



DIVE INTO CODE

MACHINE LEARNING
GRADUATION ASSIGNMENT

PROJECT

ELECTRICITY POWER CONSUMPTION

THE CODE LINK FOR MY PROJECT

<https://github.com/Mosesalieubangura/Github-code-url.git>

SELF INTRODUCTION

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LEVEL: YEAR 3

COURSE: DIVE INTO CODE (DIC)

PROJECT: ELECTRICITY POWER CONSUMPTION

ELECTRICITY POWER CONSUMPTION

Electricity power consumption has been growing rapidly in spite of serious supply constraints caused by delays in implementing new capacity additions, lower utilization of existing capacity due to maintenance problems, coal and oil availability, and draught conditions (in 1979-80), which simultaneously reduced hydro energy availability and increased agricultural demand for lift irrigation.

ENERGY CONSUMPTION IN SIERRA LEONE

The most important measure in the energy balance of Sierra Leone is the total consumption of 279.00 m kWh of electric energy per year. Per capita this is an average of **35 kWh**.

Sierra Leone can provide itself completely with self-produced energy. The total production of all electric energy producing facilities is 300 m kWh, also 108% of own requirements. The rest of the self-produced energy is either exported into other countries or unused. Along with pure consumptions the production, imports and exports play an important role. Other energy sources such as natural gas or crude oil are also used.

ENERGY BALANCE

Electricity	total	Sierra Leone per capita	USA per capita
Own consumption	279.00 m kWh	34.98 kWh	11,842.76 kWh
Production	300.00 m kWh	37.61 kWh	12,428.52 kWh

CARBON FOOTPRINT

	CO2 emissions in 2018	Sierra Leone per capita	USA per capita total
Total	1.02 m t	0.13 t	15.12 t

Development of CO2 emissions from 1979 to 2018 in million tons



Production capacities per energy source

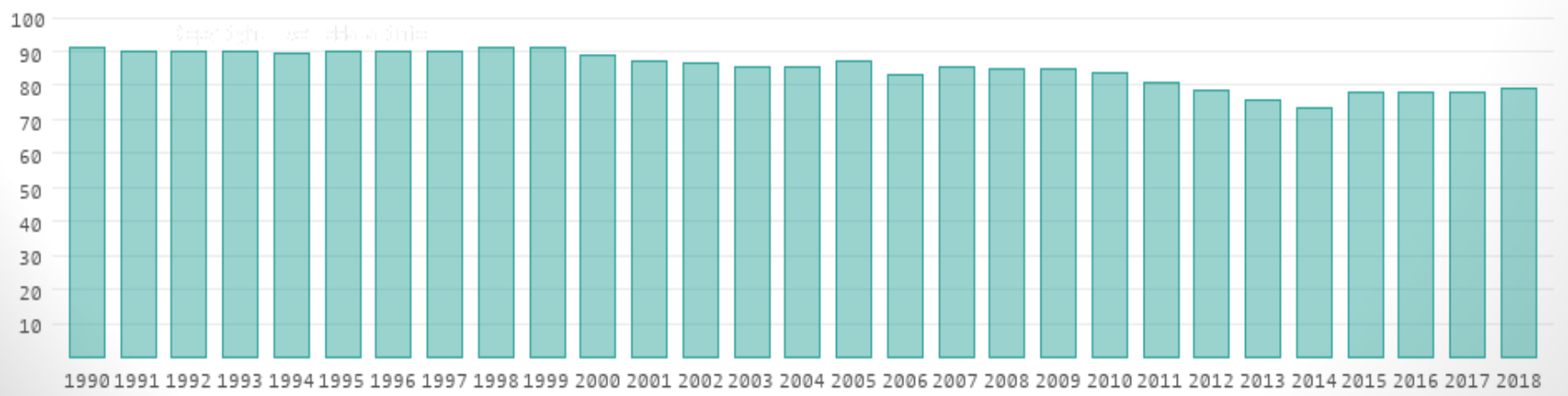
The given production capacities for electric energy have a theoretical value, which could only be obtainable under ideal conditions. They are measuring the generatable amount of energy, that would be reached under permanent and full use of all capacities of all power plants. In practice this isn't possible, because e.g. solar collectors are less efficient under clouds. Also wind- and water-power plants are not always operating under full load. All these values are only useful in relation to other energy sources or countries.

Energy source	total in Sierra Leone	percentage in Sierra Leone	percentage USA	per capita in Sierra Leone	per capita USA
Fossil fuels	228.28 m kWh	23,0 %	70,0 %	28.62 kWh	20,230.06 kWh
Nuclear power	0.00 kWh	0,0 %	9,0 %	0.00 kWh	2,601.01 kWh
Water power	506.18 m kWh	51,0 %	7,0 %	63.45 kWh	2,023.01 kWh
Renewable energy	258.05 m kWh	26,0 %	14,0 %	32.35 kWh	4,046.01 kWh
Total production capacity	992.51 m kWh	100,0 %	100,0 %	124.42 kWh	28,900.09 kWh
Actual total production	300.00 m kWh	30.2 %	43.0 %	37.61 kWh	12,428.52 kWh

Usage of renewable energies

Renewable energies include wind, solar, biomass and geothermal energy sources. This means all energy sources that renew themselves within a short time or are permanently available. Energy from hydropower is only partly a renewable energy. This is certainly the case with river or tidal power plants. Otherwise, numerous dams or reservoirs also produce mixed forms, e.g. by pumping water into their reservoirs at night and recovering energy from them during the day when there is an increased demand for electricity. Since it is not possible to clearly determine the amount of generated energy, all energies from hydropower are displayed separately.

