NAME - Raju

In [ ]:

```
pip install wbgapi
```

In [1]:

```
import pandas as pd
import wbgapi as wb
import sklearn
import seaborn as sns
from sklearn.datasets import make_blobs
from numpy import array, exp
import itertools as iter
from sklearn.cluster import KMeans
import matplotlib.pyplot as plt
from scipy.optimize import curve_fit
```

In [2]:

```
ecn_indc = ['NE.DAB.TOTL.ZS','NY.GDP.MKTP.CD']
cod_contry = ["BMU","CHE",'DNK','BGR','BGD','ARG','GBR','IND','BRA','JAM']
cli_indc=['EG.ELC.RNWX.KH','EN.ATM.CO2E.GF.KT']
ecn_data  = wb.data.DataFrame(ecn_indc, cod_contry, mrv=7)
cli_data  = wb.data.DataFrame(cli_indc, cod_contry, mrv=7)
#NE.DAB.TOTL.ZS: Total expenditure
#NY.GDP.MKTP.CD: USD GDP of a country
#EG.ELC.RNWX.KH:        Electricity production from renewable sources %
#EN.ATM.CO2E.GF.KT: Emissions of Carbon dioxide from fuel
```

In [3]:

```
# ECNMY INDICATOR
ecn_data.columns = [b.replace('YR','') for b in ecn_data.columns]
ecn_data=ecn_data.stack().unstack(level=1)
ecn_data.index.names = ['Ctry_Code', 'Year']
ecn_data.columns
ecn_data.fillna(0)
ecn_data.head(9)
```

Out[3]:

	series	NE.DAB.TOTL.ZS	NY.GDP.MKTP.CD
Ctry_Code	**Year**		
ARG	**2014**	99.595836	5.263197e+11
	2015	101.074922	5.947493e+11
	2016	101.039698	5.575314e+11
	2017	102.649034	6.436287e+11
	2018	101.889164	5.248197e+11
	2019	96.994042	4.519324e+11
	2020	93.070816	3.892881e+11
BGD	**2014**	106.487933	1.728855e+11
	2015	106.728219	1.950787e+11

In [4]:

```
# CLMATE INDICATOR
cli_data.columns = [c.replace('YR','') for c in cli_data.columns]
cli_data=cli_data.stack().unstack(level=1)
cli_data.index.names = ['Ctry_Code', 'Year']
```

```
cli_data.columns
cli_data.fillna(0)
cli_data.head(9)
```

Out[4]:

	series	EG.ELC.RNWX.KH	EN.ATM.CO2E.GF.KT
Ctry_Code	**Year**		
ARG	**2010**	2.220000e+09	86999.575
	2011	2.155000e+09	92661.423
	2012	2.752000e+09	95459.344
	2013	2.942000e+09	90835.257
	2014	2.719000e+09	96691.456
	2015	2.752000e+09	98359.941
	2016	NaN	102268.963
BGD	**2010**	0.000000e+00	39431.251
	2011	0.000000e+00	39658.605

In [5]:

```
#Preprtion of the data
dfrm1=ecn_data.reset_index()
dfrm3=dfrm1.fillna(0)
dfrm2=cli_data.reset_index()
dfrm4=dfrm2.fillna(0)
```

In [6]:

```
#Getting the indicators for all the countries
dfrm = pd.merge(dfrm3, dfrm4)
dfrm.head(10)
```

Out[6]:

series	Ctry_Code	Year	NE.DAB.TOTL.ZS	NY.GDP.MKTP.CD	EG.ELC.RNWX.KH	EN.ATM.CO2E.GF.KT
0	ARG	2014	99.595836	5.263197e+11	2.719000e+09	96691.456
1	ARG	2015	101.074922	5.947493e+11	2.752000e+09	98359.941
2	ARG	2016	101.039698	5.575314e+11	0.000000e+00	102268.963
3	BGD	2014	106.487933	1.728855e+11	1.490000e+08	45969.512
4	BGD	2015	106.728219	1.950787e+11	1.580000e+08	48782.101
5	BGD	2016	104.674816	2.214152e+11	0.000000e+00	53593.205
6	BGR	2014	101.085516	5.708201e+10	2.783000e+09	5412.492
7	BGR	2015	99.100768	5.078200e+10	3.107000e+09	5944.207
8	BGR	2016	95.092863	5.395390e+10	0.000000e+00	6153.226
9	BMU	2014	73.926721	6.413988e+09	0.000000e+00	0.000

