Carbon Footprint Dashboard in TAMUQ

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Objectives

- Problem statement
- Proposed solution
- technical standards, constraints and risks
- Performance criteria such as economic, environmental, social, political, ethical, health, safety
- The advantages of our design over its counterpart designs.
- simulation results, visual prototyping and analysis for designed circuits,program code
- Conclusion

Problem Statement

Energy Consumption and Carbon Footprint

Globally

Global Warming

Climate Change

Qatar

Ranked second World-wide

Texas A&M

Ranked second in QF

Collective Data

Proposed solution

Carbon footprint dashboard

Monitor the carbon footprint in TAMUQ

+

Recommend solutions

Reduce the carbon footprint

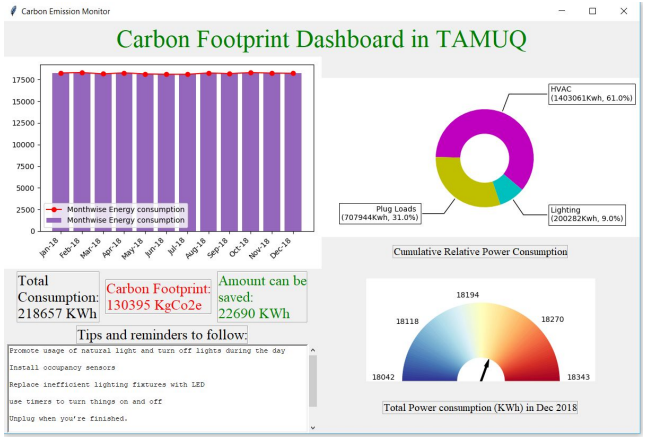
Carbon footprint dashboard

4/6 main panels
Supply power to Tamuq

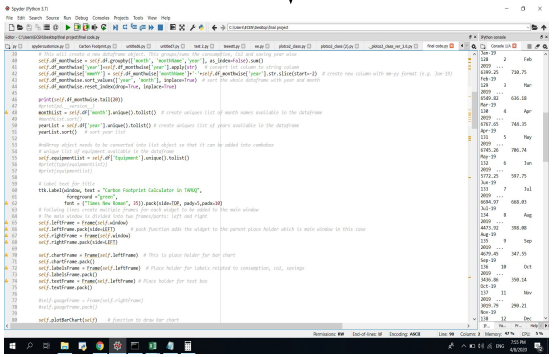
Category	subcategory
Plug loads	Computers
	AV equipment
	Serves
	printers
	Peripherals
	others
lighting	CFL light
	fluorescent light
	LED
HVAC	AHU
	heaters
	pumps

Excel spreadsheet with all components showing power consumption to calculate the carbon footprint (KgCo2e)

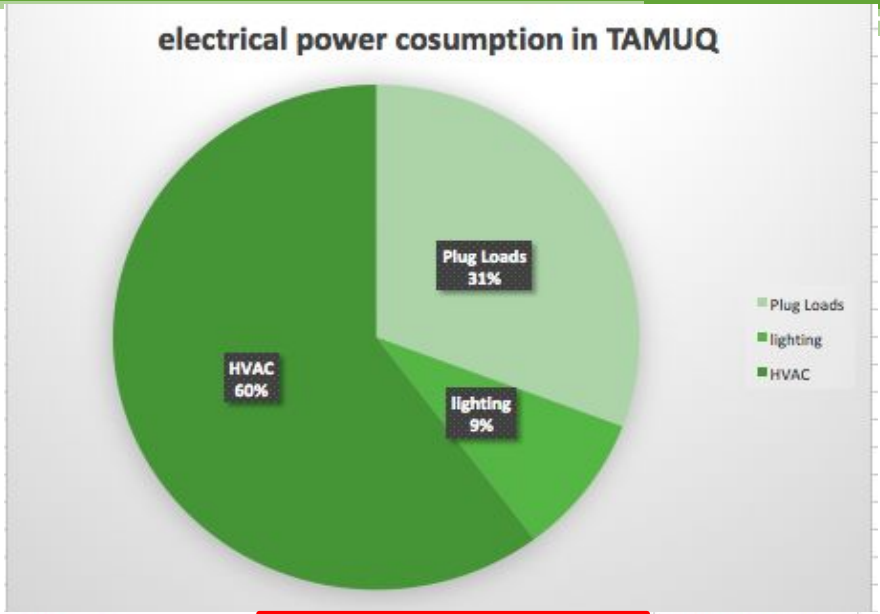
Using Qatar conversion factor = 0.596345388



Dashboard presenting the carbon footprint in Tamuq



Using Python to create the carbon footprint dashboard



	total power consumption	total carbon footprint	Total power consumption per day in Kwh	total carbon footprint per day
Plug Loads	5662.74	3380.65	18413.05	10992.5908
lighting	1656	988.632		
HVAC	11094.31	6623.3		

	Monthly Energy consumption KWh						
Meter #	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20
198344	163241	186219	170534	171,710	190990	191060	175470
198345	112312	110338	128634	127,640	133780	127800	78230
198347	130000	130000	130000	130000	130000	130000	130000
198348	189256	139513	131202	124,996	62498	63020	90370
Electrical Total consumption	594809	566070	560370	554346	517268	511880	474070
Solar Inverter production	25231	17653	21161	18224	19333	17124	17321
HVAC cooling energy consumption	2109684	1549792	1614108	1,644,776	NA	NA	NA
electrical Total consumption per day in Kwh	19826.9	18869	18679	18478.2	17242.2	17062.6	15802.3

Proposed solutions

Lighting

1. Replacement with more efficient light bulbs[1]

2. Reduce the number of light bulbs in the building

3. Use light controls: dimmers,motion sensors,occupancy sensors[2]

Plug Loads

1. **Technical solutions:** integrating circuit controls, installing meters and sub-meters ,using Advanced power strips (APS),Installing DC microgrids.
2. **Behavioral Solution:** the first method is raising awareness Campaigns, this can include workshops, newsletters ,emails and regular meetings. Encourage occupant to use equipment recommended by ENERGY STAR

HVAC

1.Recommissioning is a process for investigating, analyzing and optimizing the performance of building systems (10-15%) [3.]

2. Collecting occupants temperature preferences [5] then modifying the thermostat temperature to be increased from 18°C to 21°C[6] by taking the average.

Lighting

Example

Category	subcategory	model number	total number	power consumption per unit W	Operating hours	power consumption in Kwh	total power consumption in Kwh	Carbon footprint in kgCo2e
lighting	CFL light	GE Lighting Long Last	250	42 W	24 hr	1.008	252	150.444
	fluorescent light	GE Lighting T5 Long Last	550	80 W	24 hr	1.92	1056	630.43
	LED	Philips	500	58 W	12 hr	0.696	348	207.756
lighting Modified	LED	GE 39283	250	18.5 W	24 hr	0.444	111	66.267
	LED	Osram	550	37 W	24 hr	0.888	488.4	291.57
	LED	Philips	500	58 W	12 hr	0.696	348	207.756

	total power consumption in Kwh	Carbon footprint in kgCo2e
Lighitng	1656	988.632
lighting Modified	947.4	565.5978
saved power consumption in kwh	708.6	423.042
saved power consumption in %	43%	43%

HVAC

Changing the temperature from 18°C to 21°C would save 12% of the total power[6]

	total power consumption	total carbon footprint
Plug Loads	5662.74	3380.65
lighting	1656	988.632
HVAC	11094.31	6623.3
changing the temperature from 18 to 21		
HVAC	9762.99	5828.5

Plug loads

A combination of savings strategies demonstrate a 47% reduction in electricity consumption[4].

Total power consumption for plug loads	5662.74
Total power consumption after applying savings strategies	3001.25
percentage can be saved	47%

Total saved power

Plug Load:14.57%
Lighting: 3.87%
HVAC:7.2%

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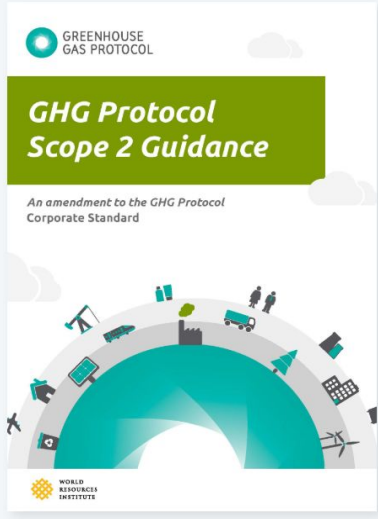
Total saved Electricity: 25.64%