In 2018, renewable energies accounted for around 79.6 percent of actual total consumption in Sierra Leone. The following chart shows the percentage share from 1990 to 2018:



POWER CONSUMPTION IN SIERRA LEONE

Sierra Leone consumed **13,386,542,000 BTU** (0.01 quadrillion BTU) of energy in 2017.

This represents **0.00%** of global energy consumption.

Sierra Leone **produced 1,234,542,000 BTU** (0.00 quadrillion BTU) of energy, covering **9%** of its annual energy consumption needs.

NON RENEWABLE (FOSSIL FUELS)

Power Consumption

94%

12,576,000,000BTU

Oil: 12,576,000,000 BTU (94%)

Oil Reserves, Years left, Production, Consumption, Imports/Exports

Gas: 0 BTU (0%)

Natural Gas Reserves, Years left, Production, Consumption, Imports/Exports

Coal: 0 BTU (0%)

-Reserves, Years left, Production, Consumption, Imports/Exports

RENEWABLE AND NUCLEAR

Power Consumption

6%

1,234,542,000

ENERGY SITUATION / STATISTICS

Energy statistics are difficult to obtain in Sierra Leone, especially for renewable energy. Although the conventional thermal energy production and consumption patterns have been reported, no consolidated set of statistics exists for the total Energy situation of Sierra Leone.

This is also reflected in international reports, such as the “Renewable Energy Statistics 2017” report by IRENA, where the solar power capacity for Sierra Leone is claimed to be 0MW.

OVERALL ENERGY USE

- ♦80% Biomass (mainly for cooking): Wood and Charcoal
- ♦13% Petroleum products (mainly for transport, lighting and private energy generation, all petroleum is imported)
- ♦Grid connected energy accounts for the remaining energy
- ♦Most of the energy is used in households

Sector	Biomass		Petroleum Products	Electricity (Grid Connected) (Thermal, Hydro etc.)	Total %
	Fuelwood	Charcoal			
Agriculture, Forestry, Fishing	1%	-	5%	2%	2%
Mining	-	-	9%	1%	2.5%
Industry/Commercial	3%	10%	12%	60%	21%
Transport	-	-	49%	-	12%
Household/Residents	96%	90%	25%	37%	62.5%
Total	100%	100%	100%	100%	100%

Source: Ministry of Agriculture and Food Security (2012), PMU (2012), MEWR and NPA-BKPS (2012).

RENEWABLE ENERGY

The country possesses vast potential in renewable energy in the form of biomass from agricultural wastes, hydro and solar power, which remain virtually untapped.”^[2]

According to the “Renewable Energy Statistics 2017” report by IRENA is a total capacity of 88 MW of Renewable Energy in the country, of which 56 MW are Hydro Power and 33 MW Bioenergy. However, as lined out above, data are incomplete. For example, Solar Energy is not included in the statistics.

According to the Ministry of Energy, the share of Renewables was 78,4% in 2013.

HYDRO POWER

In Sierra Leone, hydropower is a major energy source, holding great promise for a country which possesses several rivers that could be exploited for electricity.

According to the German Bundesministerium für Wirtschaft und Energie, there is potential for 2.000MW of hydro power. Faktsheet Republik Sierra Leone. According to the German Bundesministerium für Wirtschaft und Energie, there is potential for 2.000MW of hydro power. Faktsheet Republik Sierra Leone optimistic studies are the Power Sector Master Plan (1996), identifying 27 potential hydropower sites with a total capacity of 1,513 MW. And a study conducted by UNIDO (Hydropower Potentials in Sierra Leone, UNIDO, 2013) that estimates hydropower potentials to about 5,000 MW covering 300 sites nationwide.

SOLAR ENERGY

In February 2017 Sierra Leone was the first African country to sign the "Energy Africa Policy Compact" with the Government of the UK. As part of the compact, the Energy Revolution initiative was launched, committing to reach 250.000 households with modern energy solutions by 2018. A task force was established and within government and private sector the focus shifted notably to renewable energy, especially solar energy.

BIOMASS

Energy consumption in Sierra Leone is dominated by biomass, which accounts for over 80% of energy used. The largest source of biomass energy is wood fuel followed by charcoal^[5], while the use of agricultural crop residues and bagasse in the sugar industry remains limited. In addition, there is considerable potential (without impacting on food production) to produce bio-fuels from energy crops such as maize and cassava, and processing of charcoal into biochar.

WIND ENERGY

Sierra Leone's best wind velocities indicate a country-wide average of between 3 m/s and 5 m/s, increasing to approximately 8 m/s in some mountainous areas (Metrological Statistics, 2012). There is some indication that wind speeds of 12 m/s are possible in parts of the country, implying that wind energy could be a viable option in selected locations. Wind farms are for instance possible at certain locations such as along the coast line, at sea near the coast line and at some locations in the country.

With the low wind speed turbines now available in the market, there is a strong potential for the use of these systems in the rural areas especially in the north of the country. There is a known wind energy system of 5kw in Sierra Leone, located in the Bonthe District, along the south coastline area.