In [7]:

```
#Normalization of the dfrm values
df1 = dfrm.iloc[:,2:]
dfrm.iloc[:,2:] = (df1-df1.min())/ (df1.max() - df1.min())
dfrm.head(7)
```

Out[7]:

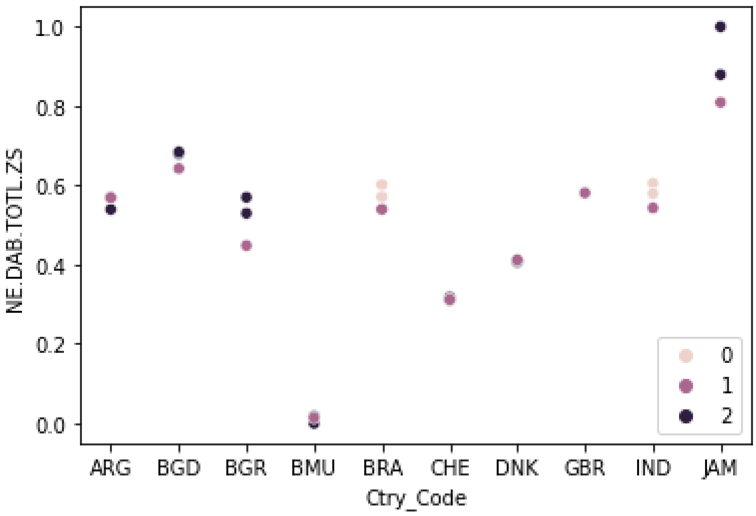
series	Ctry_Code	Year	NE.DAB.TOTL.ZS	NY.GDP.MKTP.CD	EG.ELC.RNWX.KH	EN.ATM.CO2E.GF.KT
0	ARG	2014	0.539749	0.168759	0.035192	0.608272
1	ARG	2015	0.569823	0.190971	0.035619	0.618769
2	ARG	2016	0.569107	0.178891	0.000000	0.643360
3	BGD	2014	0.679885	0.054036	0.001929	0.289188
4	BGD	2015	0.684771	0.061240	0.002045	0.306881
5	BGD	2016	0.643019	0.069789	0.000000	0.337147
6	BGR	2014	0.570039	0.016447	0.036020	0.034049

In [8]:

```
#K-means type clustering
df2 = dfrm.drop('Ctry_Code', axis = 1)
kmens = KMeans(n_clusters=3, init='k-means++', random_state=0).fit(df2)
```

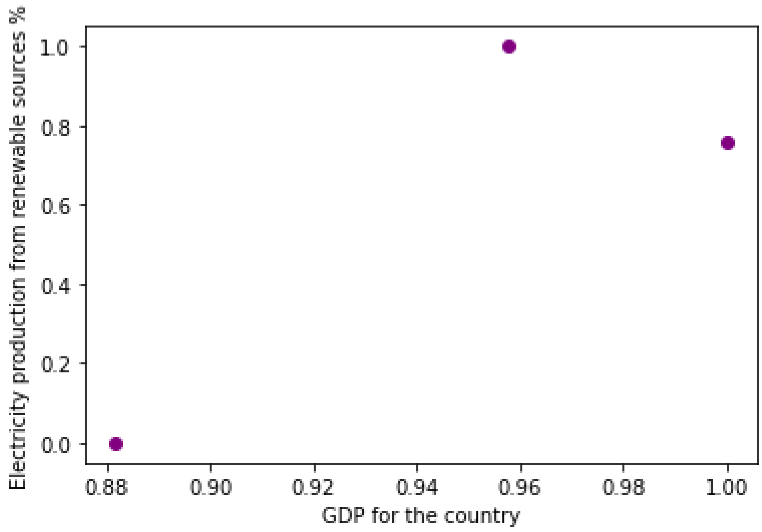
In [9]:

```
#Clustering the value of total expenditure for different countries
sns.scatterplot(data=dfrm, x="Ctry_Code", y="NE.DAB.TOTL.ZS", hue=kmens.labels_)
plt.legend(loc='lower right')
plt.show()
```



In [10]:

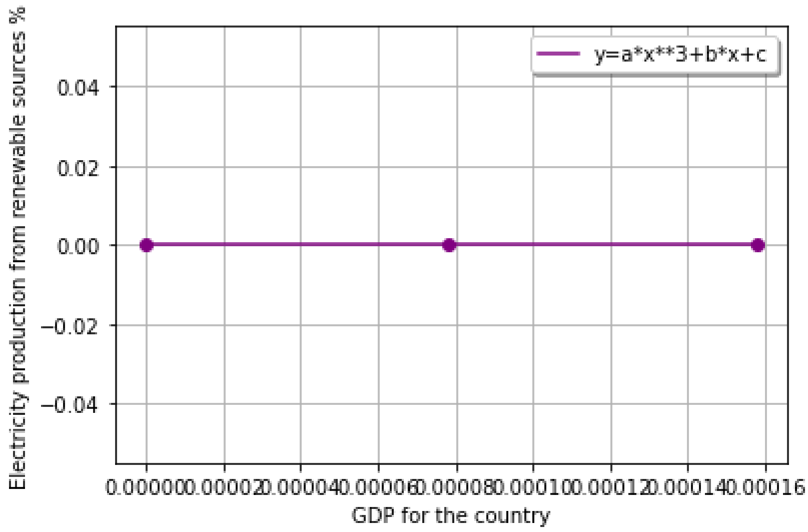
```
#Scatter plot - Electricity production from renewable sources % vs GDP in GBR

a=dfrm[(dfrm['Ctry_Code']=='GBR')]
b = a.values
x, y = b[:, 3], b[:, 4]
plt.scatter(x, y,color="purple")
plt.xlabel('GDP for the country')
plt.ylabel('Electricity production from renewable sources %')
plt.show()
```



In [13]:

```
#Using curve_fit to do the fitting for Bermuda which has a low total expenditure
e=dfrm[(dfrm['Ctry_Code']=='BMU')]
f = e.values
x, y = f[:, 3], f[:, 4]

def func(x, a, b, c):
    return a*x**3+b*x+c
pmtr, cova = curve_fit(func, x, y)
pmtr, _ = curve_fit(func, x, y)
print("Parameters value->: ", pmtr)

a, b, c = pmtr[0], pmtr[1], pmtr[2]
yfit =a*x**3+b*x+c

import warnings

with warnings.catch_warnings(record=True):
    plt.plot(x, yfit, label="y=a*x**3+b*x+c",color="purple")
    plt.grid(True)
    plt.xlabel('GDP for the country')
    plt.legend(loc='best', fancybox=True, shadow=True)
    plt.plot(x, y, 'bo', label="Y orgnl value",color="purple")
    plt.ylabel('Electricity production from renewable sources %')
    plt.show()
```

```
Parameters value->:  [ 1.52839034e-305  6.62013102e-313 -7.44535683e-317]
C:\Users\alekh\anaconda3\lib\site-packages\scipy\optimize\minpack.py:833: OptimizeWarning: C
ovariance of the parameters could not be estimated
  warnings.warn('Covariance of the parameters could not be estimated',
```

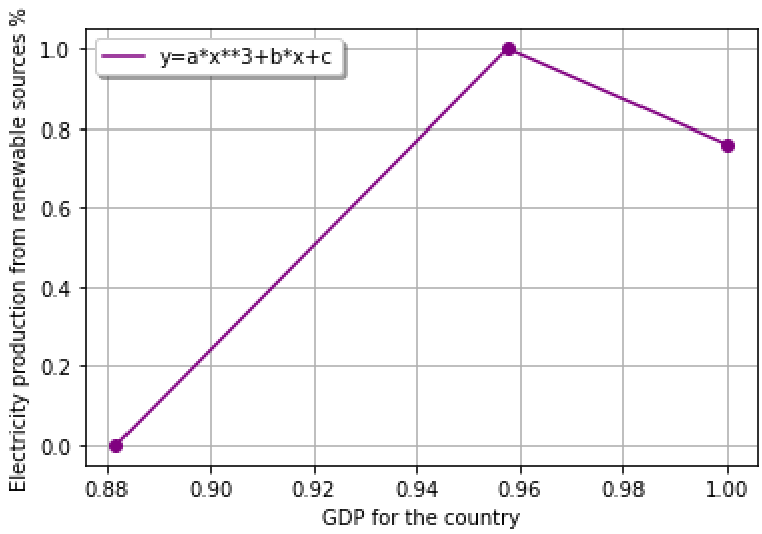


In [11]:

```
#Using curve_fit to do the fitting for GBR which has a medium total expenditure
x, y = b[:, 3], b[:, 4]

def func(x, a, b, c):
    return a*x**3+b*x+c
pmtr, cova = curve_fit(func, x, y)
pmtr, _ = curve_fit(func, x, y)
print("Parameters value->: ", pmtr)

a, b, c = pmtr[0], pmtr[1], pmtr[2]
yfit =a*x**3+b*x+c

import warnings

with warnings.catch_warnings(record=True):
    plt.plot(x, yfit, label="y=a*x**3+b*x+c",color="purple")
    plt.grid(True)
    plt.xlabel('GDP for the country')
    plt.legend(loc='best', fancybox=True, shadow=True)
    plt.plot(x, y, 'bo', label="Y orgnl value",color="purple")
    plt.ylabel('Electricity production from renewable sources %')
    plt.show()
```

```
Parameters value->:  [-56.14217118 155.71842561 -98.81657956]
```