Technical standards, risks, constraints

Technical Standards



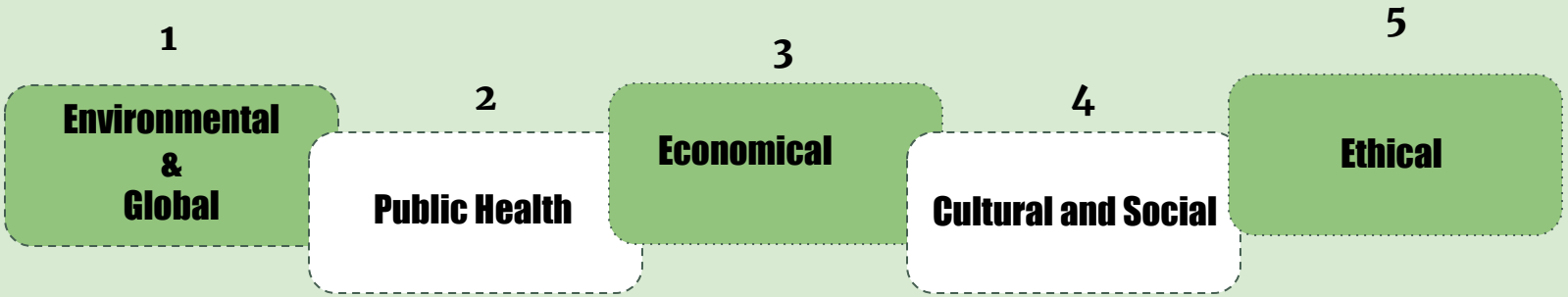
Constraints

- No available smart meters in campus
- No Authorization for installing smart meters
- No Real time data
- Data Inventory

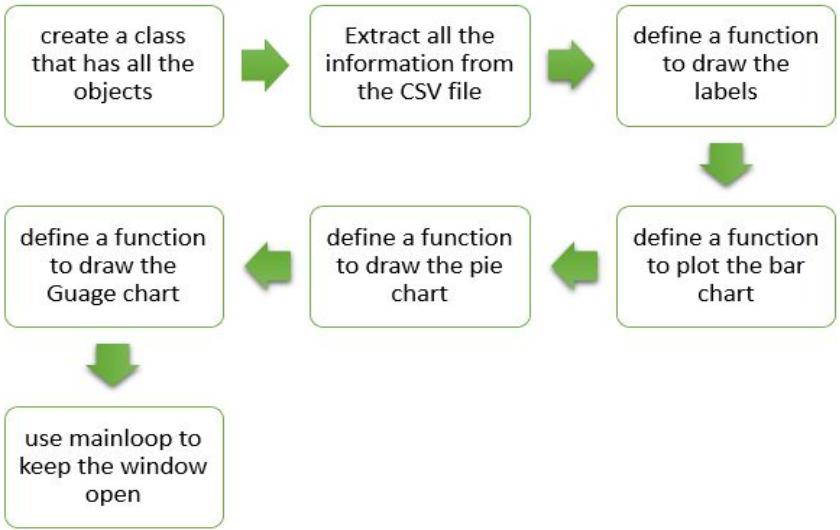
Risks

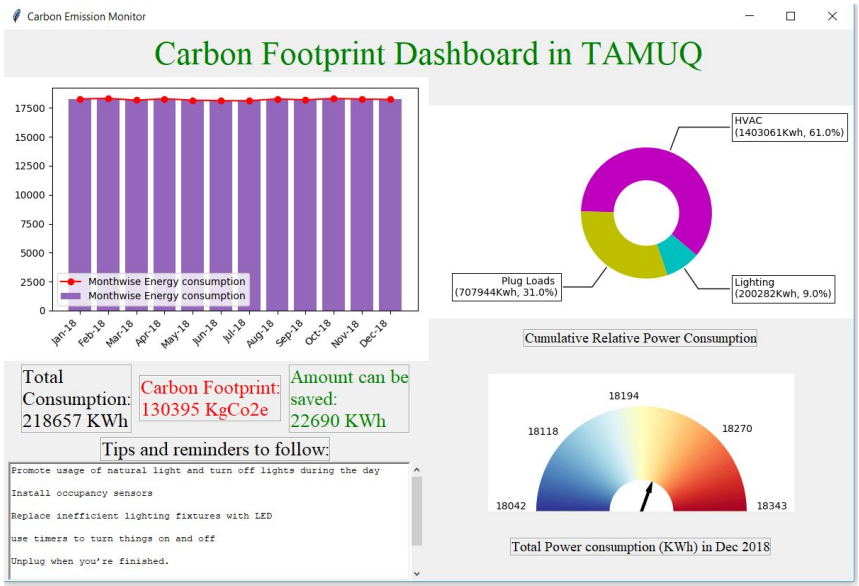
Accuracy

Performance Criteria



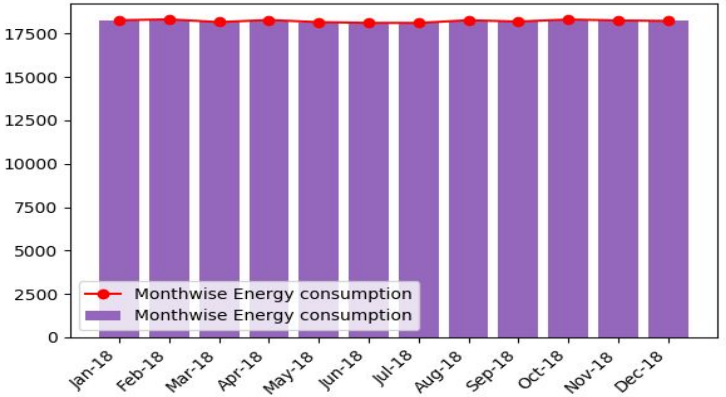
Flow chart of the Algorithm





Program code and Prototype

```
    ax1.legend()
    # This line rotates the x-axis labels by 45 degrees.
    ax1.set_xticklabels(df_chart['mmmYY'].tail(bars), rotation=45, horizontalalignment='right')
    # To pack the layout of the graph. This line will avoid any part of the plot overlapped to each other if smaller window size is used.
    fig.tight_layout()
    # Canvas a canvas with parent of chartFrame and add the figure object on the canvas
    self.canvas = FigureCanvasTkAgg(fig, master=self.chartFrame)
    # packe the canvas for the window
    self.canvas.get_tk_widget().pack()
    # finally print the plot on the window
    self.canvas.draw()
```




```
def drawLabels(self, args):
    # These are self explainatory labels syntax including their font style, size, colors, borders etc
    # padx means the padding distance in pixels on x-axis, pady is the padding on y-axis
    year_to_show = 2018
    ttk.Label(self.labelsFrame, wraplength=200, borderwidth=2, relief="groove", text = "Total Consumption:\n"+str(int(self.df_new[self.df_new['year']==year_to_show]['Consumption']))+" KWh",
            font = ("Times New Roman", 20)).pack(side=LEFT, pady = 5)
    ttk.Label(self.labelsFrame, wraplength=200, borderwidth=2, relief="groove", foreground ="red", text = "Carbon Footprint:\n"+str(int(self.df_new[self.df_new['year']==year_to_show]['CO2']))+" K
            font = ("Times New Roman", 20)).pack(side=LEFT, padx = 10, pady = 5)
    ttk.Label(self.labelsFrame, wraplength=200, borderwidth=2, relief="groove",foreground ="green", text = "Amount can be saved:\n"+str(int(self.df_new[self.df_new['year']==year_to_show]['savings
            font = ("Times New Roman", 20)).pack(side=LEFT, pady = 5)
```


```
        self.canvas.draw()

    def drawTextArea(self, args):
        # creates a label
        ttk.Label(self.textFrame, borderwidth=2, relief="groove", text = "Tips and reminders to follow:",
                font = ("Times New Roman", 20)).pack()
        # Opens file in read only mode. All the tips and info will be stored there
        f = open("tips.txt", "r")
        # creates a text area where the text from the file will be displayed.
        displayText = ScrolledText(self.textFrame, height=10, width=70, borderwidth = 3)
        # Text from the file is inserted in the text area
        displayText.insert(INSERT, f.read())
        # pack the widget to display it on the window
        displayText.pack()
        # uncomment line below if you want the text area to be read only
        #displayText.configure(state='disabled')
```