POLICY FRAMEWORK, LAWS AND REGULATIONS

The main recently ratified laws, regulations and compacts, concerning the Energy Sector, with a focus on Renewables at a glimpse are:

- The [National Electricity Act 2011](#) one of the biggest recent changes in the Electricity Sector in Sierra Leone, unbundling the vertically integrated National Power Authority, that was created by an Act of Parliament in 1982, into two entities, the Electricity Generation and Transmission Company (EGTC) and the Electricity Distribution and Supply Authority (EDSA). Furthermore, through the Electricity and Water Regulatory Act 2011, a regulatory body, the Energy and Water Regulatory Commission was established.
- The Sustainable Energy for All (SE4ALL) Action Agenda for Sierra Leone. The Action Agenda was part of an 2014 agreement of ECOWAS member states, that agreed on the development of National Renewable Energy Action Plans (NREAPs) and SE4ALL Agendas. In its agendas, Sierra Leone outlined goals, such as the electrification of all district headquarter towns, increased installed power capacity, 1.229MW in 2030, increased access to Renewable off-grid solutions, but also objectives such as increased access to improved cooking technologies or improved charcoal production. The goals are outlined for 2020 and 2030 respectively.
- The [Energy Africa Policy Compact](#). In February 2016, Sierra Leone was the first African country to sign the Energy Africa Policy Compact with the Government of the UK. As a result, the Government of Sierra Leone launched the Energy Revolution, a government-led initiative to promote the solar home system market with activities in the areas of Demand Creation, Technical Assistance for Businesses, Policy Reform and Access to Finance. The initiative is committing to reach 250,000 households with modern solar solutions by 2018 and achieve 'Power for All' by 2025. A DFID financed [Power for All Campaign](#) launched and a "Energy Task Force Meeting" established.
- The [Finance Act, 2017.pdf 2017 Finance Act](#) Duty Waivers for imported solar products that fulfill IEC Standards. In practice, it is difficult for private companies to impose the measures, due to unclear administrative processes and long delays.
- The [Energy policy of SL FINAL for Print.pdf Renewable Energy Policy of Sierra Leone](#) the [Energy Efficiency Policy of Sierra Leone](#), ratified by the Parliament in 2016 and launched in 2018, outlining the status of Renewable Energy in the country and objectives and measurements in the sector.
- In August 2017 the Millenium Challenge Coordinating Unit (MCCU), together with the Ministry of Energy, launched the "Electricity Sector Reform Roadmap 2017-2030", with a vision for the Electricity Sector up to 2030.
- The [National Energy Policy 2009](#) reviewed but still needs ratification, as of beginning of 2018.

INSTITUTIONAL SET UP IN THE ENERGY SECTOR

Some observations on the institutional set up of the (Renewable) Energy Sector in Sierra Leone are:

- The power sector has been unbundled into distinct actors for generation and transmission and for distribution and retail: The National Electricity Act 2011 "the vertically integrated National Power Authority into the Electricity Generation and Transmission Company (EGTC) and the Electricity Distribution and Supply Authority (EDSA). Furthermore, through the Electricity and Water Regulatory Act 2011, a regulatory body, the Energy and Water Regulatory Commission was established.
- There is no separate Rural Electrification Agency. The Ministry of Energy has a Renewable Energy Department and works closely with the President's Recovery Priorities team. One of the priority sectors is Energy, with the key objectives to double access to electricity from 125,000 to 250,000 households and double the operational power generation capacity from 75MW to 150MW.
- Following the launch of the Energy Revolution, the private sector association Renewable Energy Association of Sierra Leone (REASL) founded, comprising of approx. 30 members in the beginning of 2018.
- There are three Government Learning Institutions that offer courses in Renewable Energy, the Government Technical Institute in Freetown, Kissy Dockyards, the Government Technical Institute in Magburaka and the Eastern Polytechnic in Kenema.

KEY PROBLEMS OF THE ENERGY SECTOR

- **Financing/Investment:** lack of private investments, lack of economic incentives, support and implementation for PAYGO availability necessary, microfinance should be available for solar businesses, no fully functioning mobile money platform exists
- **Enabling Legal Framework:** Need for clear regulations of private sector participation in electricity generation, need for mini-grid licensing and concessions, need for standardized Power Purchase Agreements (PPAs), need for less bureaucratic process of receiving tax / duty waivers for private companies importing certified solar products, no Rural Electrification Agency exists
- **Infrastructure and Services:** Transmission and distribution infrastructure need to be improved, most parts of the country have no access to any grid, many distribution lines were destroyed during the civil war, old equipment is in place and needs to be replaced, poor energy efficiency, the existing network is very old and there are immense power losses in the generation, transmission and distribution, [\(40% transmission losses\)](#), generation capacity does not cover the demand, especially in the industry many companies are forced to rely on diesel generators, service standards of EDSA are poor, use of inefficient cook stoves / 3-stone-fires and kerosene lights/battery torches
- **Lack of accurate data:** lack of data collection in the energy sector, absence of detailed research
- **Lack of awareness:** Missing awareness on quality standards for solar, especially PicoPV products, missing awareness on Improved Cook Stoves, missing awareness on environmental benefits (climate change, health etc.) of solar and improved cook stoves, recycling programme for old batteries necessary