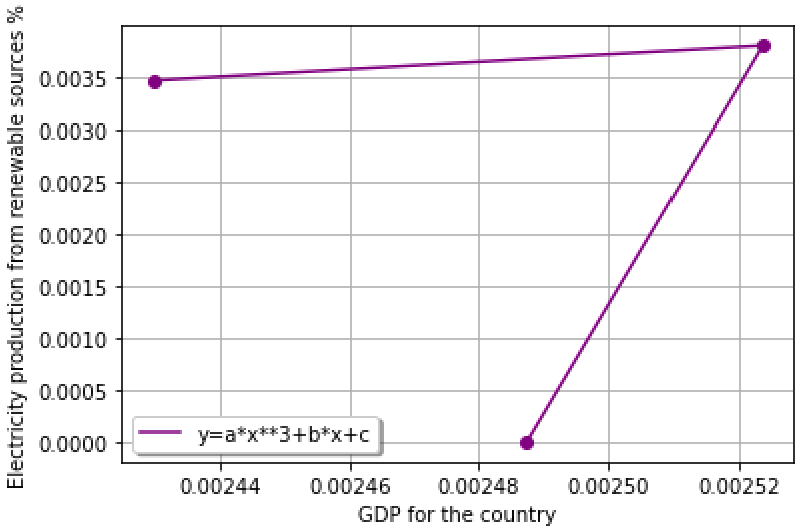
```
C:\Users\alekh\anaconda3\lib\site-packages\scipy\optimize\minpack.py:833: OptimizeWarning: C
ovariance of the parameters could not be estimated
  warnings.warn('Covariance of the parameters could not be estimated',
```



In [14]:
```
#Using curve_fit to do the fitting for Jamaica which has a high total expenditure
h=dfrm[(dfrm['Ctry_Code']=='JAM')]
j = h.values
x, y = j[:, 3], j[:, 4]

def func(x, a, b, c):
    return a*x**3+b*x+c
pmtr, cova = curve_fit(func, x, y)
pmtr, _ = curve_fit(func, x, y)
print("Parameters value->: ", pmtr)

a, b, c = pmtr[0], pmtr[1], pmtr[2]
yfit =a*x**3+b*x+c

import warnings

with warnings.catch_warnings(record=True):
    plt.plot(x, yfit, label="y=a*x**3+b*x+c",color="purple")
    plt.grid(True)
    plt.xlabel('GDP for the country')
    plt.legend(loc='best', fancybox=True, shadow=True)
    plt.plot(x, y, 'bo', label="Y orgnl value",color="purple")
    plt.ylabel('Electricity production from renewable sources %')
    plt.show()
```

```
Parameters value->:  [ 2.35676711e+08 -4.33389209e+03  7.15307227e+00]
```

```
C:\Users\alekh\anaconda3\lib\site-packages\scipy\optimize\minpack.py:833: OptimizeWarning: C
ovariance of the parameters could not be estimated
  warnings.warn('Covariance of the parameters could not be estimated',
```



It can be understood from the visualisations that the country with a high total expenditure has a direct relationship between GDP of the country and the electricity production from renewable sources %. For the country with a medium total expenditure, the relationship between GDP of the country and the electricity production from renewable sources % is direct till a certain GDP and after than it becomes indirect. For the country with a low total expenditure, the relationship between GDP of the country and the electricity production from renewable sources % is parallel to x axis

In [12]:
```
def err_ranges(x, func, param, sigma):

    # initiate arrays for lower and upper limits
    lower = func(x, *param)
    upper = lower
```

```
    uplow = []   # list to hold upper and lower limits for parameters
    for p,s in zip(param, sigma):
        pmin = p - s
        pmax = p + s
        uplow.append((pmin, pmax))

    pmix = list(iter.product(*uplow))

    for p in pmix:
        y = func(x, *p)
        lower = np.minimum(lower, y)
        upper = np.maximum(upper, y)

    return lower, upper
```

In [ ]:

In [ ]: