Asian Journal of Electrical Sciences
ISSN: 2249-6297 (P) Vol.10 No.2, 2021, pp.40-43

DOI: https://doi.org/10.51983/ajes-2021.10.2.3165

A Case Study of Energy Conservation Using Python in Bapatla Engineering College, Andhra Pradesh

Chittari Surya Nirma Varma, Guruvindapalli Salmon Raju, Satya Dinesh Madasu and Ravindra Janga
Department of Electrical and Electronics Engineering, Bapatla Engineering College Bapatla, Andhra Pradesh, India
E-mail: varmasurya2001@gmail.com, salmonraju209@gmail.com, msdinesh.nitjsr@gmail.com, ravindrajanga@gmail.com
(Received 17 August 2021; Revised 9 September 2021; Accepted 15 October 2021; Available online 21 October 2021)

Abstract - **Energy Audit, in general, is the process of turning conservation concepts into reality by combining technically possible solutions with cost-effective organization within a set time limit. Auditing has grown in importance in recent decades because of its numerous advantages, including low maintenance and environmental benefits. The main goal is to lower the cost of energy use per unit. It serves as a benchmark for managing energy in an organization as well as a foundation for planning the most efficient use of energy. This proposed project examines the economic viability of replacing legacy equipment with modern technology like python, as well as calculating the return-on-investment period and doing research in Bapatla Engineering College, India**
Keywords: **Energy Audit, Return Back Period, Economic Viability, Python**

I. INTRODUCTION

Nowadays, electrical energy auditing plays a very significant part in the domain of electric efficiency. In this regard, load consumption data, stock register data, previous year's monthly bills, and used python programming for the purpose of electric energy auditing, conducting an energy audit usually reveals a large potential of saving energy [1]. One of the major energy consumptions among residential and commercial is educational sectors in India which grows rapidly day by day and which tends to demand electricity. In today's world, using current technology in every project is becoming increasingly important to complete tasks efficiently. Python is one of the languages that continue to rise in popularity year after year. Several major industrial and commercial buildings have implemented internal energy management programs based on energy audits to reduce energy waste or meet the requirements of certain legislation and standards. In addition to the walk-through audit and utility cost analysis, there are other actions to consider [2]. Before the auditing process begins, the team is normally tasked with determining the required resources for the budget and timeframe, as well as acquiring the necessary information. Furthermore, depending on the time duration, building complexity, client criteria, and financial limits, an energy audit can be performed at three different levels [3]. To maximize the opportunities afforded by large commercial office buildings while minimizing the dangers posed by their challenges, a complete approach might be adopted. This method, which considers all loads and equipment, provides the highest cost savings and the widest range of upgrades from which the owner can pick. Methodical data gathering increases savings, simplifies analysis, and documents recommendations in a way that makes implementation much easier. Python programming can also assist in identifying anomalous energy losses as well as opportunities. Before evaluating prospective improvements, calculation techniques should focus on calibrating the building's energy use with weather-corrected billing data [4]. We can use several sorts of libraries in Python programming depending on the purpose. Matplotlib was built with the notion that you should be able to produce basic plots with just a few commands, or even just one! You shouldn't have to create objects, execute methods, or specify properties to see a histogram of your data; it should just work.

Matplotlib's First Goals were

1. Plots, especially the text, should be of publishing standard (antialiased, rotated, etc.).
2. Output in PostScript for use with TEX documents.
3. For application development, it can be included in a graphical user interface.
4. The code should be easy to comprehend.
5. Plotting should be simple.
6. The program is free to download, use, and distribute because it is Open Source [5].

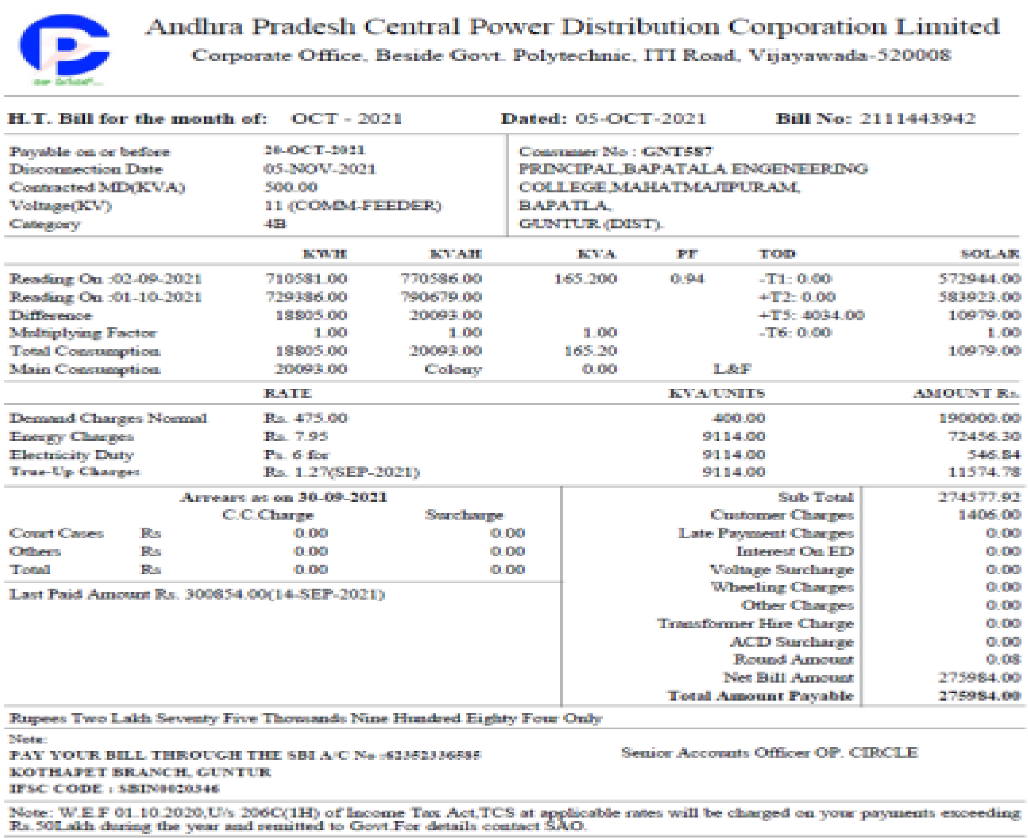
Buildings' contribution to global energy consumption, both residential and commercial, has gradually climbed, reaching values of 20 to 40 percent in industrialized countries, and has surpassed the contributions of other important sectors such as industry and transportation [6]. Industrialization and population expansion are expanding at an exponential rate in most countries around the world, driving up energy demand [7]. In developing countries like India, a lack of energy acts as a roadblock to progress. Electric power is in high demand in India due to the country's rapid economic growth. Most of the electric demand is currently met by coal power plants, putting strain on fossil fuels. This can provide a reliable power supply while also reducing the negative environmental impact of fossil fuels [8]. India is rapidly moving toward dispersed generation to lessen the stress on the national grid, and different studies reveal that a renewable-based micro-grid is the most viable option for decentralized energy generation [9]. Building energy conservation measures (ECMs) can reduce greenhouse gas

(GHG) emissions in metropolitan areas dramatically. Local governments have established a variety of measures aimed at increasing the amount of information available on building energy use to support ECM implementation. Audits are both expensive and time-consuming. Policymakers are looking into ways to use available data to target ECMs across a city to speed up ECM deployment [10]. Employees come to think of energy as a controllable expense and endeavor to preserve it in day-to-day activities because of the energy audit process in the industry [11]. Energy insecurity has been a major impediment to Asia's economic development. As a result, three alternative metrics of energy insecurity are developed. The empirical findings show that energy insecurity is on the rise in Bangladesh, China, India, Indonesia, Malaysia, and Nepal. The trend of variable but recently improving energy security, on the other hand [12]. The influence of India's Energy Conservation Building Code (ECBC), which applies to commercial buildings with a connected load of more than 100 kW or a contract demand of more than 120 kVA, has been studied on six distinct types of buildings in Jaipur [13]. Energy audits are an important aspect of energy conservation, and energy management is equally important. It is a preliminary investigation into the establishment of an energy management program [14]. The purpose of the energy audit was to improve the building's design with incremental needs to improve energy efficiency even more. Since its first implementation in 2011, the Energy Conservation Building Code (ECBC) has undergone numerous revisions, with the most recent revisions being in 2019. The ECBC energy conservation criteria cover the building envelope, heating, ventilation, air conditioning, lighting, and other aspects of the building [15].

As a result, an energy conservation Auditing case study was done at Bapatla Engineering College in India. To create a report that demonstrates the reduction of energy consumption by replacing existing equipment with modern equipment, as well as to identify opportunities to save economy and energy which helps in the growth of India. For auditing purpose and successful implementation, some steps must adhere as given below in this article

1. Collect Load consumption data.
2. Collect Previous Years Monthly Bills from 2018 to 2022.
3. Collect Previous Years Stock Register.
4. Cost Benefit Analysis.
5. Energy consumption monitoring Energy and cost Index in Pie Charts or Sankey diagrams.
6. Energy Conservation Schemes.
7. Detail project Report.

In the Indian state of Andhra Pradesh, central authority distribution corporation Limited is the AP Government fully owned utility which was formed as per Government order Ms No 41 [16] bills as shown in figure 1. The bill depicts Bapatla Engineering college monthly consumption which is stock register data as shown in the figure 2.



Andhra Pradesh Central Power Distribution Corporation Limited
Corporate Office, Beside Govt. Polytechnic, ITI Road, Vijayawada-520008

H.T. Bill for the month of: OCT - 2021 Dated: 05-OCT-2021 Bill No: 2111443942

Payable on or before	20-OCT-2021	Consumer No : GNT587
Disconnection Date	05-NOV-2021	PRINCIPAL,BAPATALA ENGENEERING
Contracted MD(KVA)	500.00	COLLEGE,MAHATMAJIPURAM,
Voltage(KV)	11 (COMM-FEEDER)	BAPATLA,
Category	4B	GUNTUR (DIST).

	KWH	KVAH	KVA	PF	TOD	SOLAR
Reading On :02-09-2021	710581.00	770586.00	165.200	0.94	-T1: 0.00	572944.00
Reading On :01-10-2021	729386.00	790679.00			+T2: 0.00	583923.00
Difference	18805.00	20093.00			+T5: 4034.00	10979.00
Multiplying Factor	1.00	1.00	1.00		-T6: 0.00	1.00
Total Consumption	18805.00	20093.00	165.20			10979.00
Main Consumption	20093.00	Colony	0.00	L&F		

	RATE	KVA/UNITS	AMOUNT Rs.
Demand Charges Normal	Rs. 475.00	400.00	190000.00
Energy Charges	Rs. 7.95	9114.00	72456.30
Electricity Duty	Ps. 6 for	9114.00	546.84
True-Up Charges	Rs. 1.27(SEP-2021)	9114.00	11574.78

Arrears as on 30-09-2021

		C.C.Charge	Surcharge
Court Cases	Rs	0.00	0.00
Others	Rs	0.00	0.00
Total	Rs	0.00	0.00

Last Paid Amount Rs. 300854.00(14-SEP-2021)

Sub Total	274577.92
Customer Charges	1406.00
Late Payment Charges	0.00
Interest On ED	0.00
Voltage Surcharge	0.00
Wheeling Charges	0.00
Other Charges	0.00
Transformer Hire Charge	0.00
ACD Surcharge	0.00
Round Amount	0.08
Net Bill Amount	275984.00
Total Amount Payable	275984.00

Rupees Two Lakh Seventy Five Thousands Nine Hundred Eighty Four Only

Note:
PAY YOUR BILL THROUGH THE SBI A/C No :62352336585
KOTHAPET BRANCH, GUNTUR
IFSC CODE : SBIN0020346

Senior Accounts Officer OP. CIRCLE

Note: W.E.F 01.10.2020,U/s 206C(1H) of Income Tax Act,TCS at applicable rates will be charged on your payments exceeding Rs. 50Lakh during the year and remitted to Govt.For details contact SAO.

Fig. 1 Collected Previous Monthly Bills

Description pf the Location		Fans		Tube Lights		Computers	Printers	Scanners	LCD	Water Coolers	Xerox	Servers & Hubs	Air Condition	Motors	Total Load in KW
		Ceiling	Wall Mounted	Single	Double										
GEB	Quantity	328	33	232	113	246	6	5	5	3	5	3	112.6 Ton	49.2 HP	
	Power In KW	26.24	4.95	9.28	9.04	36.9	4.5	2.5	7.5	1.5	7.5	1.5	140.07	36.16	287.64
Admin Block	Quantity	143	27	118	242	220	17	3	5	3	3	6	86 Ton	12.5 HP	
	Power In KW	11.44	4.05	4.72	19.36	33	12.75	1.5	7.5	1.5	4.5	3	107.5	9.18	220
Research Park	Quantity	312	-	154	272	338	6	4	10	4	3	3	138 Ton	27.5 HP	
	Power In KW	24.96	-	6.16	21.76	50.7	4.5	2	15	2	4.5	1.5	172.5	20.21	325.79
Main Building	Quantity	307	16	262	85	228	7	5	8	4	4	4	50 Ton	72.5 HP	
	Power In KW	24.56	2.4	10.48	6.8	43.2	5.25	2.5	12	6	6	2	62.5	53.28	236.97
CMB	Quantity	161	18	194	52	90	4	4	6	2	3	2	29.6 Ton	92.5 HP	
	Power In KW	12.88	2.7	7.7	4.16	13.5	3	2	9	1	4.5	1	37	67.98	166.42
Chemical Block	Quantity	28	6	41	8	33	2	1	1	1	1	1	8 Ton	1.5 HP	
	Power In KW	2.24	0.9	1.64	0.64	4.95	1.5	0.5	1.5	0.5	1.5	0.5	10	1.1	27.47
Centeen	Quantity	49	14	22	54	1	1	1	-	2	-	1	33 Ton	25 HP	
	Power In KW	3.92	1.12	0.88	4.32	0.15	0.75	0.5	-	2	-	0.5	41.25	18.375	73.765
Ladies Hostel	Quantity	157	-	239	10	116	-	-	-	2	-	1	1.5 Ton	15 HP	
	Power In KW	12.56	-	9.56	0.8	17.4	-	-	-	1	-	0.5	1.75	11.025	54.6
Street Lights	Quantity	-	-	36	16	-	-	-	-	-	-	-	-	40 HP	
	Power In KW	-	-	9	8	-	-	-	-	-	-	-	-	29.4	46.4
Auditorium Hall	Quantity	120	-	27	85	8	4	1	-	1	3	1	13.5 Ton	1 HP	
	Power In KW	9.6	-	1.08	6.8	1.2	3	0.5	-	0.5	4.5	0.15	16.87	0.735	44.94
Total Load															1484

Fig. 2 Collected Stock Registered Data

II. PYTHON PROGRAME FOR EFFICIENT BULB

By using conditional statements, the equipment details are compared with the standards of Bureau of energy efficiency India (BEE).

Code

```
equipment=input (“enter device name”)
equipcost=float (input(“enter the value:”))
st=float    (input(“enter the time in seconds”))
#st=start time
ls=int(input(“enter life span”))
#ls=life span
CRI=int(input(“Enter color rendering index value”))
#color rendering index
ct=float      (input(“Enter the color temperature in kelvin”))
#Color temperature
if equipcost<=150 and st<0.5 and ((ls>20000)and(ls<50000))
 and ((CRI>0)and(CRI<100)) and ((ct>5000)and(ct<6500):
                print(“efficient”)
         else:
               print(“Inefficient”)
```

Response

```
enter device name: x enters the cost:130
enter the time in seconds0.3
enter life span34000 Enter color rendering index value45
Enter the color temperature in kelvin5678
efficient
```

III. RESULUT AND ANALYSIS

In this section, the results are analyzed the electrical appliances' percentage of consumption on the total load consumption by stepwise.

1. Total Tube Light Consumption = Single Type Consumption + Double Type Consumption
2. Single Type Consumption = Sum of Consumption (GEB, Main block, Research Park, Admin Block etc) = 128.4 KW
3. Double Type Consumption = Sum of Consumption (GEB, Main Block, Research Park, Admin Block etc) =81 .68 KW
4. Total Tube Light Consumption per day = 128.4 + 81.68 = 142.18 KW
5. Total Load Consumption in the college per day = 1484.00 KW
6. Annual Percentage of Tube Light Consumption = ((142.18 * 365)/(1484.00 * 365)) * 100 = 9.58%
7. Annual percentage consumption of bulb on total load = 9.58%

A. Comparison with Standard Values

1. According to Bureau of Energy Efficiency Standards in India, The Light Load can be allowed to have 2- 10% Annual Consumption.
2. The Light Load Consumption in Bapatla Engineering College is 9.58% of Total Load in the Institution.

Similarly, the fans in the Institution have consumed 9.74% of Total load.

B. Cost Benefit analysis and Energy Consumption in Bar Diagrams

```
import numpy as np
import matplotlib.pyplot as plt
#creating data set
```

```
data=
{‘OldBC’:60500,’newBC’:26500,’OldBP’:822825,’newB
P’:291500,’oldFC’:128400,’newFC’:48150,’OldFP’:26867
70,’newFP’:48150}
equipdetails=list(data.keys())
values=list(data.values())
fig=plt.figure(figsize=(10,10))
plt.bar(equipdetails,values,color=‘maroon’,width= 0.5)
plt.xlabel("Equipment name")
plt.ylabel("Equipment values")
plt.title("Comparsion of Old and new Equipment details")
plt.show()
#bulb price, NewBp=New bulb price, OldFC=old fan
consumption,
NewFC=new fan consumption,
OldFP=old fan price,
newFP=new fan price
#OldBC=Old bulb Consumption,
NewBC=new bulb consumption,
OldBP=old
```

Output has been depicted in figure 3.

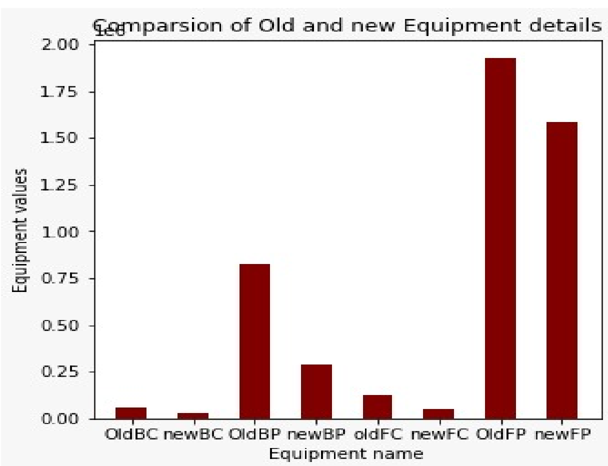


Fig. 3 Comparison of Electrical Appliances

IV. CONCLUSION

The energy usage is shown in bar diagrams in this study using efficient libraries in Python programming. The most common method for locating an efficient bulb is to use a python programming code. The cost-benefit analysis is performed using the stock registered data provided by Bapatla Engineering College, India and the results are compared with standard BEE values and calculate the investment’s return on investment using the cost-benefit analysis which can compute depreciation and amortization using financial analysis. Finally, this proposal examines the economic viability of replacing existing equipment with modern equipment, as well as the calculation of return on investment and the examination of possible operating scenarios using existing source-load combinations and composition.

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