PIE Chart

CODE


```
139    def drawPie(self, *args):
140        # creates a figure object and add subplot
141        self.fig1, ax = plt.subplots(figsize=(6, 3), subplot_kw=dict(aspect="equal"))
142        # Group the actual data equipment wise and sum the consumption for each equipment and copy the result into a temp dataframe
```

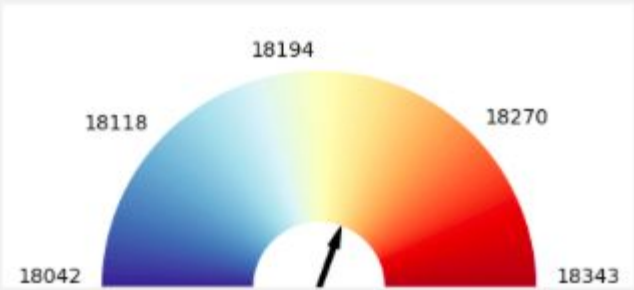
```
157            # this loop will append the labels into list with percentage values and actual consumption
158            for x in data:
159                temp = round((x/dataSum)*100)
160                newList[i] = equipment[i]+' \n('+str(x)+'Kwh, '+str(temp)+'%)'
```

```
157            # this loop will append the labels into list with percentage values and actual consumption
158            for x in data:
159                temp = round((x/dataSum)*100)
160                newList[i] = equipment[i]+' \n('+str(x)+'Kwh, '+str(temp)+'%)'
161                i=i+1
```

Guage Chart

```
193
194     def drawGuage(self, args):
195         # select the minimum and maximum consumption
196         mn = self.df_monthwise['Consumption'].min()
197         mx = self.df_monthwise['Consumption'].max()
198
```

```
207         labels = [' ']*len(dial_colors)*2
208         labels[1] = mx # maximum value to dispaly here
209         labels[25] = int(values_list[75])  #75% of the max value
210         labels[50] = int(values_list[50])  # 50% of the max value
211         labels[75] = int(values_list[25])  # 25% of the max value
212         labels[98] = mn  # diplay the min value on the left most side
213
```



Total Power consumption (KWh) in Dec 2018

Advantages

- Projection for load profile
- Use the dashboard to raise awareness for the TAMUQ community
- Our tool is flexible and can be used for commercial buildings

Troubleshooting and Experimental Testing

1. Expected real-time data
2. Selecting a different approach based on the available data
3. Collecting Data
4. Accuracy

Summary

- Carbon footprint in Qatar
- Proposed solution
- Advantages
- Prototype
- standards,risks,constraints

Future recommendations & improvements

- Apply smart meters
- Generate real time data
- Real time dashboard

References

[1] “lamp.com,” *Any*. [Online]. Available: https://www.any-lamp.com/osram-substitube-t5-un-ho-37w-840-145cm-cool-white-replaces-80w.

[2] “Lighting control system,” *Wikipedia*, 13-Mar-2020. [Online]. Available: https://en.wikipedia.org/wiki/Lighting_control_system.

[3]“Energy Saving Tips for Commercial and Industrial Buildings,” *Daisy Energy*, 31-Oct-2018. [Online]. Available: https://daisyenergy.ca/energy-saving-tips-commercial-industrial-buildings/.

[4]Engaging Tenants in Reducing Plug Load Energy Use.” [Online]. Available: https://www.aceee.org/files/proceedings/2016/data/papers/8_178.pdf

[5]Facilities.unc.edu. 2020. [online] Available at: https://facilities.unc.edu/files/2016/03/Electricity-Consumption-Report.pdf

[6] O. Bureau, “BEE: Raising AC setting by 1° can save 6% power,” *@businessline*, 27-Jun-2018. [Online]. Available: https://www.thehindubusinessline.com/news/bee-raising-ac-setting-by-1-can-save-6-power/article24272825.ece.