AM TRYING TO PREDICT THE DATASET OF ELECTRICITY POWER CONSUMPTION IN SIERRA LEONE

```
In 1  import numpy as np # linear algebra
import pandas as pd # data processing, CSV file I/O (e.g. pd.read_csv)

import os
for dirname, _, filenames in os.walk('/kaggle/input'):
    for filename in filenames:
        print(os.path.join(dirname, filename))
```

```
/kaggle/input/electricity-consumption/train.csv
/kaggle/input/electricity-consumption/test.csv
```

```
In 2  !pip install DataScienceHelper
```

```
Collecting DataScienceHelper
```

```
  Downloading datasciencehelper-1.5.2.tar.gz (6.4 kB)
```

```
Building wheels for collected packages: DataScienceHelper
```

```
  Building wheel for DataScienceHelper (setup.py) ... done
```

```
  Created wheel for DataScienceHelper: filename=datasciencehelper-1.5.2-py3-none-any.whl size=5727
sha256=6aaeddf275658cdbca7b7f0564ea1b409583a584d2286b32b46d052c0b3399ae
```

```
  Stored in directory: /root/.cache/pip/wheels/49/5e/d2/84a664218a270ce173c1d02086f556367a00002afe0
aae6409
```

```
Successfully built DataScienceHelper
```

```
Installing collected packages: DataScienceHelper
```

```
Successfully installed DataScienceHelper-1.5.2
```

In 3 `!pip install --upgrade pip`

```
Collecting pip
  Downloading pip-20.2.2-py2.py3-none-any.whl (1.5 MB)
  | 1.5 MB 402 kB/s eta 0:00:01
Installing collected packages: pip
  Attempting uninstall: pip
    Found existing installation: pip 20.2.1
    Uninstalling pip-20.2.1:
      Successfully uninstalled pip-20.2.1
  Successfully installed pip-20.2.2
```

In 4

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import DataScienceHelper as dsh
import plotly.express as px
from sklearn.model_selection import train_test_split
from sklearn.metrics import accuracy_score
```

```
%matplotlib inline
```

In 5

```
import time
from datetime import datetime
import re
from math import *
```

In 6

```
data = pd.read_csv("/kaggle/input/electricity-consumption/train.csv")  
data.head()
```

Out 6

ID	datetime	temperature	var1	pressure	windspeed	var2	electricity_consumption	
0	0	2013-07-01 00:00:00	-11.4	-17.1	1003.0	571.910	A	216.0
1	1	2013-07-01 01:00:00	-12.1	-19.3	996.0	575.040	A	210.0
2	2	2013-07-01 02:00:00	-12.9	-20.0	1000.0	578.435	A	225.0
3	3	2013-07-01 03:00:00	-11.4	-17.1	995.0	582.580	A	216.0
4	4	2013-07-01 04:00:00	-11.4	-19.3	1005.0	586.600	A	222.0

In 7 data.tail()

Out 7

ID	datetime	temperature	var1	pressure	windspeed	var2	electricity_consumption	
26491	34891	2017-06-23 19:00:00	-0.7	-15.0	1009.0	51.685	A	225.0
26492	34892	2017-06-23 20:00:00	-2.9	-11.4	1005.0	56.105	A	213.0
26493	34893	2017-06-23 21:00:00	-1.4	-12.9	995.0	61.275	A	213.0
26494	34894	2017-06-23 22:00:00	-2.9	-11.4	996.0	67.210	A	210.0
26495	34895	2017-06-23 23:00:00	-2.1	-11.4	1009.0	71.880	A	210.0

In 8 data.isnull().sum()

Out 8

```
ID          0
Datetime    0
temperature  0
var1         0
pressure     0
windspeed   0
var2         0
electricity_consumption  0
dtype: int64
```

In 9 data.describe()

Out 9

ID	temperature	var1	pressure	windspeed	electricity_consumption	
count	26496.000000	26496.000000	26496.000000	26496.000000	26496.000000	26496.000000
mean	17455.500000	5.098989	-1.916233	986.450615	23.959956	298.359601
std	10122.873673	8.682860	10.424860	12.002647	48.280321	108.020555
min	0.000000	-17.100000	-32.900000	953.000000	1.075000	174.000000
25%	8717.750000	-2.900000	-10.700000	978.000000	3.155000	219.000000
50%	17435.500000	6.400000	-1.400000	986.000000	6.545000	267.000000
75%	26177.250000	12.100000	7.900000	995.000000	22.260000	342.000000
max	34895.000000	23.600000	18.600000	1024.000000	586.600000	1386.000000

In 10 data.count()

Out 10

```
ID 26496 datetime          26496
temperature                26496
var1                       26496
pressure                   26496
windspeed                  26496
var2                       26496
electricity_consumption    26496
dtype: int64
```


In 11 data.info()

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 26496 entries, 0 to 26495
Data columns (total 8 columns):
#      Column                                Non-Null Count  Dtype
---  -
0      ID                                26496 non-null  int64
1      datetime                        26496 non-null  object
2      temperature                    26496 non-null  float64
3      var1                          26496 non-null  float64
4      pressure                      26496 non-null  float64
5      windspeed                    26496 non-null  float64
6      var2                          26496 non-null  object
7      electricity_consumption  26496 non-null  float64
dtypes: float64(5), int64(1), object(2)
memory usage: 1.6+ MB
```

In 12 data.memory_usage()

Out 12

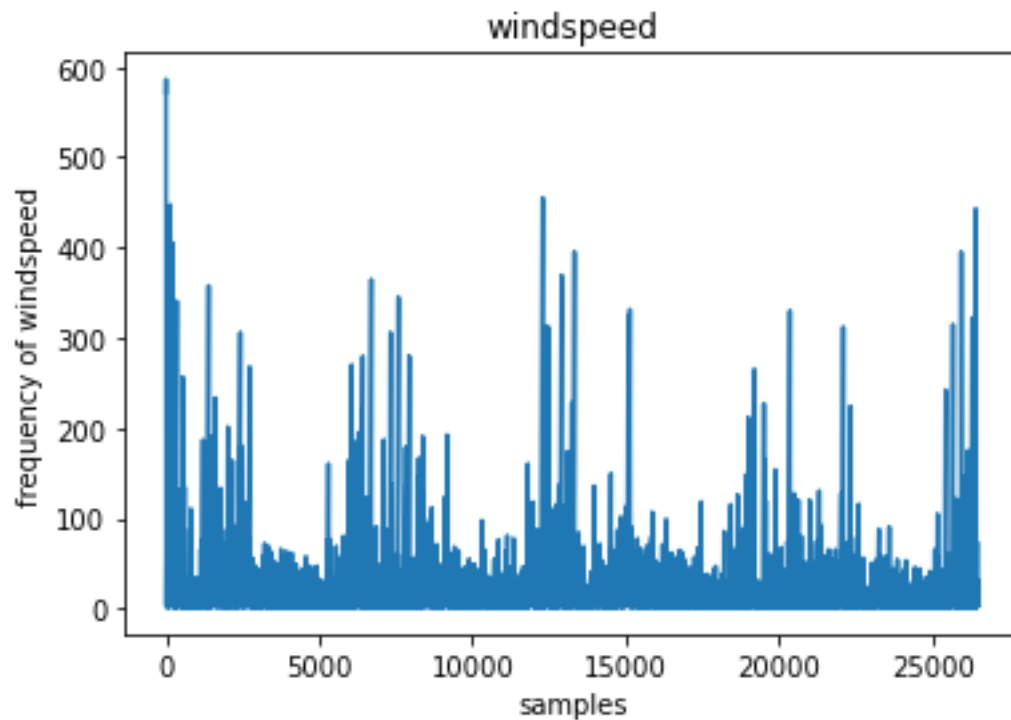
```
Index          128
ID            211968
datetime       211968
temperature    211968
var1           211968
pressure       211968
windspeed      211968
var2           211968
electricity_consumption 211968
dtype: int64
```

In 13 data.windspeed.value_counts()

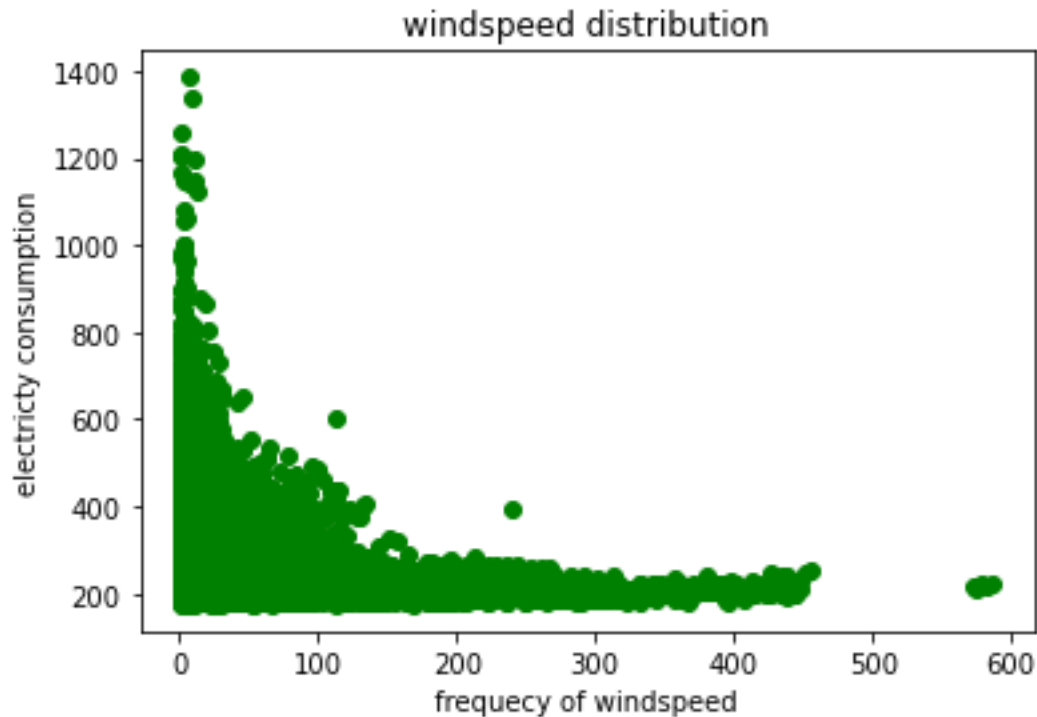
Out 13

```
2.265          380
1.890          369
2.015          359
2.390          354
2.140          347
...
318.210         1
123.435         1
282.485         1
160.465         1
27.825          1
Name: windspeed, Length: 5603, dtype: int64
```

```
In 14  plott = data.windspeed  
       plt.plot(plott)  
       plt.xlabel("samples")  
       plt.ylabel("frequency of windspeed")  
       plt.title("windspeed")  
       plt.show()
```



```
In 15 plt.scatter(data.windspeed,data.electricity_consumption,c='green')  
plt.xlabel("frequency of windspeed")  
plt.ylabel("electricity consumption")  
plt.title("windspeed distribution")  
plt.show()
```



```
In16  average = round(data.windspeed.mean(),3)
      max_windspeed = round(max(data.windspeed),3)
      min_windspeed = round(min(data.windspeed),3)
      print(f'The average windspeed is : {average} ')
      print(f'The maximum windspeed is : {max_windspeed}')
      print(f'The minimum windspeed is : {min_windspeed}')
```

The average windspeed is : 23.96

The maximum windspeed is : 586.6

The minimum windspeed is : 1.075

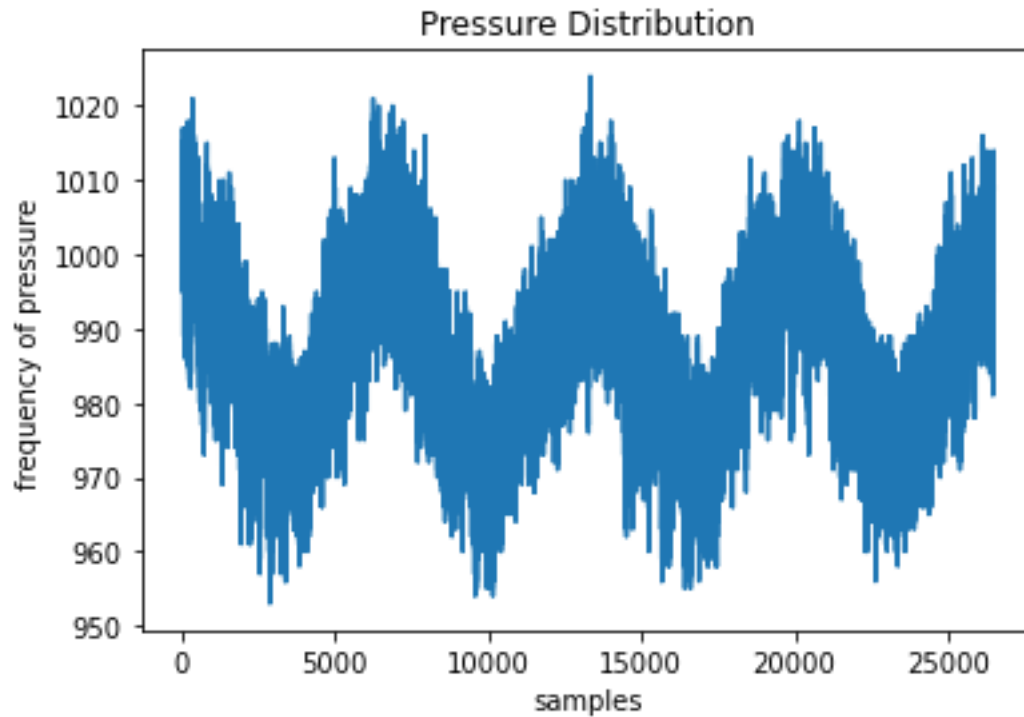
```
In17  avg_pressure = round(data.pressure.mean(),3)
      max_pressure = round(data.pressure.max(),3)
      min_pressure = round(data.pressure.min(),3)
      print(f'The average pressure is : {avg_pressure}')
      print(f'The maximum pressure is : {max_pressure}')
      print(f'The minimum pressure is : {min_pressure}')
```

