SHAHEED RAJGURU COLLEGE OF APPLIED SCIENCES FOR WOMEN, UNIVERSITY OF DELHI, DELHI-110096

ENVIRONMENT AUDIT REPORT

2019-2020

*Note: CO_2 emission in the form of biogas or CH_4 oxidation is not counted in GHG inventories.

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1. Introduction:

Shaheed Rajguru College of Applied Sciences for Women (SRCASW) engage in the effort to reduce Green House (GHGs) gas emission and realizes its role in understanding the effects of global warming and climate change. The institute takes initiative in conducting studies in collecting GHG inventories, that can form the baseline for measuring the progress and provide a foundation for setting and meeting the targets. These inventories in the form of auditing are summarized in the report which will also help in evaluating the cost-effective GHG reduction opportunities and strategies. The present audit report is designed to give a comprehensive and yet easy-to-read review to the readers. Moreover, the report will help in comparing, and conserving the resources like energy, water, waste and fossil fuel consumption. The environment audit report is thus inclined to make SRCASW assess general practices in terms of the impact on the environment. The report also aims to spread awareness on how strongly the institute is involved in curtailing those practices.

2. Goals of Environment audit:

Following are the goals and ambition of the reports:

1. To create a baseline survey for comparing and measuring the progress.
2. To examine the current practises and their contribution in terms of CO_2, N_2O, and CH_4 equivalence.
3. To compare, innovate and install green and alternative sources of energy.
4. To reduce dependencies on energy obtained from fossil fuels.
5. To identify and mitigate the problems of waste disposal.
6. To escalate the growth of the green cover of the campus.
7. To spread the awareness for environmental consciousness and sustainable use of resources.
8. To identify and assess environmental risk, if any in SRCASW.

3. Methodology:

The data was collected using survey forms from 1) Students, 2) Teaching Staff and 3) Non-teaching staff from all the departments, administrative building, canteen and hostels. The data comprise 1765 students (1652, day scholars and 115, hostlers), ~130 teaching staff, and ~30 non-teaching staff members. The number of working days was taken for January, February and the first 10 days in March, after which the lockdown was imposed. The Audit report is carried out for i) CO2 emission from transportation (Carbon auditing), ii) CO2 emission from the energy usage (Energy auditing), iii) GHG emission from wastewater and solid waste (Water and Waste auditing), and iv) potential CO2 sinks in the college.

*Note: CO2 emission in the form of biogas or CH4 oxidation is not counted in GHG inventories.

I. CO_2 emission from the Transportation

A carbon footprint is the total greenhouse gas emissions caused directly and indirectly by an individual, organization, event or product. It is calculated by summing the emissions resulting from every stage of a product or service's lifetime. The calculations, formulae and results discussions are supported with the help of tables and graphs. The data was collected from (i) the academic block, (ii) the administrative building, and (iii) the canteen and hostel area. In the academic block, the data were collected separately for each department.

I.1 Components of the Calculations:

The calculations are based on the findings and assumptions (reported elsewhere) mentioned below. These findings were obtained by calculating the data collected from the google forms that were circulated in all the departments amongst students, teaching and non-teaching staff.

Activity (total fuel consumption in L) * Emission Factor (kg of CO_2 per litre of fuel) = CO_2 Equivalence (CO_2e) of emissions.

Fuel consumption per person = Distance (kms) * Avg. fuel consumption (L per km)**

1. Average fuel consumption per km travel = 0.05 kg CNG
2. Average Diesel consumption per km travel = 0.07 kg Diesel
3. Average Petrol consumption per km travel (2 wheeler) = 0.03 kg Petrol
4. Average Petrol consumption per km travel (4 wheeler) = 0.1 kg Petrol
5. Travel by metro per km travel = 0.065 kg CO2 per commuter
6. Average travel by e-rickshaw per day = 4 km per person

Annual $kgCO_2e$ Consumption of SRCASW through transportation= 687.4 tonnes CO_2e

Table I.1 Region-wise distribution of kgCO2 equivalence emission for 4-wheelers, 2-wheelers and public transportation.

Department	$kgCO_2e$ for 4 wheelers	$kgCO_2e$ for 2 wheelers	$kgCO_2e$ for Public transport	TOTAL $kgCO_2e$ per day
Biochemistry	57.6	1.0	600.3	658.9
Biomedical Sciences	24.5	2.2	607.8	634.4
Chemistry	14.8	6.0	552.1	572.9
Computer Science	28.6	17.2	852.7	898.5
Electronics	9.4	2.5	493.1	504.9
Food technology	34.3	9.6	276.8	320.8
Instrumentation	11.3	7.0	689.1	707.4
Mathematics	29.2	4.1	658.9	692.2
Management & Financial Studies	49.1	78.6	1206.8	1334.5

*Note: CO2 emission in the form of biogas or CH4 oxidation is not counted in GHG inventories.

Microbiology	72.0	1.1	542.5	615.7
Psychology	263.1	7.5	838.0	1108.6
Physics	23.7	15.4	694.0	733.0
Statistics	32.4	7.0	771.7	811.1
Administrative Building	55.8	7.0	164.7	227.5
Canteen and Hostel	0	13.4	2.0	15.4
Total	705.6	179.6	8950.6	**9835.8**

