWh - equivalent)	hydro_pct	solar_pct	wind_pct
0	Brazil	BRA	2010	7.085883	5719.390137	0.000000	30.867586	80.715274	0.000000	0.435621
1	Brazil	BRA	2011	7.284781	5982.458496	0.000000	37.777081	82.122692	0.000000	0.518575
2	Brazil	BRA	2012	7.048717	5714.571289	0.013479	69.481461	81.072500	0.000191	0.985732

In [ ]:

```
#Le plot de consommation d'energie renouvables
g = sb.PairGrid(result.sort_values("Renewables per capita (kWh - equivalent)", ascending=False),\
                x_vars=['hydro_pct','solar_pct','wind_pct'],\
                y_vars=['Entity'], height=5, aspect=0.75, hue='Year')

#Ajoutté des stripplot
g.map(sb.stripplot, size=8, orient="h", jitter=False,
      palette="flare", linewidth=1, edgecolor="w")
g.set(ylabel='Entity')
plt.legend(loc='lower left',bbox_to_anchor=(-2.45,1.05), ncol=11)
sb.despine(left=True, bottom=True)

x_axis = ["Consommation d'énergie hydroélectrique (%)", "Consommation d'énergie solaire (%)", "Consommation d'énergie éolienne (%)"]
for ax, x_axis in zip(g.axes.flat, x_axis):
    ax.set(xlabel=x_axis)
    ax.xaxis.grid(False)
    ax.yaxis.grid(True)

plt.show()
```