The average pressure is : 986.451

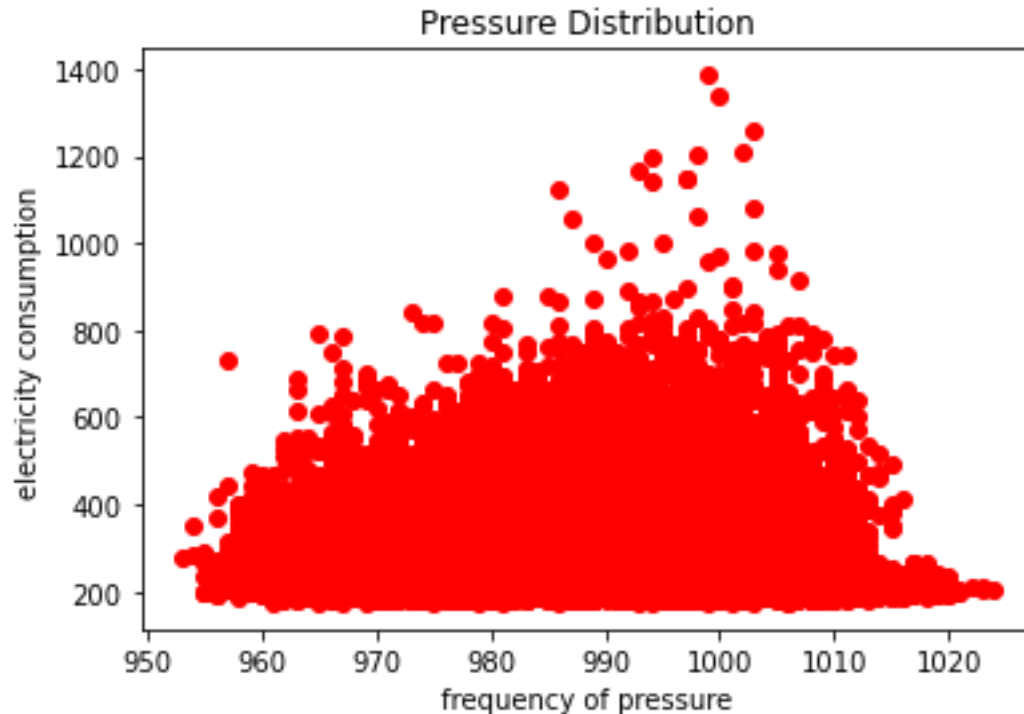
The maximum pressure is : 1024.0

The minimum pressure is : 953.0

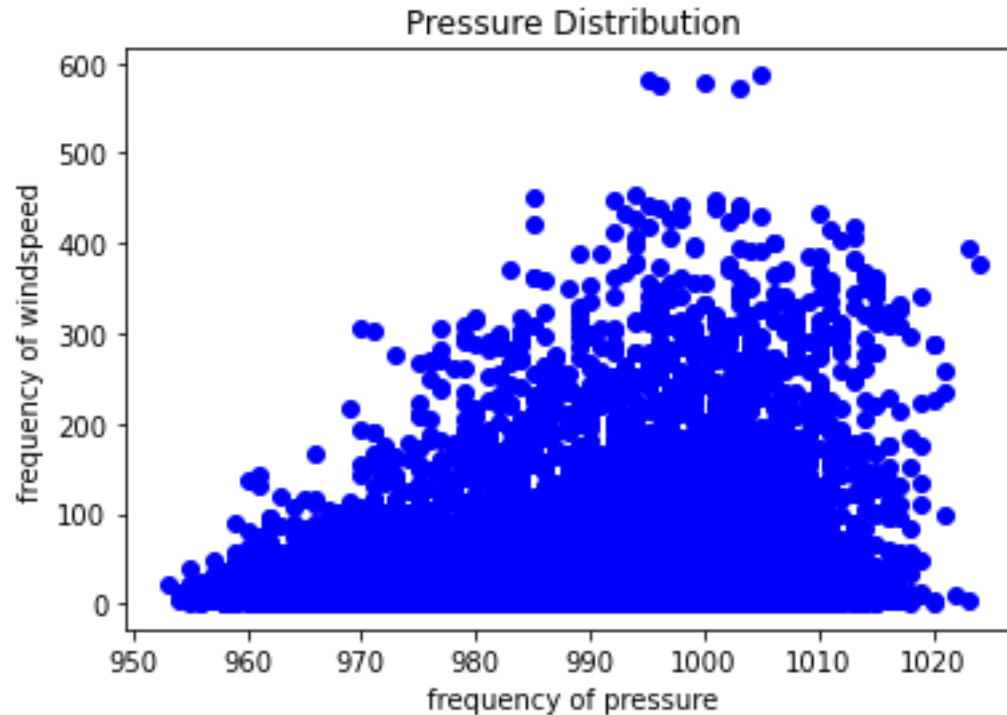
```
In18 plt.plot(data.pressure)
plt.xlabel("samples")
plt.ylabel("frequency of pressure")
plt.title("Pressure Distribution")
plt.show()
```



```
In19 plt.scatter(data.pressure,data.electricity_consumption,c='red')  
plt.xlabel("frequency of pressure")  
plt.ylabel("electricity consumption")  
plt.title("Pressure Distribution")  
plt.show()
```

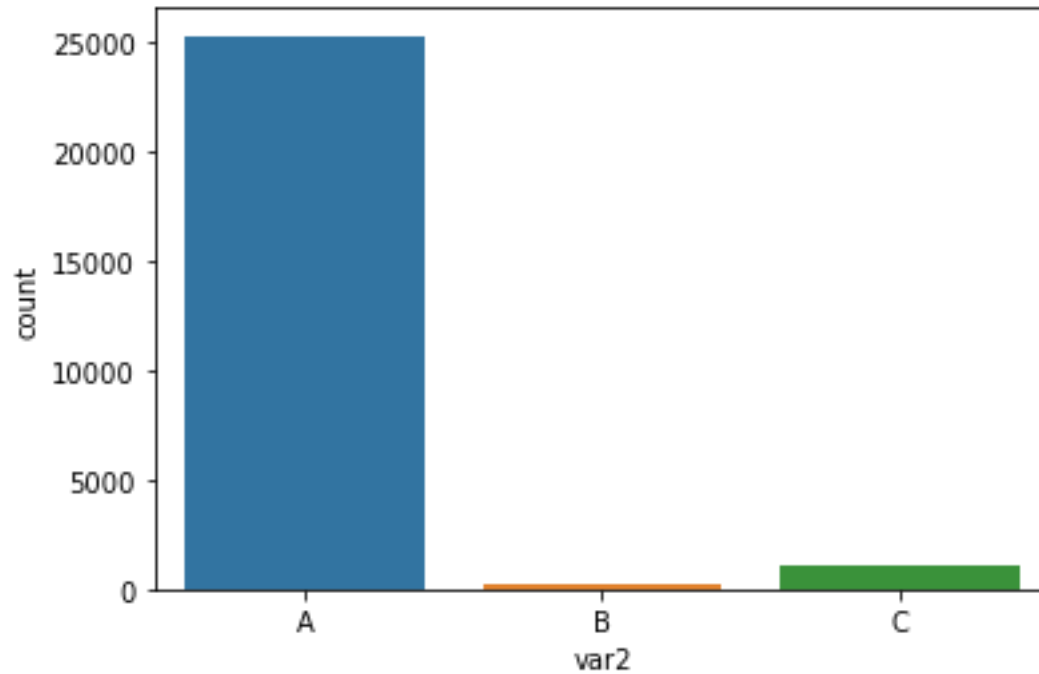


```
In20 plt.scatter(data.pressure,data.windspeed,c='blue')  
plt.xlabel("frequency of pressure")  
plt.ylabel("frequency of windspeed")  
plt.title("Pressure Distribution")  
plt.show()
```



In 21 `sns.countplot(x='var2',data = data)`

Out 21 `<matplotlib.axes._subplots.AxesSubplot at 0x7f66e65e2f90>`



In 43

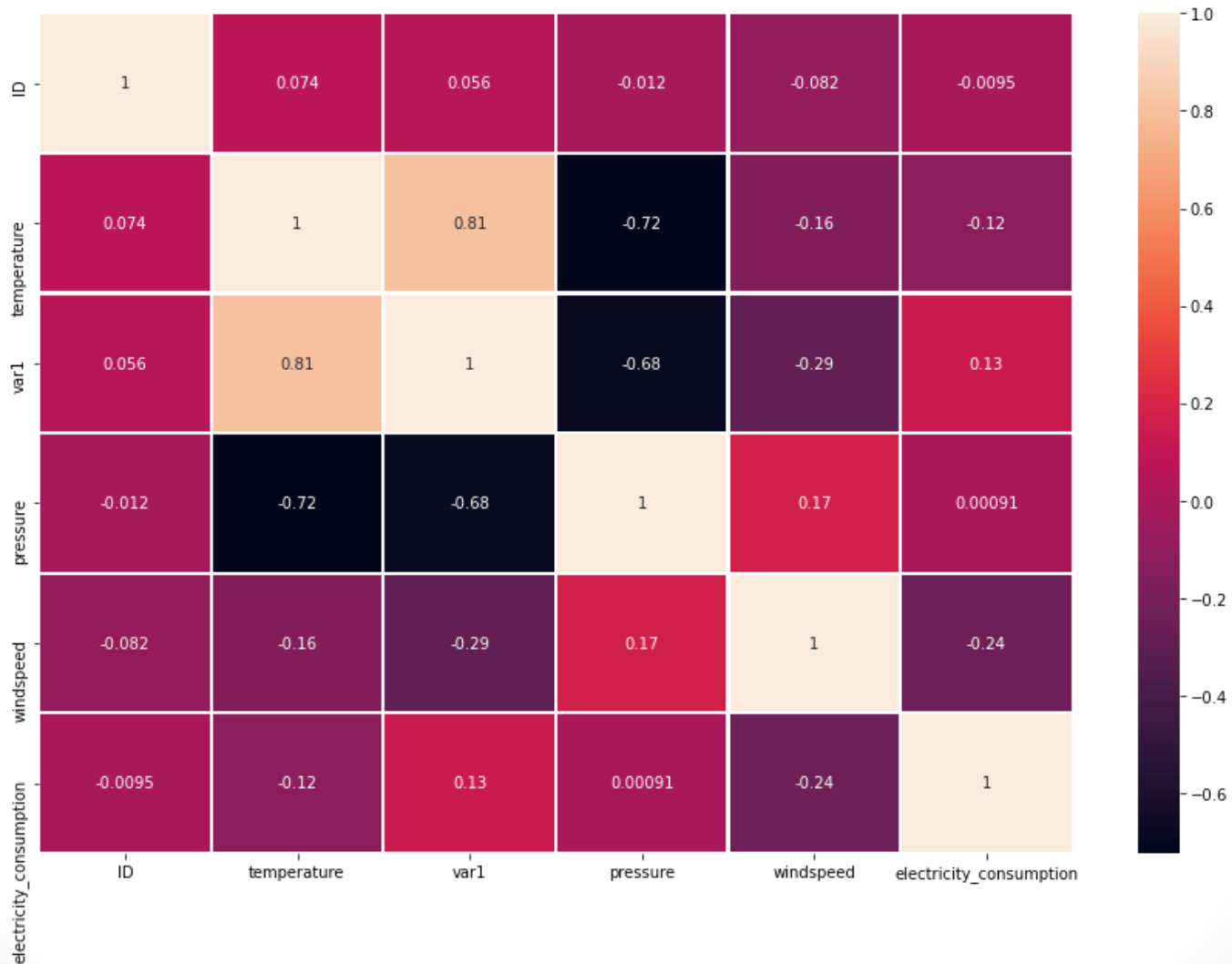
```
fig,ax = plt.subplots(figsize = (15,10))
```

```
corr = data.corr()
```

```
sns.heatmap(corr,xticklabels = corr.columns,annot = True,yticklabels = corr.columns,linewidth =1.2)
```

Out 43

<matplotlib.axes._subplots.AxesSubplot at 0x7f66e6c07e50>



```
In 23    corr[abs(corr['electricity_consumption']) > 0.1]['electricity_consumption']
```

```
Out 23    temperature          -0.117254  
         var1                0.133914  
         windspeed          -0.238883  
         electricity_consumption 1.000000  
         Name: electricity_consumption, dtype: float64
```

```
In 24    data.var1.value_counts()
```

```
Out 24    10.0            836  
         8.6             809  
         10.7            797  
         7.9             779  
         9.3             770  
         ...  
         -29.3           3  
         17.9            2  
         -32.9           1  
         18.6            1  
         -32.1           1  
         Name: var1, Length: 71, dtype: int64
```

```
In 25 data.var2.value_counts()
```

```
Out 25 A      25239  
      C      1040  
      B       217  
      Name: var2, dtype: int64
```

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Reference

This is what i have gathered so far for my Graduation Assignment project title ELECTRICITY POWER CONSUMPTION, also gathered some assistance material on KAGGLE to add some important materials on my project. Although there are many codes, i just collected few just to show some examples.



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END OF SESSION