VIT UNIVERSITY

(Estd. u/s 3 of UGC Act 1956)

Vellore-632 014, Tamil Nadu, India.

OPEN COURSE DEVELOPMENT FOR GOOGLE APPLICATIONS

EXC-1081

ELECTRICITY CONSUMPTION TREND IN VIT

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Contents:

TOPIC ADDRESSED BY THE PROJECT

- Reducing or maintaining electrical power
- Vellore as a smart city.

AIM/OBJECTIVE

The aim of our project is to provide an outline of electricity consumption trends in VIT, Vellore campus using big data analytics.

This analysis would help to monitor the electricity usage and thus reduce the costs and power required. Also it will help to analyse the fields where there is inadequate or more than required supply of energy.

Provide an outline for electricity trend in the smart city project to be implemented in Vellore.

EXPECTED RESULTS

- With the change in weather conditions, the consumption of Air conditioners and Fans shows peak variations. With the change in the floor position of the building the heat capacity increases or decreases and hence usage of AC also.

- Similarly with every changed weather season, the sunset and sunrise time changes, thus the usage of streetlights and classroom lights vary accordingly.

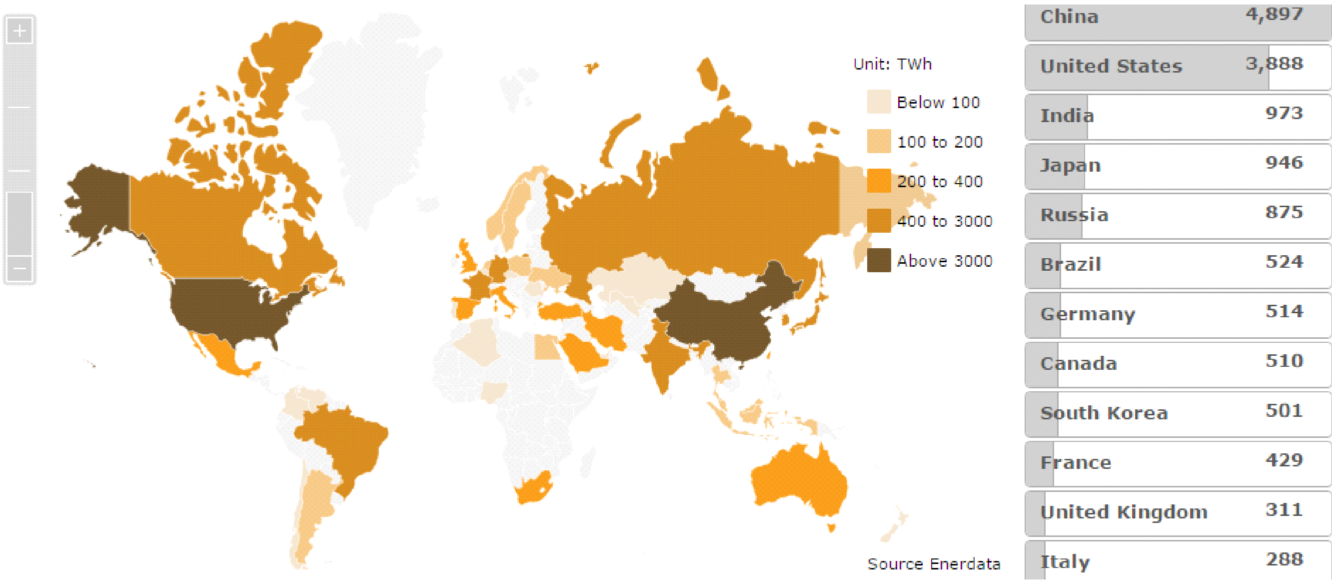
- Sometimes the labs have all their equipments in working condition even when there is no class scheduled during that slot of time. How much energy is consumed under such circumstances?

- These are some questions that we expect to answer with factual data and not just relative evaluation, using BIG DATA analytics

INTRODUCTION:

Electric energy consumption is the form of energy consumption that uses electric energy. Electric energy consumption is the actual energy demand made on existing electricity supply.

At the world level, energy consumption was cut down by 1.5% during 2009, for the first time since World War II. [4] Except in Asia and Middle East, consumptions were reduced in all the world regions. In OECD countries, accounting for 53% of the total, electricity demand scaled down by more than 4.5% in both Europe and North America while it shrank by above 7% in Japan. Electricity demand also dropped by more than 4.5% in CIS countries, driven by a large cut in Russian consumption. Conversely, in China and India (22% of the world's consumption), electricity consumption continued to rise at a strong pace (+6-7%) to meet energy demand related to high economic growth. In Middle East, growth rate was softened but remained high, just below 4%.



ELECTRICITY CONSUMPTION TRENDS FOR THE TOP 10 CONSUMERS ACROSS THE WORLD IN THE YEAR 2014

24	India	940	81%	3%	16%	1,237

Rank	Country	Total TWh	Fossil	Nuclear	Renewable	Inhabitants (millions)
—	WORLD	20,900 (20.9 PWh)	68%	11%	21%	7,040
1	China	4,830 (4.83 PWh)	78%	2%	20%	1,356
2	United States	4,070 (4 PWh)	66%	19%	13%	314
3	Canada	543	24%	15%	59%	34.9
4	Mexico	246	75%	2%	23%	117
5	Brazil	498	17%	1%	82%	199
6	Argentina	124	54%	4%	41%	41.1
7	Venezuela	102	35%	0	65%	30.0
8	Germany	585	57%	15%	25%	81.9
9	France	482	9%	75%	16%	65.4
10	United Kingdom	347	67%	19%	12%	63.7
11	Italy	321	68%	0	32%	60.9
12	Spain	261	48%	21%	31%	46.2
13	Ukraine	166	45%	47%	8%	45.6
14	Poland	148	89%	0	10%	38.5
15	Sweden	136	2%	38%	60%	9.5
16	Norway	119	2%	0	98%	5.0
17	Netherlands	115	81%	4%	14%	16.8
18	Belgium	88.9	35%	48%	14%	11.1
19	Finland	84.9	26%	33%	41%	5.4
20	Russia	948	63%	16%	21%	144

ELECTRICITY CONSUMPTION TREND IN INDIA

The per capita electricity consumption in India has been increasing continuously over the last decade because of the significant improvement in electrification of villages. Still, India is far behind when compared to the rest of the world. India's per capita electricity consumption is the lowest among BRICS nations and is just 1/3rd the world average.

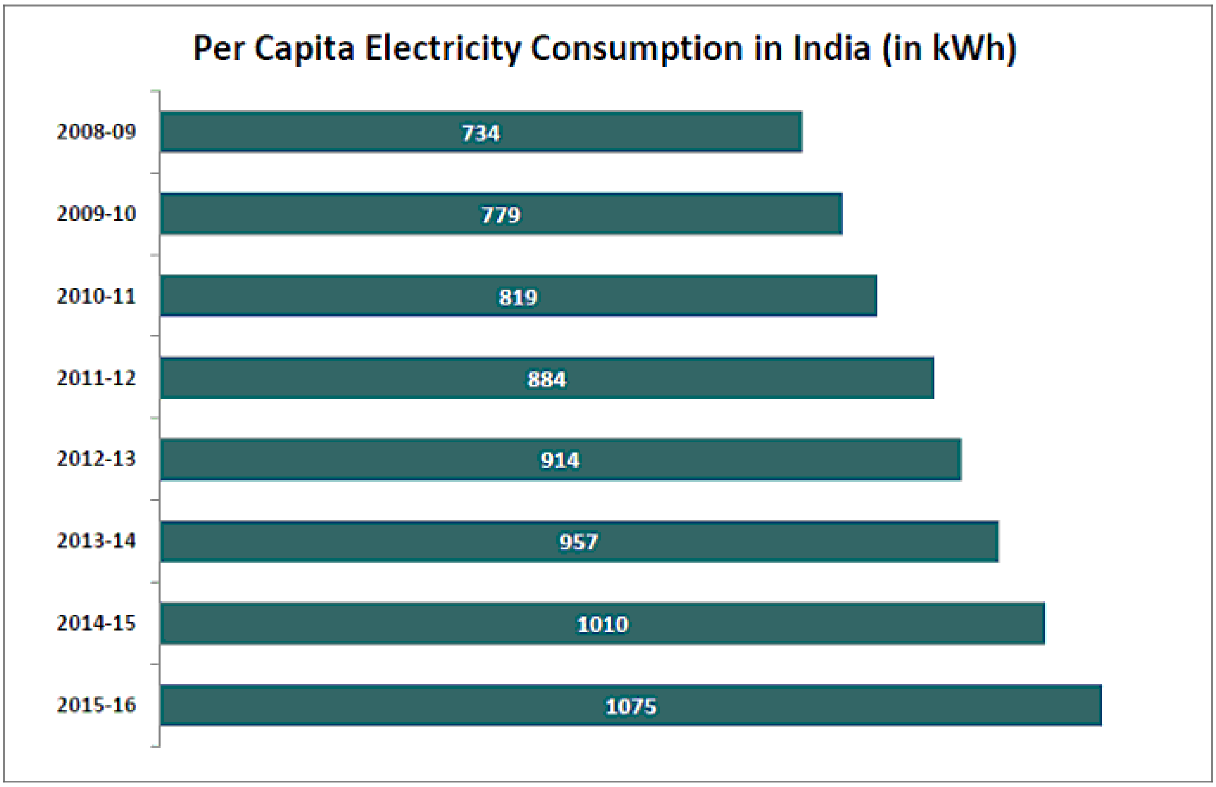
Electrification of remote villages is still a priority item on the agenda of successive governments. While significant progress has been made, there is still a long way to go. India's per capita electricity consumption is lowest among the BRICS nations. It is also about 1/3rd the world's average per capita electricity consumption.

Per Capita Electricity Consumption up 46% in 8 years

India per capita electricity consumption has been continuously increasing over the years. From 734 kWh in 2008-09, the per capita consumption has reached 1075 kWh in 2015-16, an increase of 46% in 8 years. The per capita consumption has been increasing at an average of 6% every year. The per capita consumption crossed 1000 kWh in 2014-15 for the first time. The highest increase in the per capita consumption during these 8 years has been in 2011-12 where it grew by almost 8%.

Wide variation across states

As per the latest available consumption figures by states (for 2012-13), there is wide variation across states in the consumption pattern. The highest per capita consumption is in the Union Territories. Among the states, the per capita consumption in Pondicherry, Goa, Punjab, Gujarat, Haryana and Delhi is way above the national average. Bihar has the lowest per capita consumption which is almost 1/6th the national average. Per capita consumption in all the north eastern states is below the national average. The per capita consumption in states like West Bengal, Madhya Pradesh, Kerala, Uttar Pradesh and Jharkhand is also below the national average.



ENERGY SECTOR AND BIG DATA

Today's energy and utility companies face an unfamiliar landscape in which they must integrate alternative energies, expand situational awareness across the system and deepen their relationships with customers, while continuing to do what they have always done—delivering reliable, safe and affordable energy to everyone. Organizations that want to expand their business are adopting analytics to increase agility and responsiveness, reduce operational costs and improve asset reliability.

Analyst firm GTM Research predicts, global utility company expenditure on data analytics will grow from $700 million in 2012 to $3.8 billion in 2020, with gas, electricity and water suppliers in all regions of the world increasing their investment.

Big data is a critical element to solving key business problems for utility companies. It can turn the information from smart meter and smart grid projects into meaningful operational insights and understandings about their customer's behaviour.

As smart grid and smart meters become crucial to the industry, they will likely start generating hundreds of terabytes of data every year—or unstructured text data compiled from maintenance records and Twitter feeds. The accuracy, breadth and depth of these new data points present new opportunities for the utility companies that are prepared to take advantage of them.

Meanwhile, becoming a customer-centric, information-driven organization is no longer simply an option for most utility companies, it's a business imperative. Technology shifts, regulatory changes and the emergence of empowered consumers all demand a new approach to customer engagement. With analytics, energy companies can make the shift to engage with customers in highly personalized ways that can increase customer satisfaction, lower the cost of service and promote new products and services.

For utilities to compete in this new environment successfully and ensure safe, reliable, affordable and sustainable energy, they will have to fundamentally transform their current business processes. Utilities must leverage big data analytics to help them translate data into actionable insights, enabling better operational decisions. This includes predictive maintenance, power quality optimization and demand response analytics—among others.

The analytics opportunity for utilities is clear, but there continues to be a lack of real push and value delivery. This change begins with a realistic review of their analytics maturity levels: where they want to get to, and what they want to achieve. That framework gives a baseline for key investments and initiatives.

By using built-in analytics, utilities can see comprehensive information about each of their assets, such as history, maintenance records and operating condition data. This information can be combined in new ways to provide insights to help improve planning, construction, operations and maintenance practices. Such innovations will help utilities shift from traditional and costly time-based asset management, where network repairs are done on schedule regardless of how much useful life is left in an asset, to a more informed reliability-based approach of making repairs when they are actually needed. Moreover a coordinated cross-enterprise vision can help reduce IT costs.

With the flood of big data from grid instrumentation, meters and connected consumers, utilities increasingly are applying analytics to unlock the value of their data. For energy and utility companies, success in analytics is best achieved by using a foundation of common capabilities that can be applied to various utility domains and systems to integrate them .Analytics can enable utilities not only to improve current business processes, but also to transform them altogether. With analytics, companies are becoming more competitive—digitizing our world with new ways to drive better business engagement and providing us with prolific amounts of data and new delivery models to create new business value.

The energy industry enjoys a unique position of providing a product and service that's essential to the well-being of its customers and the world economy. Despite the changes in the industry, energy and utility companies can continue to meet the core expectations to deliver safe, reliable, affordable and sustainable energy.

BACKGROUND AND JUSITIFICATION

The daily electricity bill of VIT University, Vellore comes around a million bucks per day!!

VIT campus is spread across a vast area of 250 acres. A striking feature of VIT is the well- planned and comprehensive infrastructure provided for both students and faculty. Fully furnished and well-equipped labs decorate every building in the University with over 55 servers to manage all the data transmissions. Moreover, the university is blessed with ample features that support all kinds of events - Auditoriums, plush open spaces, outdoor stages and much more.

A striking feature of VIT is the well-planned and comprehensive infrastructure provided for both students and faculty. There are seven academic blocks in VIT which are extremely specialised in their own particular field, namely- MB, GDN, CDMM, SMV, CBMR, TT and SJT. The layout has been excellently planned to make the maximum utilisation of the 250 acre campus. The idea behind these separate blocks is to make every block equipped with the necessary amenities whilst providing the perfect atmosphere for both studies and research.

There are 17 blocks for men hostels and 7 blocks for girl's hostel. And the high tech digitalisation used in the whole campus leads to a large amount of usage of electricity.

Though VIT ensures that the consumption is minimal in any case, an analysis done on the usage patterns and consumption capacity subjugated on various parameters can be done.

PROJECT REQUIREMENTS

- We would require the electricity bills of the hostels and the buildings in VIT.

- We would also require the energy footprints of various appliances installed in VIT campus. For the energy footprint we have a machine to check the individual power requirement of the devices, we require the permission to evaluate the same.

- We would require clusters in order to implement the big data analytics.

- We would require lab allotment data (i.e. slots filled for every room or class in VIT)

WORK FLOW

PHASE-1

- We will fetch the data (i.e. electricity bills, consumption rate etc.) and compile and store it in a Database.
- The data collection is an important part and plays a major role for further analytics to be performed
- Data will be integrated, noise will be removed and would be qualified according to our requirements and then stored in a data warehouse.

PHASE -2

- We will work upon the qualified and churned out data and apply techniques such as map-reduce and use hive to further shortlist data into required format.
- Then data mining and machine learning algorithms will be performed on the worked out data to bring out results.

PHASE-3

- We will us the result obtained in the 2nd phase to monitor the consumption trends across the VIT and implement hardware techniques to resolve issues caused by over consumption or wastage of electricity.

PROJECT IMPLEMENTATION

TEAMING UP IOT WITH BIG DATA

Webuilt a smart meter which would measure the power consumption of a particular device. This can be done with the help of an energy meter, we used and arduino board to provide it with code so that whenever requested the meter responds with the calculated amount of electricity used in terms on rupees. This is facilitated by a GSM module attached the with arduino board.

SOFTWARE IMPLEMENTATION

We have used pandas (NUMPY) library of python to read and process the csv file and bring out efficient results of the data that we collected.

HARDWARE IMPLEMENTATION

We built a smart meter of our own using an arduino board, a gsm module, a counter sensor, energy meter, sockets, plugs and wires for connection.

RESULTS OF ANALYSIS

The figure 1 gives the graph of consumption rate between certain time slots of day every month .the time slots we choose were the following 3:

8:00 am to 12:00 pm

12:00 pm to 4:00 pm

4:00 pm to 8:00 pm

According to the graph the consumption rate between these slots does not show much variation as is supposed to be since all the time periods have regular classes .This proves the data is consistent and does not have discrepancies.

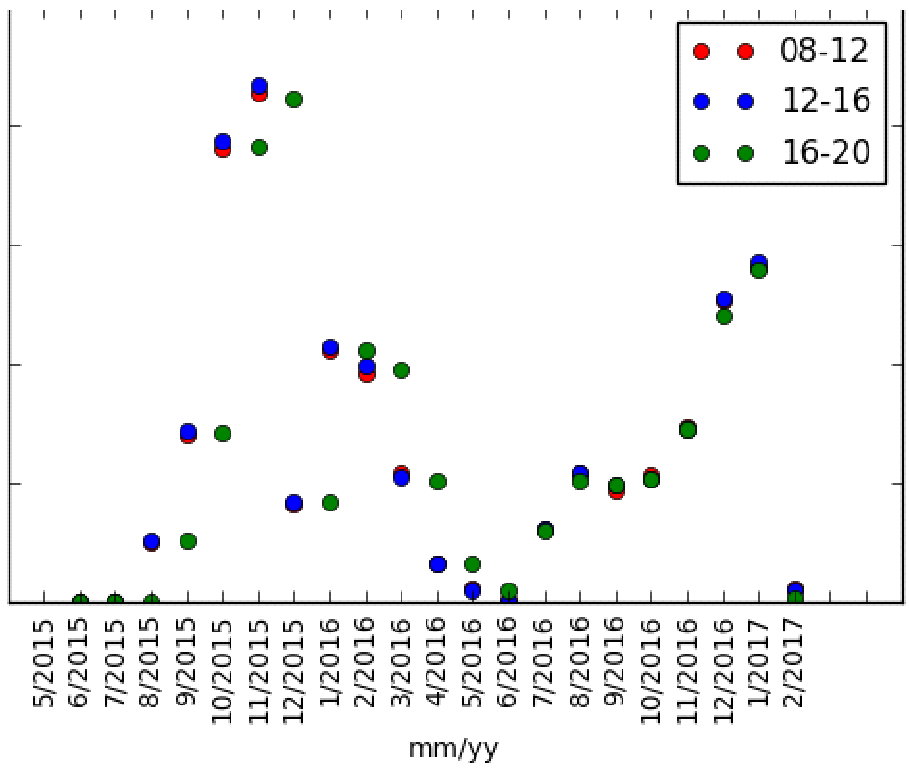


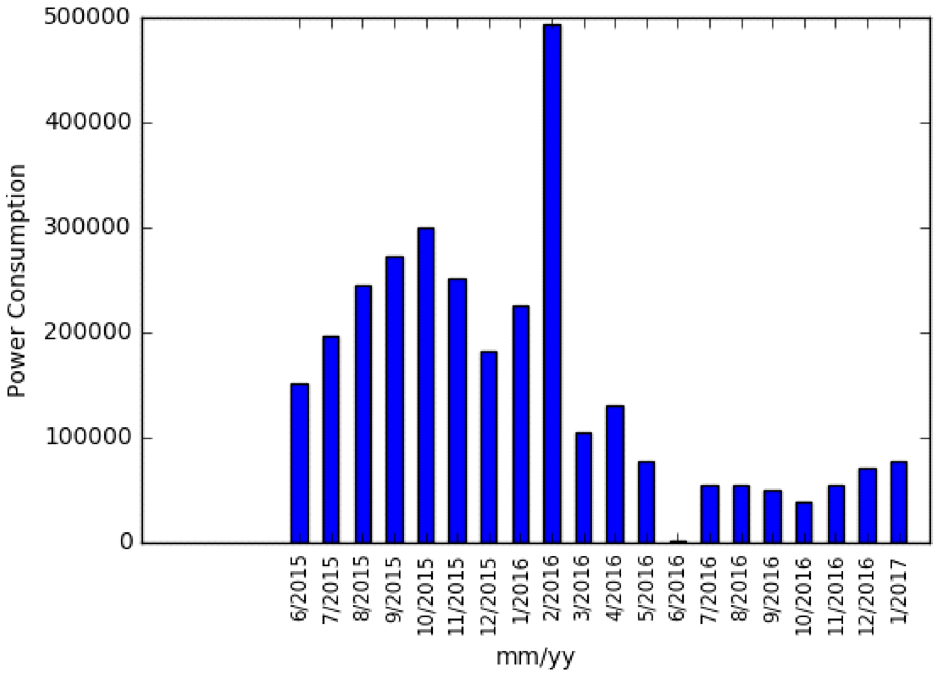
FIGURE 1

The figure 2 given below is the graph for power consumption (in kWh) for every month between the specified time periods i.e. from June 2015 to January 2017

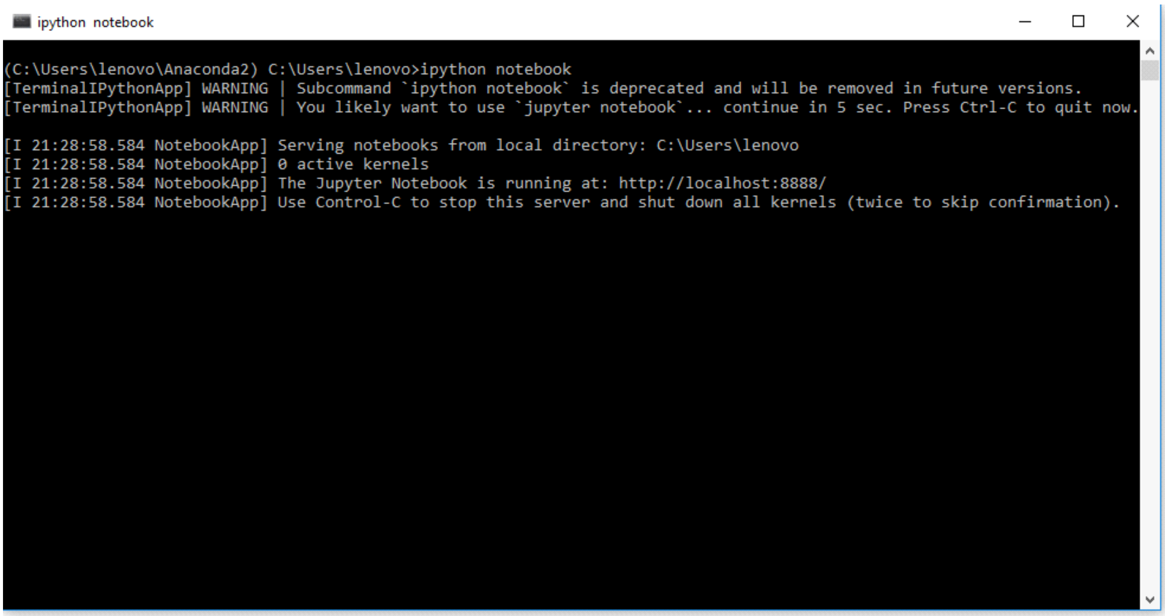
According to the graph

We get the following results

- The energy consumption was very high during the fall sem. 2015-16 and winter sem. 2016 as compared to the next operational semesters.
- . There is a huge dip in fall sem. 2016-17 consumption rate and remains constant for the entire semester. This gives an indication of efficient electricity management by the concerned authorities with the start of a fresh session.
- The consumption in Feb ’16 shows an extreme high and gives an indication of optimum electricity usage and some major issues in handling the consumption rate.



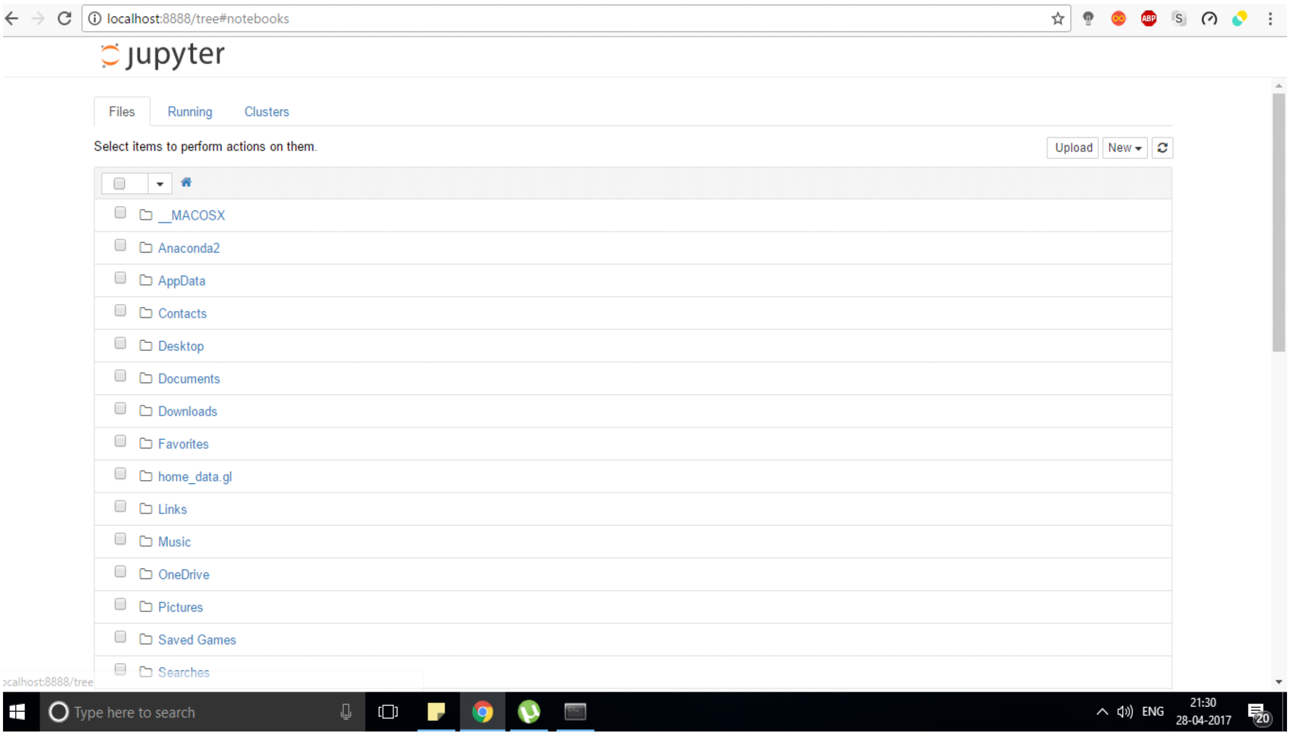
- The consumption is very low during the month of June since this month summer vacations are there. Similarly the month of December shows less consumption as compared to the other months



USING JUPYTER NOTEBOOK

The notebook is composed of cells. Every cell has a unique purpose depending upon its type. Each cell in the notebook is a Python code-cell by default. To change the type of the cell, use the first dropdown box in the toolbar

Create or upload using the file drop down menu we can create a new project or upload an existing file (.ipynb) or any other extension. Or

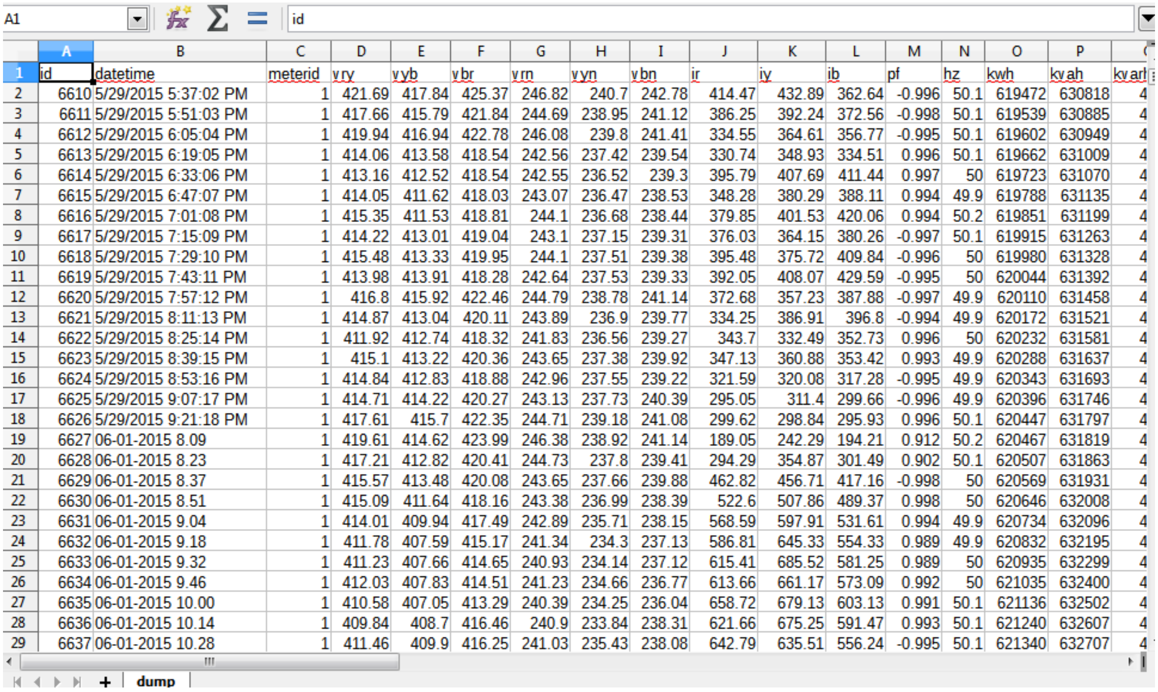


To create a new notebook, click on the "New" button at the top of the list and select a kernel from the dropdown (as seen below). Which kernels are listed depend on what's installed on the server.

Simple editing: we change the cell to a “Markdown” cell type. This type is used to create rich text in the notebook

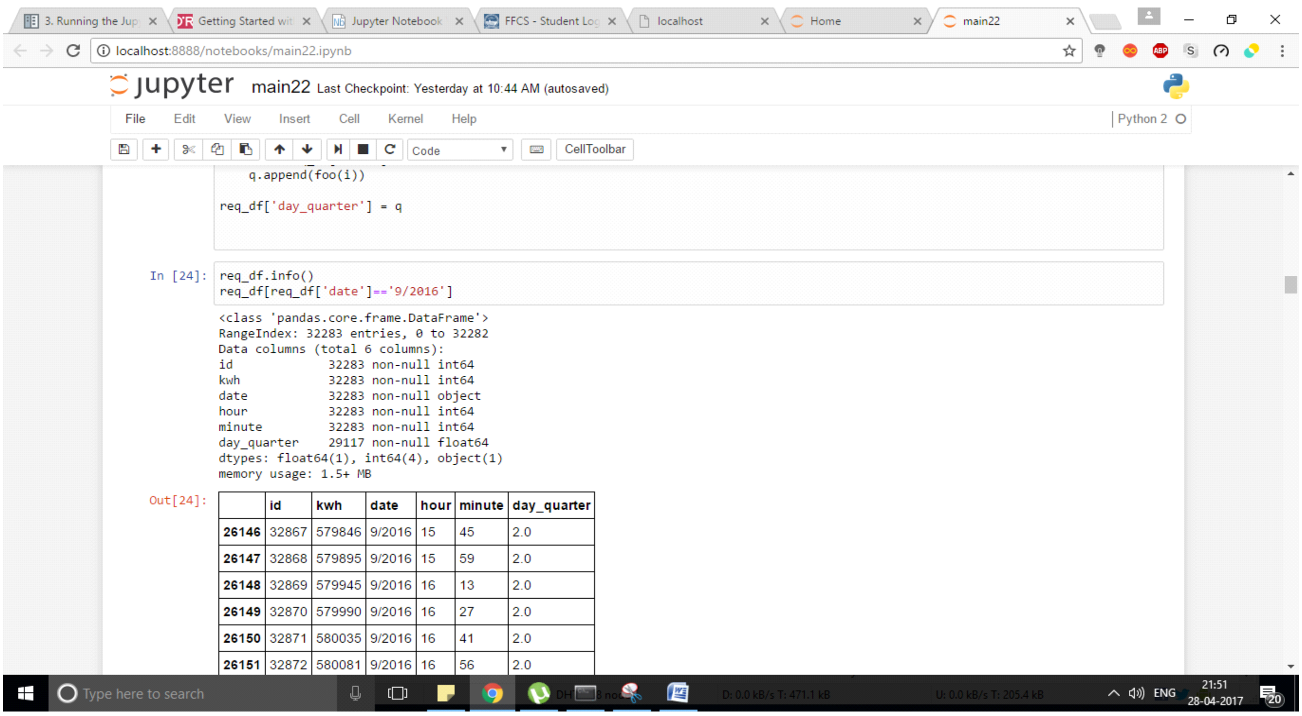
Save notebooks: modifications to the notebooks are automatically saved every few minutes. To avoid modifying the original notebook, make a copy of the notebook document (menu File -> Make a copy ...) and save the modifications on the copy.

Some excerpts from the project



	id	datetime	meterid	v ry	v yb	v br	v rn	v yn	v bn	ir	iy	ib	pf	hz	kwh	kv ah	kv ar
2	6610	5/29/2015 5:37:02 PM	1	421.69	417.84	425.37	246.82	240.7	242.78	414.47	432.89	362.64	-0.996	50.1	619472	630818	4
3	6611	5/29/2015 5:51:03 PM	1	417.66	415.79	421.84	244.69	238.95	241.12	386.25	392.24	372.56	-0.998	50.1	619539	630885	4
4	6612	5/29/2015 6:05:04 PM	1	419.94	416.94	422.78	246.08	239.8	241.41	334.55	364.61	356.77	-0.995	50.1	619602	630949	4
5	6613	5/29/2015 6:19:05 PM	1	414.06	413.58	418.54	242.56	237.42	239.54	330.74	348.93	334.51	0.996	50.1	619662	631009	4
6	6614	5/29/2015 6:33:06 PM	1	413.16	412.52	418.54	242.55	236.52	239.3	395.79	407.69	411.44	0.997	50	619723	631070	4
7	6615	5/29/2015 6:47:07 PM	1	414.05	411.62	418.03	243.07	236.47	238.53	348.28	380.29	388.11	0.994	49.9	619788	631135	4
8	6616	5/29/2015 7:01:08 PM	1	415.35	411.53	418.81	244.1	236.68	238.44	379.85	401.53	420.06	0.994	50.2	619851	631199	4
9	6617	5/29/2015 7:15:09 PM	1	414.22	413.01	419.04	243.1	237.15	239.31	376.03	364.15	380.26	-0.997	50.1	619915	631263	4
10	6618	5/29/2015 7:29:10 PM	1	415.48	413.33	419.95	244.1	237.51	239.38	395.48	375.72	409.84	-0.996	50	619980	631328	4
11	6619	5/29/2015 7:43:11 PM	1	413.98	413.91	418.28	242.64	237.53	239.33	392.05	408.07	429.59	-0.995	50	620044	631392	4
12	6620	5/29/2015 7:57:12 PM	1	416.8	415.92	422.46	244.79	238.78	241.14	372.68	357.23	387.88	-0.997	49.9	620110	631458	4
13	6621	5/29/2015 8:11:13 PM	1	414.87	413.04	420.11	243.89	236.9	239.77	334.25	386.91	396.8	-0.994	49.9	620172	631521	4
14	6622	5/29/2015 8:25:14 PM	1	411.92	412.74	418.32	241.83	236.56	239.27	343.7	332.49	352.73	0.996	50	620232	631581	4
15	6623	5/29/2015 8:39:15 PM	1	415.1	413.22	420.36	243.65	237.38	239.92	347.13	360.88	353.42	0.993	49.9	620288	631637	4
16	6624	5/29/2015 8:53:16 PM	1	414.84	412.83	418.88	242.96	237.55	239.22	321.59	320.08	317.28	-0.995	49.9	620343	631693	4
17	6625	5/29/2015 9:07:17 PM	1	414.71	414.22	420.27	243.13	237.73	240.39	295.05	311.4	299.66	-0.996	49.9	620396	631746	4
18	6626	5/29/2015 9:21:18 PM	1	417.61	415.7	422.35	244.71	239.18	241.08	299.62	298.84	295.93	0.996	50.1	620447	631797	4
19	6627	06-01-2015 8.09	1	419.61	414.62	423.99	246.38	238.92	241.14	189.05	242.29	194.21	0.912	50.2	620467	631819	4
20	6628	06-01-2015 8.23	1	417.21	412.82	420.41	244.73	237.8	239.41	294.29	354.87	301.49	0.902	50.1	620507	631863	4
21	6629	06-01-2015 8.37	1	415.57	413.48	420.08	243.65	237.66	239.88	462.82	456.71	417.16	-0.998	50	620569	631931	4
22	6630	06-01-2015 8.51	1	415.09	411.64	418.16	243.38	236.99	238.39	522.6	507.86	489.37	0.998	50	620646	632008	4
23	6631	06-01-2015 9.04	1	414.01	409.94	417.49	242.89	235.71	238.15	568.59	597.91	531.61	0.994	49.9	620734	632096	4
24	6632	06-01-2015 9.18	1	411.78	407.59	415.17	241.34	234.3	237.13	586.81	645.33	554.33	0.989	49.9	620832	632195	4
25	6633	06-01-2015 9.32	1	411.23	407.66	414.65	240.93	234.14	237.12	615.41	685.52	581.25	0.989	50	620935	632299	4
26	6634	06-01-2015 9.46	1	412.03	407.83	414.51	241.23	234.66	236.77	613.66	661.17	573.09	0.992	50	621035	632400	4
27	6635	06-01-2015 10.00	1	410.58	407.05	413.29	240.39	234.25	236.04	658.72	679.13	603.13	0.991	50.1	621136	632502	4
28	6636	06-01-2015 10.14	1	409.84	408.7	416.46	240.9	233.84	238.31	621.66	675.25	591.47	0.993	50.1	621240	632607	4
29	6637	06-01-2015 10.28	1	411.46	409.9	416.25	241.03	235.43	238.08	642.79	635.51	556.24	-0.995	50.1	621340	632707	4

Snap of the csv file used




```
    q.append(foo(i))

req_df['day_quarter'] = q
```

In [24]:

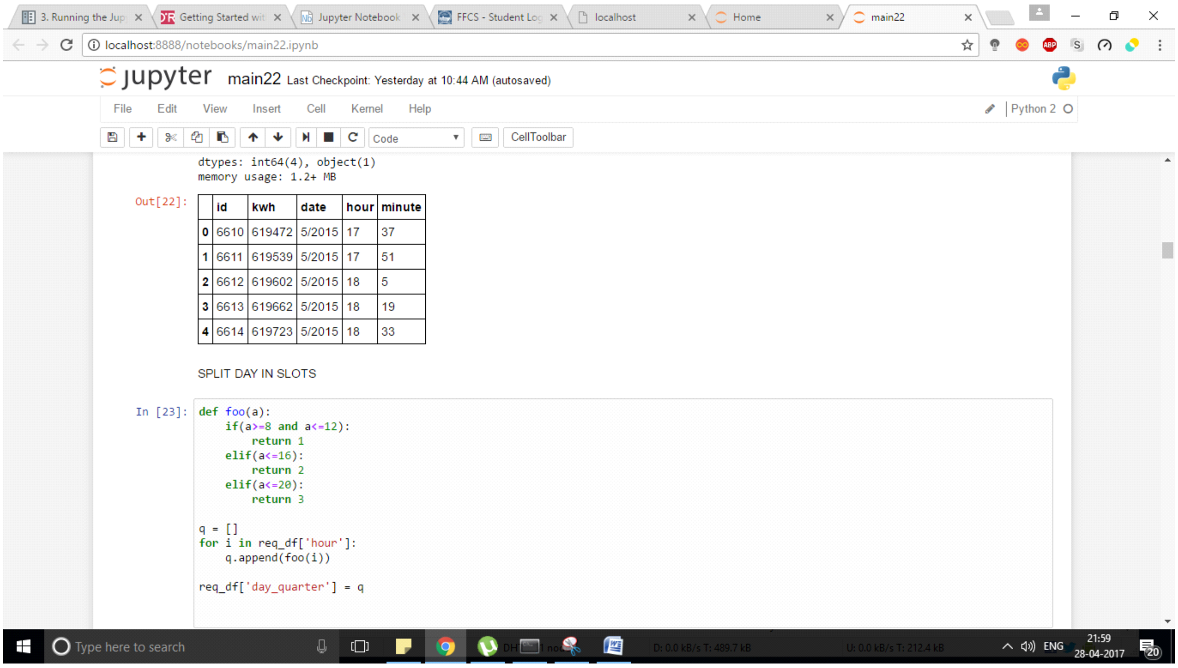
```
req_df.info()
req_df[req_df['date']=='9/2016']
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 32283 entries, 0 to 32282
Data columns (total 6 columns):
id             32283 non-null int64
kwh            32283 non-null int64
date           32283 non-null object
hour           32283 non-null int64
minute         32283 non-null int64
day_quarter    29117 non-null float64
dtypes: float64(1), int64(4), object(1)
memory usage: 1.5+ MB
```

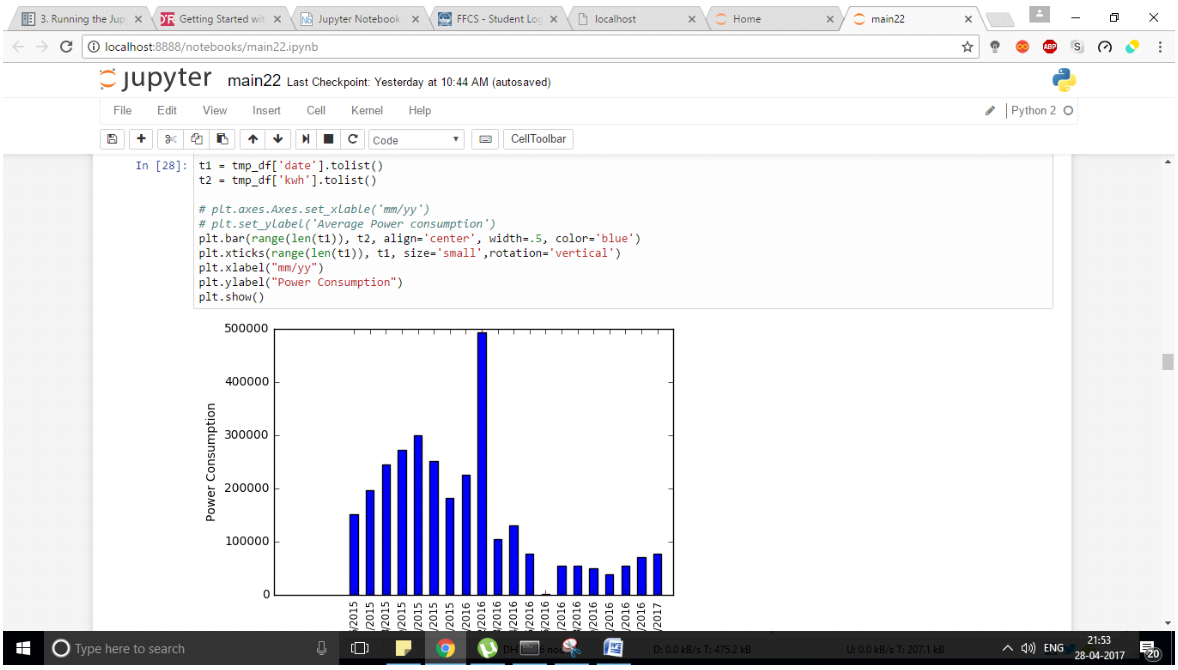
Out[24]:

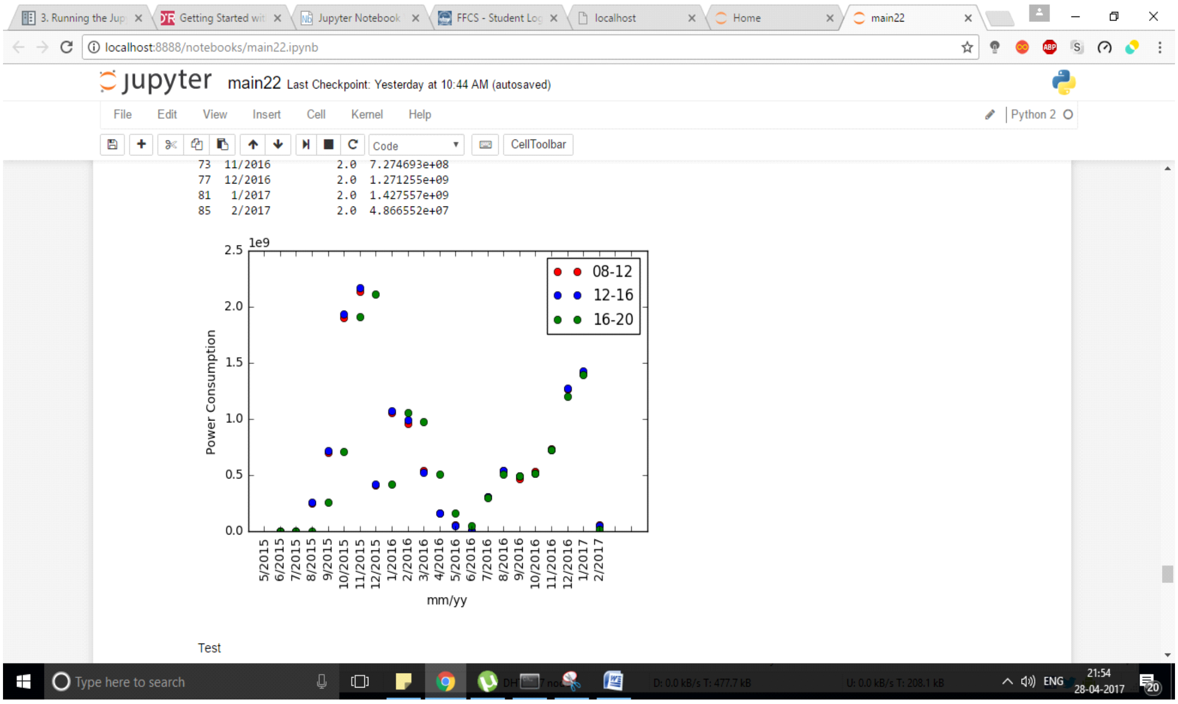
	id	kwh	date	hour	minute	day_quarter
26146	32867	579846	9/2016	15	45	2.0
26147	32868	579895	9/2016	15	59	2.0
26148	32869	579945	9/2016	16	13	2.0
26149	32870	579990	9/2016	16	27	2.0
26150	32871	580035	9/2016	16	41	2.0
26151	32872	580081	9/2016	16	56	2.0

We have used the NUMPY library and pandas for reading and working on the data



We have drawn plots in ipython notebook depecting usage statistics





FUTURE GOALS

- As Vellore has been declared as a smart city, the patterns obtained during the project can further be modified and a proper implementation plan can be given so that the electricity consumption is minimal.

- Since Vellore city is still in development it will be easier and more feasible to plan before the planned projects start functioning. This might help to reduce the energy required and also facilitate for more development due to reduced costs in the energy consumption process.
- We have planned to integrate the above results with the general time table of VIT classes and perform a cumulative analysis on it. This wold help in applications such as lift operation management, which we would next implement.

SOURCE CODE FOR ARDUINO

```
#include<LiquidCrystal.h>
LiquidCrystallcd(7,6,5,4,3,2);

int led=13; // declering LED in 13th pin
#definepulsein8//defining the pulse input pin 8
unsignedintpusle_count=0; //Declaring Pulse count type as integer
float units=0; //Declaring units as Float
unsignedint rupees=0; //declaring rupees types as unsigned integer

unsignedint temp=0,i=0; //declaring temp&i as unsigned integer

charstr[70],flag1=0,flag2=0; // character length as string and declaring flags


voidsetup()
{
lcd.begin(16,2);  // initializing LCD type as 16x2
Serial.begin(9600); // initializing serial baud rate as 9600
pinMode(led, OUTPUT);
pinMode(pulsein, INPUT);
digitalWrite(pulsein, HIGH);
lcd.setCursor(0,0);
lcd.print("Wireless Energy");
lcd.setCursor(0,1);
lcd.print("      Meter    ");
delay(2000);
lcd.clear();
lcd.print("By   ");
delay(2000);
lcd.clear();
lcd.print("GSM Initilizing...");
gsm_init();
lcd.clear();
lcd.print("System Ready");
Serial.println("AT+CNMI=2,2,0,0,0");
init_sms();
send_data("System Ready");
send_sms();
```

	delay(1000);
	digitalWrite(led, LOW);
	lcd.clear();
	}
	voidloop()
	{
	serialEvent(); // checking serial event
	units=rupees/5.0; // calculation of unit
	lcd.setCursor(0,0);
	lcd.print("Units:");
	lcd.print(units);
	lcd.print(" ");
	lcd.setCursor(0,1);
	lcd.print("Rupees:");
	lcd.print(rupees);
	lcd.print(" ");
	read_pulse();
	if(temp==1)
	{
	check();
	}
	}
	voidserialEvent() // serial event for receiving and checking the incoming sms
	{
	while(Serial.available())
	{
	if(Serial.find("#"))
	{
	digitalWrite(led, HIGH);
	delay(1000);
	digitalWrite(led, LOW);
	while (Serial.available())
	{
	charinChar=Serial.read();
	str[i++]=inChar;
	if(inChar=='*')
	{
	temp=1;

```
return;
      }
      }
    }
   }
 }

voidinit_sms() //initializing & configuration of sending message
{
Serial.println("AT+CMGF=1");
delay(200);
Serial.println("AT+CMGS=\"+919626071110\"");
delay(200);
}

voidsend_data(String message)
{
Serial.println(message);
delay(200);
}

voidsend_sms()
{
Serial.write(26);
}

//Reading Pulse from Energy Meter
voidread_pulse()
{
if(!digitalRead(pulsein))
    {
digitalWrite(led, HIGH);
      units++;
      rupees=units*5;
while(!digitalRead(pulsein));
digitalWrite(led,LOW);

    }
}

//Checking the status of Message
```

```
voidcheck()
{

if(!(strncmp(str,"units",5)))
      {
Serial.println("AT+CMGF=1");
delay(200);
Serial.println("AT+CMGS=\"+918056921941\"");
delay(200);
lcd.setCursor(0,1);
send_data("Energy Meter Unit:");
Serial.println(units);
send_data("\nRupees:");
Serial.println(rupees);
delay(200);
Serial.write(26);
       flag1=1;
       flag2=1;
       temp=0;
      }
     }



voidmessage_sent()
{
lcd.clear();
lcd.print("Message Sent.");
delay(1000);
}

voidgsm_init()
{
lcd.clear();
lcd.print("Finding Module..");
booleanat_flag=1;
while(at_flag)
  {
Serial.println("AT");
while(Serial.available()>0)
    {
```

	if(Serial.find("OK"))
	at_flag=0;
	}
	delay(1000);
	}
	lcd.clear();
	lcd.print("Module Connected..");
	delay(1000);
	lcd.clear();
	lcd.print("Disabling ECHO");
	booleanecho_flag=1;
	while(echo_flag)
	{
	Serial.println("ATE0");
	while(Serial.available()>0)
	{
	if(Serial.find("OK"))
	echo_flag=0;
	}
	delay(1000);
	}
	lcd.clear();
	lcd.print("Echo OFF");
	delay(1000);
	lcd.clear();
	lcd.print("Finding Network..");
	booleannet_flag=1;
	while(net_flag)
	{
	Serial.println("AT+CPIN?");
	while(Serial.available()>0)
	{
	if(Serial.find("+CPIN: READY"))
	net_flag=0;
	}
	delay(1000);
	}
	lcd.clear();
	lcd.print("Network Found..");

	delay(1000);
	lcd.clear();
	}

SOURCE CODE FOR IPYTHON

```
importnumpyasnp
importpandasaspd
importsklearn
importos
importmatplotlib.pyplotasplt
df=pd.read_csv('dump.csv')
print(df.columns.values)
print(df.info())
df.describe()
```

#FORMAT DATE

```
req_df=df[['id','datetime','kwh']].copy()
# req_df.info()
date_col, time_col=req_df['datetime'].str.split(' ').str
# len(date_time[0])
delreq_df['datetime']
# date_col = date_time[0]
# time_col = (date_time[1] + date_time[2])

req_df['date'] =date_col.str.replace('-','/')
# req_df.head(25)
# req_df['month'] =
req_df['date'].str.split('/').str[0].astype(str).astype(int)
# req_df['day'] =
req_df['date'].str.split('/').str[1].astype(str).astype(int)
# delreq_df['date']
# req_df['date'] = (req_df['date'].str.split('/').str[1].astype(str) +
req_df['date'].str.split('/').str[2].astype(str)).astype(int)
req_df['date'] =
(req_df['date'].str.split('/').str[0].astype(int).astype(str)
+'/'+req_df['date'].str.split('/').str[2].astype(str))
t =req_df.loc[req_df['date'] =='4/2016']
```

#FORMAT TIME

```
print(len(time_col))
time= []
cnt=0
# print(time_col[3822])
foriintime_col:
cnt+=1
i=str(i)
if(len(i)>5):
hr, mn, s =i.split(':')
if(s[len(s)-2]=='P'andhr!='12'):
```

```
hr=str(int(hr) +12)
elif(s[len(s)-2]=='A'andhr=='12'):
hr='0'
time.append(hr+'.'+mn)
else:
time.append(str(i))
# print(time[3822])
req_df['time'] = time
req_df['hour']
=req_df['time'].str.split('.').str[0].astype(str).astype(int)
req_df['minute']
=req_df['time'].str.split('.').str[1].astype(str).astype(int)
delreq_df['time']
# print(type(time_col[16].split(':')[0]))
```

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```
req_df.info()
req_df.head()
# req_df.describe()
```

#SPLIT DAY IN SLOTS

```
deffoo(a):
if(a>=8and a<=12):
return1
elif(a<=16):
return2
elif(a<=20):
return3

q = []
foriinreq_df['hour']:
q.append(foo(i))

req_df['day_quarter'] = q

req_df.info()
req_df[req_df['date']=='9/2016']
```

#Plot 1

```
xlab=req_df.date.unique()
tmp_df=pd.DataFrame(columns=('date', 'kwh')).copy()
# req_df.loc[req_df['date'] == xlab[0]]
```

In [ ]:

In [27]:

```
c2 =0
foriinxlab:
j_df=req_df.loc[req_df['date'] ==i]
tmp_df.loc[c2] = (i,(j_df['kwh'].iloc[len(j_df)-1] -j_df['kwh'].iloc[0]))
if(i=='3/2016'):
tmp_df.loc[c2] = (i,104407)
if(i=='11/2015'):
```

```
tmp_df.loc[c2] = (i,252418)
if(i=='8/2015'):
tmp_df.loc[c2] = (i,245604)
    c2 +=1

tmp_df.drop(tmp_df.index[len(tmp_df)-1], inplace=True)
tmp_df.drop(tmp_df.index[0], inplace=True)

# tmp_df.info()
print(tmp_df.head(25))



t1 =tmp_df['date'].tolist()
t2 =tmp_df['kwh'].tolist()

# plt.axes.Axes.set_xlable('mm/yy')
# plt.set_ylabel('Average Power consumption')
plt.bar(range(len(t1)), t2, align='center', width=.5, color='blue')
plt.xticks(range(len(t1)), t1, size='small',rotation='vertical')
plt.xlabel("mm/yy")
plt.ylabel("Power Consumption")
plt.show()
```

UPDATE kwpm values

```
up_df=pd.DataFrame(columns=('date', 'day_quarter', 'kwh'))
kwh_df=req_df['kwh'].copy()

up_df.loc[0] =req_df.loc[0].copy()
# up_df
foriinrange(1,len(req_df)):
#     print(i)
new_value=kwh_df.loc[i]
if(new_value<up_df.loc[i-1]['kwh']):
new_value=new_value+up_df.loc[i-1]['kwh']
up_df.loc[i] = (req_df['date'].iloc[i], req_df['day_quarter'].iloc[i],
new_value)

up_df.head(15)
```

#Test

```
print(up_df.loc[4159]['kwh'])
print(up_df.loc[4160]['kwh'])
print(up_df.loc[4161]['kwh'])
print(kwh_df.loc[4161]
```

#Prepare data

```
c2 =0
foriinxlab:
j_df=req_df.loc[req_df['date'] ==i]
tmp_df.loc[c2] = (i,(j_df['kwh'].iloc[len(j_df)-1] -j_df['kwh'].iloc[0]))
if(i=='3/2016'):
```

```
tmp_df.loc[c2] = (i,104407)
if(i=='11/2015'):
tmp_df.loc[c2] = (i,252418)
if(i=='8/2015'):
tmp_df.loc[c2] = (i,245604)
    c2 +=1
```

#POWER CONSUMPTION PER MONTH

```
tmp_df.drop(tmp_df.index[len(tmp_df)-1], inplace=True)
tmp_df.drop(tmp_df.index[0], inplace=True)

# tmp_df.info()
print(tmp_df.head(25))


new_df=pd.DataFrame(columns=('date', 'day_quarter', 'kwh'))
counter=0
foriinxlab:
j_df=up_df.loc[req_df['date'] ==i]
for kinrange(1,5):
tdf=j_df.loc[j_df['day_quarter']==k]
if(len(tdf)>0):
new_df.loc[counter] = (i,k,tdf['kwh'].iloc[len(tdf)-1] -
tdf['kwh'].iloc[0])
counter+=1

# new_df.drop(tmp_df.index[len(tmp_df)-1], inplace = True)
# new_df.drop(tmp_df.index[0], inplace = True)

# print(new_df.head(25))
new_df
```

#PLOT2

```
data=pd.DataFrame(new_df)
#end of dataset generation
importmatplotlib.datesasmdates
fig, ax=plt.subplots()

# for temp in range(1,5):

slot= ['08-12','12-16','16-20']
fori, colorinenumerate(['red', 'blue', 'green'], start=1):
dat= data[data['day_quarter']==i]
    t1 =dat['date'].tolist()
    t2 =dat['kwh'].tolist()
    x = [j for j inrange(2,len(t1)+2)]
plt.plot(x,t2,'o',color =color, label = slot[i-1])

print(data[data['day_quarter']==2])
u_date=up_df.date.unique()
x = [iforiinrange(1,25)]
plt.xticks(x, u_date, rotation='vertical')
plt.xlabel("mm/yy")
plt.ylabel("Power Consumption")
```

```
plt.legend()

plt.show()
```