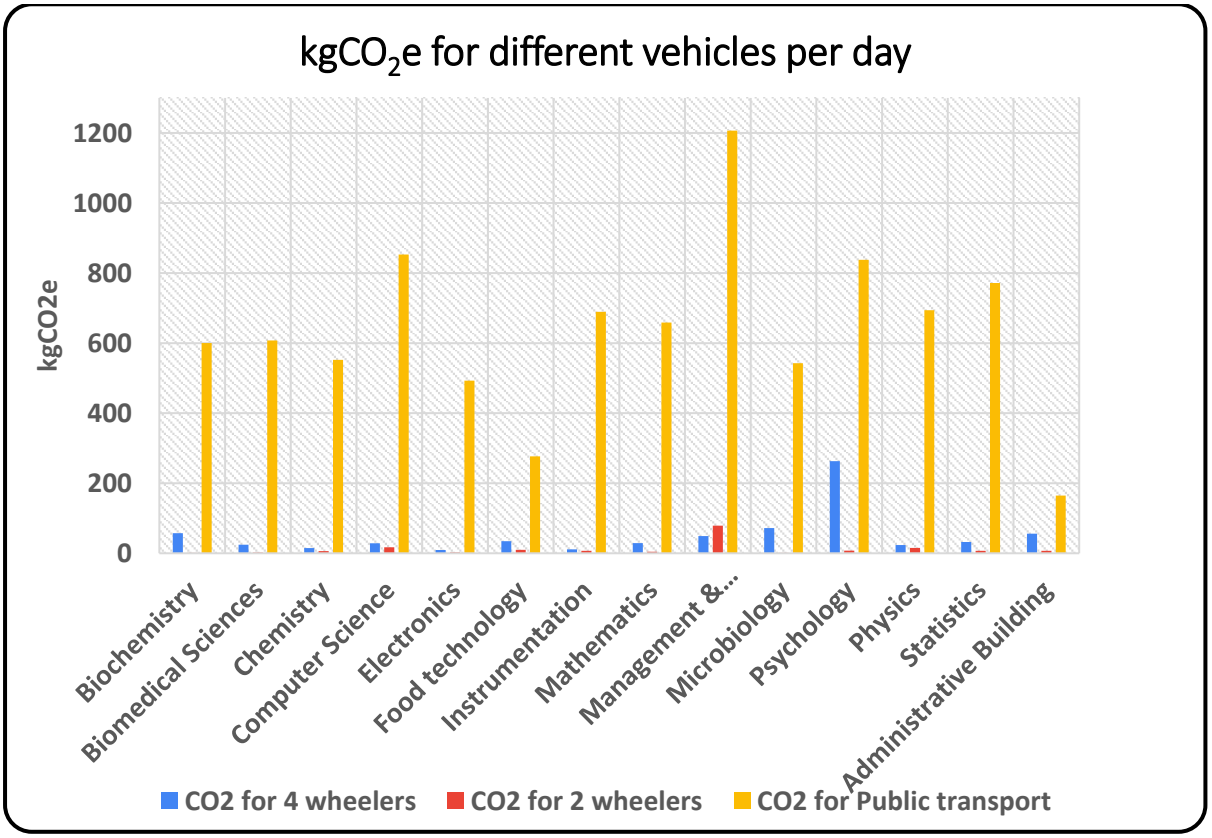


Fig I.1. Region-wise distribution of $kgCO_2$ equivalence emission for 4-wheelers, 2-wheelers and public transportation.

*Note: CO2 emission in the form of biogas or CH4 oxidation is not counted in GHG inventories.

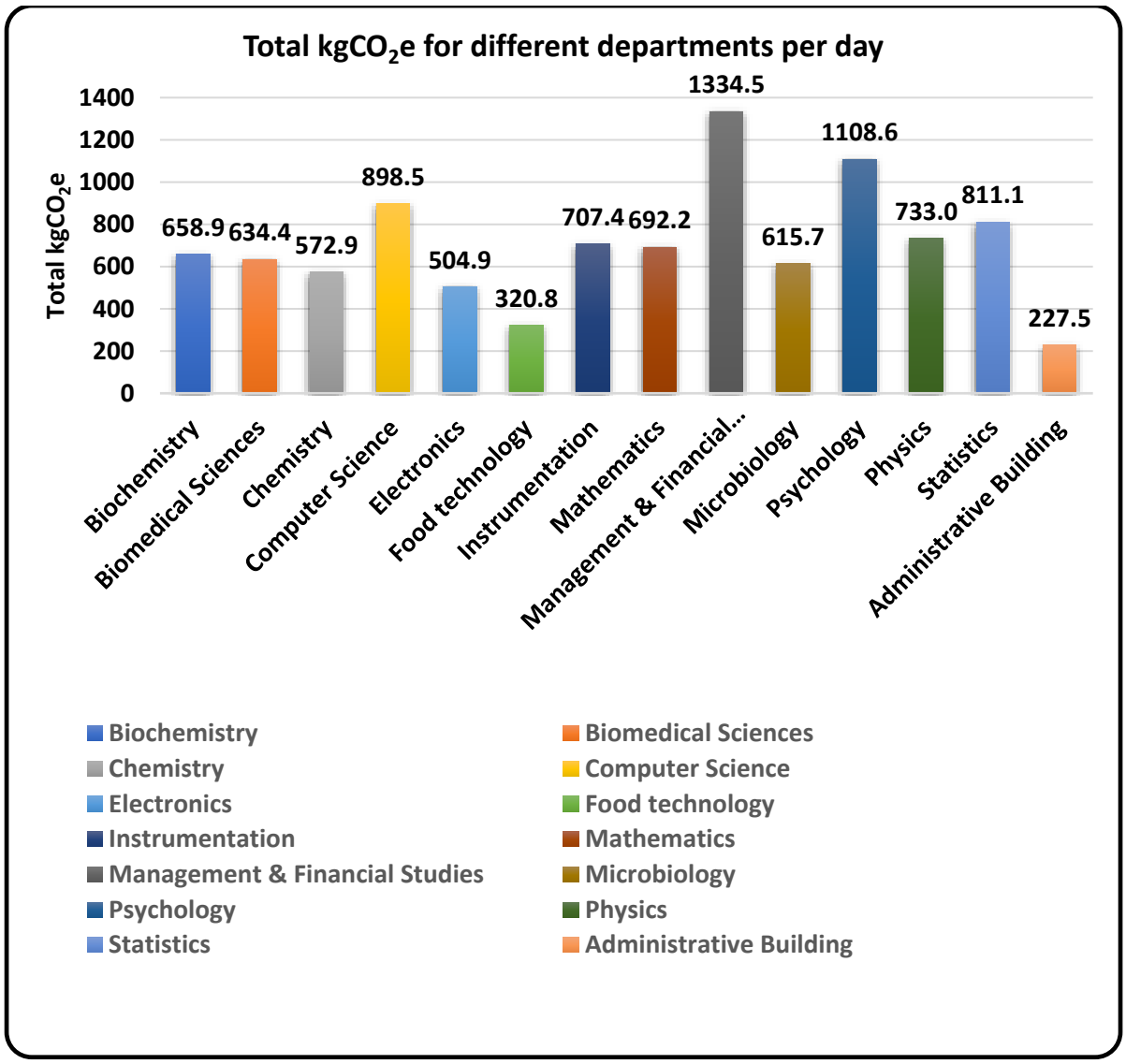


Fig I.2. Total kgCO_2 equivalence emission for different regions of SRCASW.

I.2 Results and Discussion:

The annual CO_2 emission from transportation for the college is ~687 tonnes CO_2e. A steep decline of ~80 % CO_2 emission was reported as compared to the previous years (Ref. report 2016-2019). The likely reason for this difference is the prolonged lockdown period. The results also show the maximum contribution of the college's CO_2 emission due to public transportation. This may appear intriguing as it involves means of transportations (metro, CNG buses, e-rickshaw) that don't run on fossil fuel. This is because of the higher number of participants travelling by public transportation which contains students at large. Thus, the primary factor that controlled the kgCO_2 emission of the college is the number of participants for different modes of transportation.

*Note: CO2 emission in the form of biogas or CH4 oxidation is not counted in GHG inventories.

II. CO_2 emission from the Electricity

Although CO2 emission from electricity is remotely generated and therefore indirect, the combustion of fossil fuel to produce electricity is a major contributor to GHGs. The electricity in SRCASW is provided by the state electricity board which is grid electricity, hence for calculations, the emission factor was taken for the coal in producing electricity. The data was collected for i) academic, ii) administrative, and iii) canteen, and the hostel. The electricity consumption was collected in three different categories which are as follows:

Category I: Electrical and Electronic gadgets, Instruments (heavy and light machines), Charging devices (Laptops, mobile phones)

Category II: Desktop Computers

Category III: These include electrical gadgets that are used in common i.e. they are present in administrative Block, Academic Block, hostel, staff room, corridors etc. They include the following gadgets: AC (Variable refrigerant flow (VRF); non-VRF), Fans, Tubelights.

II.1 Components of the Calculations:

Emission Factor for electricity produced by coal = 0.975 $kgCO_2e/kWh$

Activity (total electricity consumption in kWh) * Emission Factor (kg of CO_2 per kWh) = CO_2 Equivalence (CO_2e) of emissions.

kWh/ day (per equipment/ appliance) = Rating in Watts/ 1000 * usage in no. of hours per day

Total Electricity consumption per day = Category I + Category II + Category III

Total Electricity consumption of SRCASW per day 5550.81 kWh

Total CO_2e emission of SRCASW per day = 5412.039 kgCO2e

Total annual CO_2e emission of SRCASW ~378.8 tonnes CO_2e

Table II.1. Department-wise consumption of the electricity by categories I, II, and III.

S.No	Departments	CATEGORY I Energy consumption kWh/day	CATEGORY II Energy consumption kWh/day
1	Biochemistry	5.718	4.2
2	Biomedical Science	6	3
3	Chemistry	7.253	5.25
4	Computer Science	28.366	211.4
5	Electronics	82.1	57.4
6	Food technology	97.08	3.6
7	Instrumentation	14.9	56

*Note: CO2 emission in the form of biogas or CH4 oxidation is not counted in GHG inventories.

8	Mathematics	0.723	154.456
9	Microbiology	3.512	3.2
10	Management Studies & BFIA	10.7	0.2
11	Physics	34.6	24.6
12	Psychology	1.25	1
13	Statistics	16.6	111.6
	TOTAL	308.86	635.95

S.No.	CATEGORY III Appliances	Energy Consumption in kWh/ Day
1.	Air Conditioners – VRV Units	3580.8
2.	Air Conditioners – Non-VRV Units	396
3.	Fans	382.72
4.	Tubelights	246.496
	TOTAL	4606.0

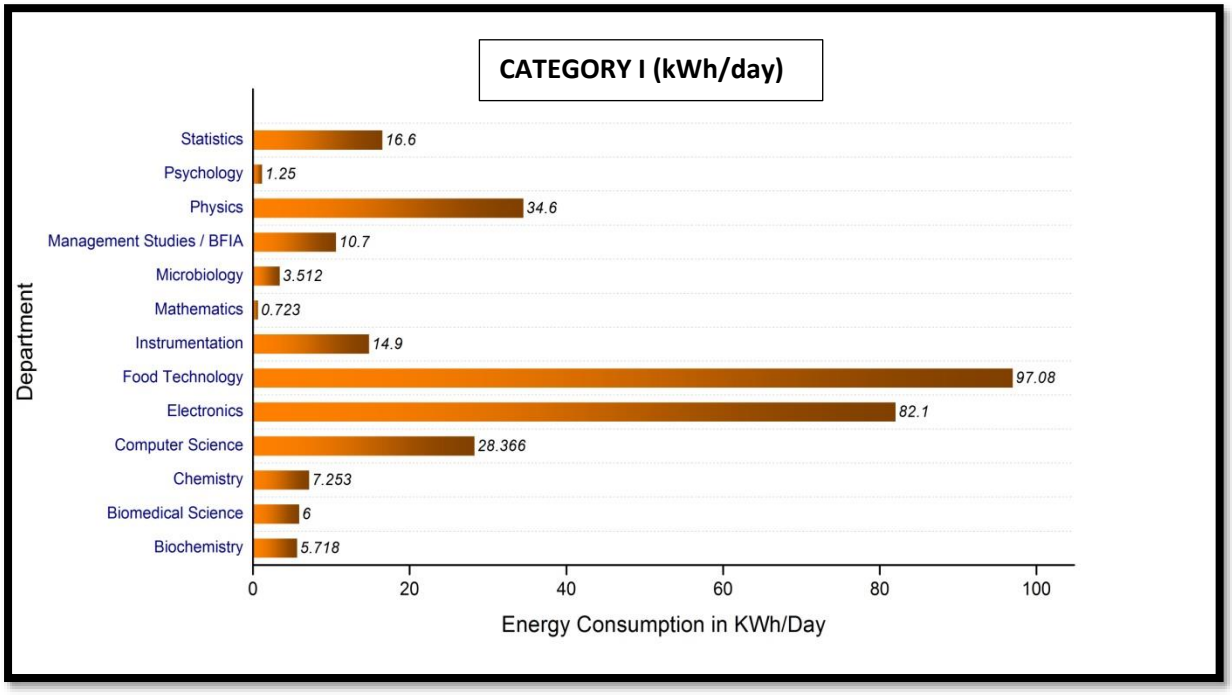


Fig. II.1. Department-wise consumption of the electricity by category I.

*Note: CO_2 emission in the form of biogas or CH_4 oxidation is not counted in GHG inventories.

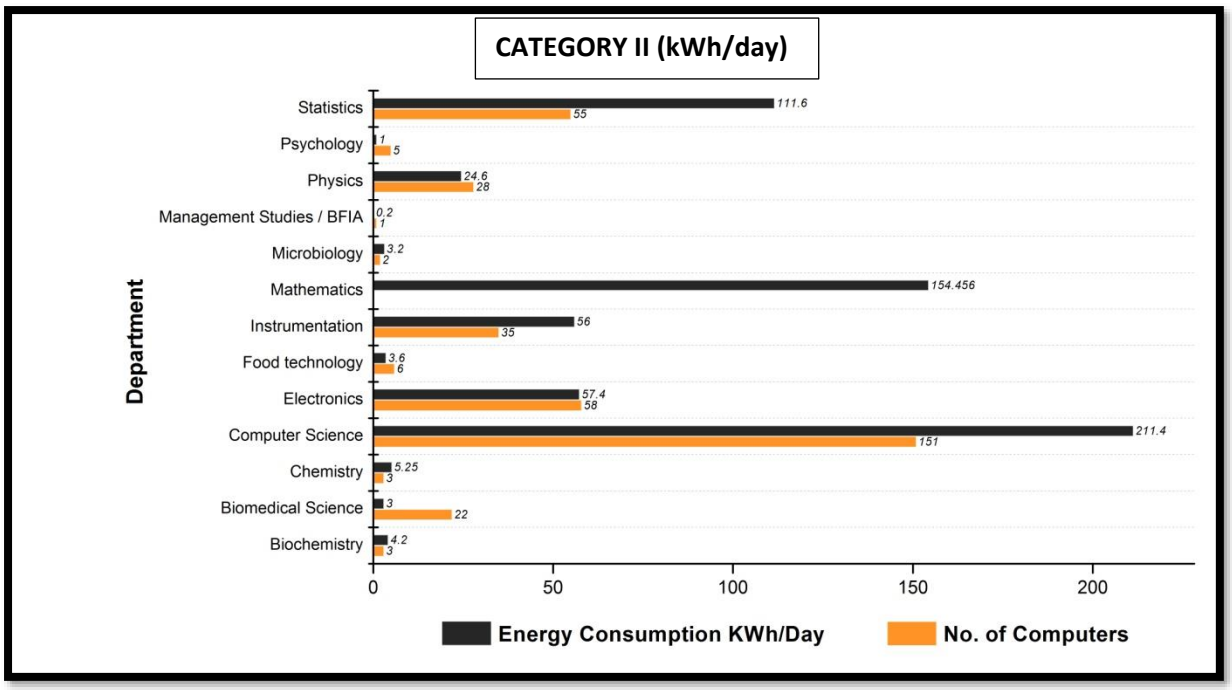


Fig. II.2. Department-wise consumption of the electricity by category II.

II.2. Results and Discussions:

The above analysis for energy consumption of various departments depicts their consumption in kWh for a day, which is then converted into the annual consumption of SRCASW. The total annual CO_2 emission from electricity for the college is ~379 tonnes CO_2e. The higher side can be seen for the department of Food Technology and Electronics because of heavier instruments, lab equipment and machines.

III. GHG emission from the Waste Water and Solid Waste

This section covers III.1. Water Auditing, and III.2. Waste Auditing. The water auditing covered the total water consumption of the college and the N_2O and CH_4 emissions from the wastewater. The N_2O and CH_4 are released from the nitrification, and process breaking of the organic compounds, respectively during the disposal of the wastewater. The N_2O and CH_4 emission have been calculated by taking into account per person-day contribution in generating wastewater. The contribution of the day scholars, teaching and non-teaching staff who stay only during working hours in the college, has been considered 50 % to the hostlers who are living on the campus.

The GHG emission for the waste has been estimated by calculating the CH_4 emission per kgs of solid waste. The CH_4 is released from the disposal of solid waste in the dumping site.* In the current waste audit report, the solid waste (kgs) included plastic wastes, sanitary, glass-metal scraps, other dry waste and miscellaneous. The paper waste and e-waste is recycled 100 % by the college and are collected by licensed and authorized manufacturers. Also, wet waste is managed through composting in the college. Hence, they were not included while calculating the solid waste.

*Note: CO2 emission in the form of biogas or CH4 oxidation is not counted in GHG inventories.

III.1. Water Audit:

III.1. 1. Components of the Calculations:

Emission Factor for N_2O per person-day for generating wastewater = 0.0003 kgN_2O/person-day

Emission Factor for CH_4 per person-day for generating wastewater = 0.3 $kgCH_4$/person-day

Total number of persons in college * Emission Factor * 70 days (lockdown) = Total kgN_2O and $kgCH_4$ per year.

Table III.1. Block-wise distribution of the water consumption.

S. No.	Name of the block	Consumption of water (in L per month)
1	Administration and Non-Teaching Staff	**11,700**
2	Academic	**54,350**
3	Hostel	**207,900**
	Total	**273,950**

Table III.2. Department-wise distribution of the academic block of the water consumption.

S. No.	Name of the department	Consumption of water (in L per month)
1	Biochemistry	2160
2	Biomedical science	1200
3	Chemistry	23500
4	Computer Science	Nil
5	Electronics	30
6	Food technology	3000
7	Instrumentation	4500
8	Mathematics	Nil
9	Microbiology	1200
10	Management Studies	450
11	BFIA	450

*Note: CO2 emission in the form of biogas or CH4 oxidation is not counted in GHG inventories.

12	Physics	8965
13	Psychology	305
14	Statistics	8620

Table III.3. Purpose-wise distribution of the water consumption by different sections of the college a) Hostel, b) Academic block and Teaching-staff, and c) Administrative and Non-teaching staff.

S. No.	Purpose	Consumption of water (in L per month)			Total
		(a) Hostel	(b) Academic and Teaching-staff	(c) Administrative and Non-teaching staff	
1	Sanitation (Flush)	37,800	19,665	4,500	61,965
2	Drinking water	18,900	12,652	6,870	38,422
3	Laboratory	--	20,003	--	20,003
4	Miscellaneous (brushing, bathing, washing hands etc.)	151,200	2,030	330	153,560
	Total	207,900	54,350	11,700	273,950

*Note: CO_2 emission in the form of biogas or CH_4 oxidation is not counted in GHG inventories.

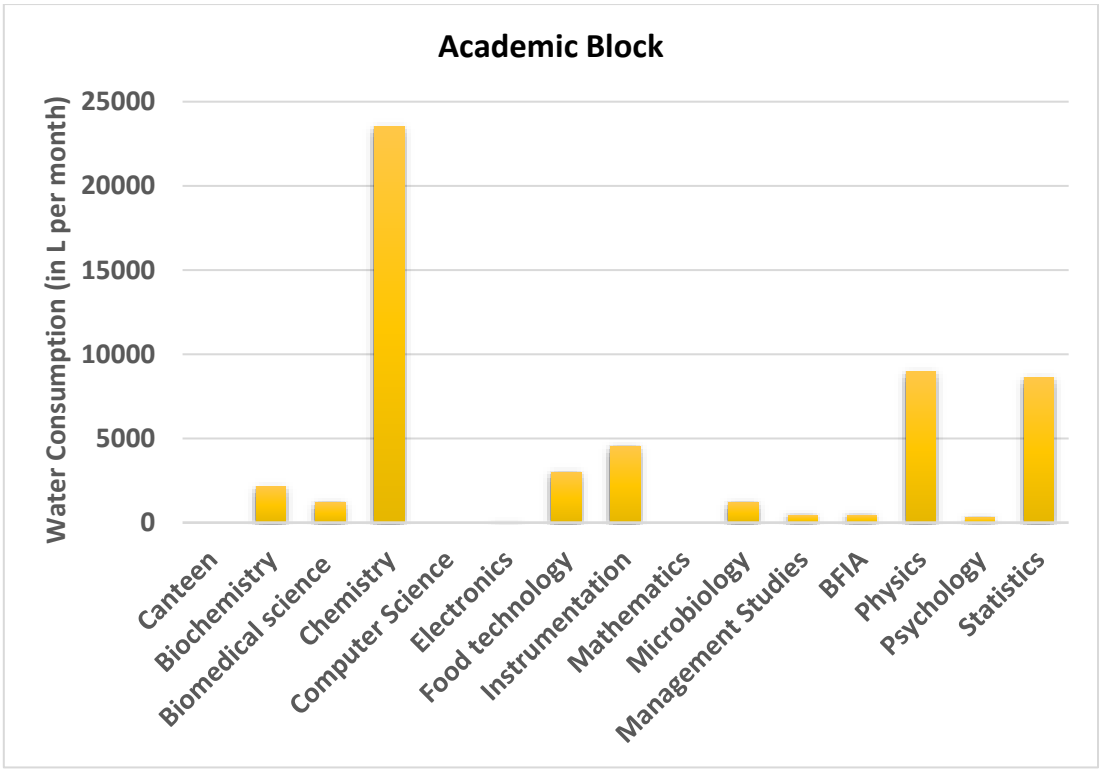


Fig. III.1. Department-wise distribution of the water consumption in the academic block.

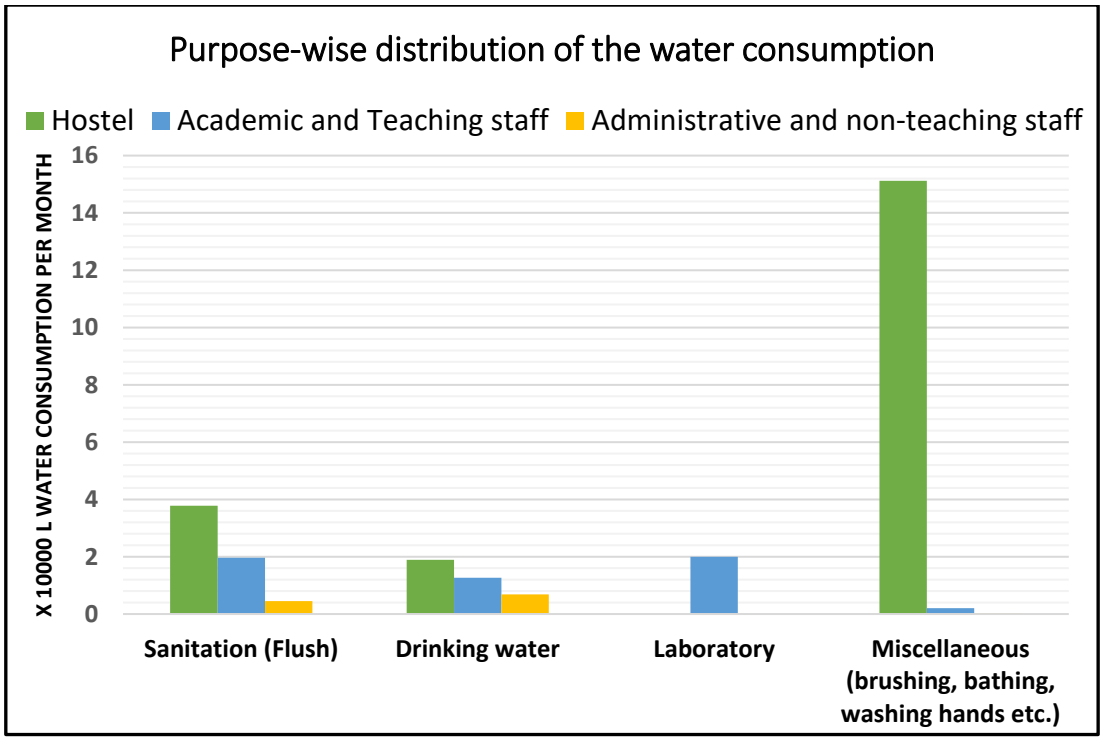


Fig.III.2 a. Purpose-wise distribution of the water consumption of the college (Bar-representation).

*Note: CO_2 emission in the form of biogas or CH_4 oxidation is not counted in GHG inventories.

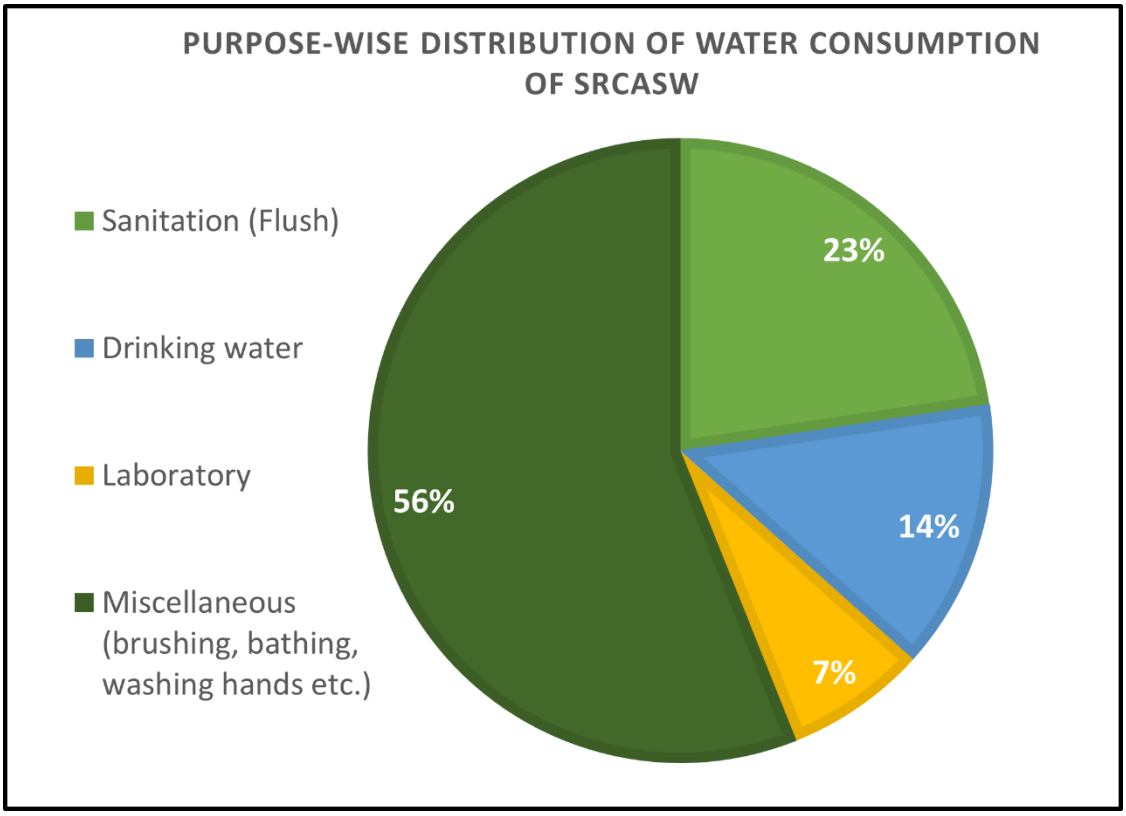


Fig.III.2 b. Purpose-wise distribution of the water consumption of the college (Pie-Representation).

III.1.2. Results and Discussion:

The total N_2O and CH_4 generated by the college is ~21.5 kgN_2O/person-year and 21,441 kgCH4/person-year, respectively. The total water consumption of SRCASW for 2019-2020 is 273,950 L per month. This is ~70 % less than the previous years (ref. environment audit report 2016-2019). The fall in consumption can be attributed to the prolonged lockdown periods. The results show that maximum consumption of water is obtained from hostels. In terms of purpose, maximum usage of water is reported by miscellaneous activities i.e. more than 50 %. However, if we ignore the contribution from the hostel, maximum water consumption occurred in sanitation (~23 %) which includes flushing toilets. In the academic block, maximum consumption of water is reported by the Chemistry department, because of huge quantity of the water consumed in lab experiments.

III.2. Waste Audit:

III.2.1. Components of the Calculations:

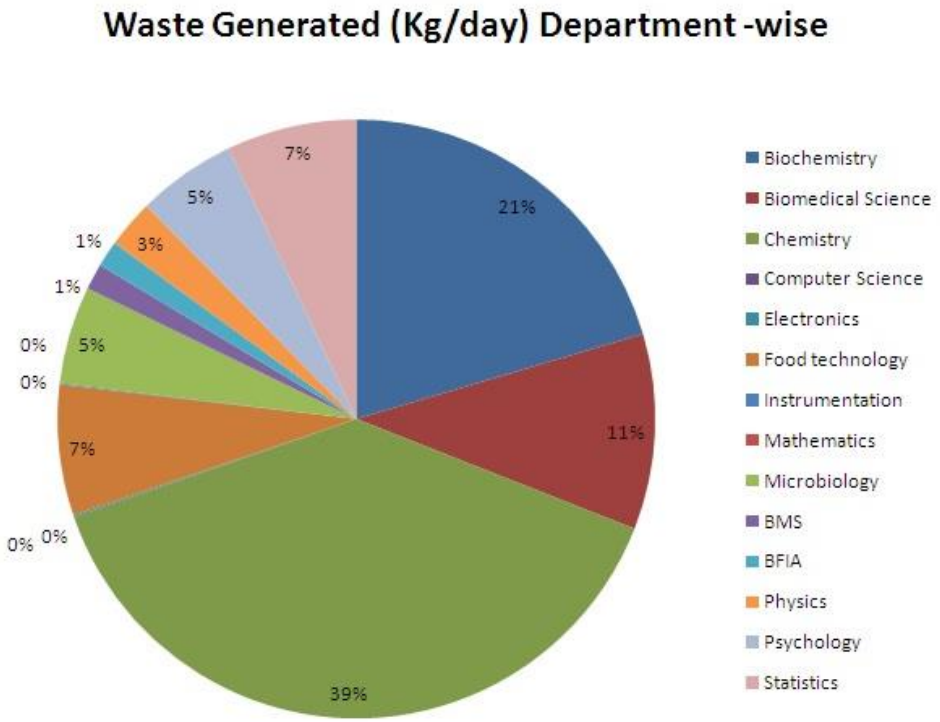
Emission Factor for CH_4 for solid waste disposal (SWD) = 0.9 $kgCH_4$

Activity (kgs of solid waste per year) * Emission Factor = Total $kgCH_4$ per year.

Table III.4. Distribution of the waste generated through different processes by the departments of SRCASW.

*Note: CO2 emission in the form of biogas or CH4 oxidation is not counted in GHG inventories.

Departments	Total Waste Generated (kg/day)	Paper waste	Sanitary waste	Plastic waste	Lab Waste						Others
					Glass	E-waste	Dry/solid	Wet(L)	Needle	Biological Waste/Food Waste	
Biochemistry	2.9	0.5		0.5	0.2	0.1	0.5	1	0.1		
Biomedical Science	1.5										
Chemistry	5.5	2		1	0.5		0.5	1			0.5
Computer Science	0										
Electronics	0.014					0.014					
Food technology	1	0.1		0.1	0.05		0.5			0.25	
Instrumentation	0.01					0.01					
Mathematics	0										
Microbiology	0.75	0.05	0.1		0.1		0.1	0.15		0.25	
Management Studies	0.2	0.1		0.1							
BFIA	0.2	0.1		0.1							
Physics	0.37	0.25		0.05		0.01	0.03				0.03
Psychology	0.76	0.01	0.25								0.5
Statistics	1	0.56		0.44							



*Note: CO_2 emission in the form of biogas or CH_4 oxidation is not counted in GHG inventories.

Fig. III.3. Pie-chart distribution of the waste generated by different department of SRCASW.

III.2.b. Results and Discussion:

The total $kgCH_4$ generated annually from the waste (SWD) is 171.2 kgs. The total waste generated by the college is ~19.0 kgs. This waste is sent to the municipal body which is dumped in the landfill site as SWD. Out of the total e-waste generated by the college, a negligible waste of only ~0.2 kgs is generated by the college. 100 % e-waste is recycled which is sent to a licensed e-waste managing authority through the proper channel. Out of the total paper waste of the college, only ~2 kgs generated by the college forms the part of SWD. More than 99 % of the paper waste is sent to a recycling unit. Moreover, >99 % of wet waste generated in the college is recycled through composting. Only 2.6 kgs of wet waste form the part of SWD.

IV. Calculating Potential GHG sinks

IV.1. Tree Cover

The approximate number of trees in the college is 400. On average one tree sequesters about 14 kgs of CO_2 per year.

Total CO_2 sequestered by tree cover = **-5,600 kg CO_2/year**

IV.2. Composting

The total wet waste generated by the college for 2019-2020 was ~750 kgs. The CO_2 sequestration factor (SF) for wet waste utilized in preparing compost is -0.103 $kgCO_2$/kg wet waste

Total CO_2 consumption in the composting per year = **-77.3 kg CO_2/year**

IV.3. An alternative source of Energy- Solar Panels

Each solar panel which is a residential unit produces 9 kWh. In a year it produces 10,000 kWh. The CO_2 sequestration factor (SF) for 1 kWh electricity production is -0.383 $kgCO_2e$.

Hence, total CO_2 sequestration by solar panels = **-3,830 $kgCO_2$/year**

Total GHG sink of SRCASW = -9,507.3 $kgCO_2$/year

V. Net GHG emission of SRCASW

The net annual GHG emission of the college is reported as follows:

V.1. Net $kgCO_2$ emission for the period 2019-2020 is ~367 tonnes annually.

V.2. Net $kgCH_4$ emission for the period 2019-2020 is ~21,612 kgs annually.

V.3. Net kgN_2O emission for the period 2019-2020 is ~21.5 kgs annually.

*Note: CO2 emission in the form of biogas or CH4 oxidation is not counted in GHG inventories.

VI. Future strategies and suggestions on making SRCASW carbon-neutral

Carbon-neutrality refers to cutting down CO_2 and GHG emissions to zero. This can be achieved through carbon-offsetting practises like promoting green technologies and green engineered structures in the college, by following green practices, increasing the tree cover, promoting and expanding recycling practices like rainwater harvesting, composting, biogas production, waste reduction and by generating awareness and motivation amongst college students and teaching-non teaching staff members.

SRCASW is already committed to the task of gradually reducing the CO_2 footprint of the college. It is aimed at reducing its dependencies on fossil fuels and replacing them with alternative sources of green energies. In this direction, SRCASW has already installed solar panels. Further, it is focussing on increasing the number of solar panels in the college, which will cut on using grid-electricity. The college has a massive green cover that contains around 400 trees and several herbs of different species and varieties. This includes ornamental trees, fruit trees, timber trees and several local varieties. The herbal varieties include several medicinal plants and herbs. The college has been acknowledged with the *Green Award* in 2017. To reduce its consumption of water, the water collected by rainwater harvesting is used for washing, gardening, irrigating plants and raising the groundwater table. In continuation to its initiative for reducing waste from reaching landfill sites, it recycles the organic waste through composting. The college promotes awareness and instils motivation through an eco-club, *PRAVRIDHI*, that aims to create, innovate, and allows a critical inquiry into the environmental issues and sustainable ways of living. It recognizes the pivotal role of the students and youths as future changemakers. It conducts activities and organizes workshops, discussions, drives, marches, and working on fields.

SRCASW strongly adheres to its goal of becoming a *carbon-neutral* campus. The strategy is by implementing the step-wise-step process of commitment, counting and analysis, action, reduction, offset, evaluation, and repeating the whole process (fig. VI.1).

Commitment, towards becoming carbon-neutral, and in achieving carbon-neutral goals.

Counting and Analysis, of the total resource consumption by compiling an inventory using GHGs calculator, emission factors.

Action, in starting to work towards GHG neutrality.

Reduction, by focusing on limiting energy usage in the form of, transportation, electricity, and minimizing waste generation.

Offsetting, by neutralizing the volume of GHGs through funding projects supporting solar panel installation, biogas plants, and rainwater harvesting.

Evaluation and repeating, of the results, targets, and by compiling the list of suggestions, and improvements.

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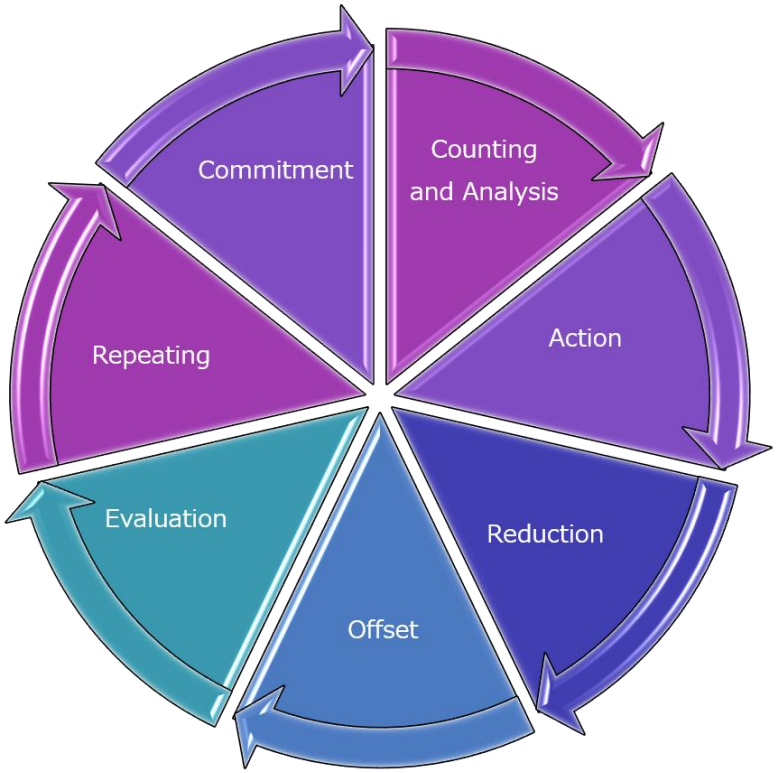

Fig. VI.1. A step-wise-step circular process for becoming carbon-neutral

Thus, it can be concluded that all the indicators of the environmental audit report were properly studied and information about the indicators was collected, analyzed and followed with the conclusions, recommendations and solutions.

VI. Resources

Environmental Protection Agency, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 – 2000 EPA 430-R-02-003 (Washington, D.C., April 2002); http://www.epa.gov/oppeoee1/globalwarming/publications/emissions/us2002/index.html.

Intergovernmental Panel on Climate Change, Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (Geneva, May 2000); http://www.ipcc-nggip.iges.or.jp/public/gp/gpgaum.htm.

Intergovernmental Panel on Climate Change, Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual (Geneva, 1997); http://www.ipcc-nggip.iges.or.jp/public/gl/invs6.htm.

Lewis and Clark, University, Guidelines for college-level Greenhouse Gas Emissions Inventories.

U.S. Environmental Protection Agency, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 – 1999 EPA 236-R-01-001 (Washington, D.C., April 2001) at N-1; http://www.epa.gov/oppeoee1/globalwarming/publications/emissions/us2001/index.html.

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