The initial Carbon Footprint estimate for the academic year 2020/2021 at Beni-Suef University BSU: GHG Protocol

OVERVIEW

This report details the carbon footprint generated by Beni-Suef University in the academic year 2020 - 2021 and covers Scope 1, 2 and selected scope 3 activities. All the data collected and analyzed within this report follow the World Resources Institute Greenhouse Gas Protocol principles of relevance, completeness, consistency, transparency, and accuracy. In the reporting year, the overall CO_2 emissions at Beni-Suef University were 7323 $mtCO_2e$ and 56% of these emissions were from electricity consumption; thus, Scope 2 contributed to the highest emissions. The second largest contributor was university commute (Scope 3) at 21.3 %. Additionally; the carbon intensity was 0.08 per student and faculty staff and was 0.03 per m^2. BSU has launched many educational campaigns and awareness programs aiming to reduce carbon emissions, which resulted in reducing electricity consumption throughout campus. However, there are still different recommendations that can be made to reduce overall CO_2 emissions.

.

I- INTRODUCTION

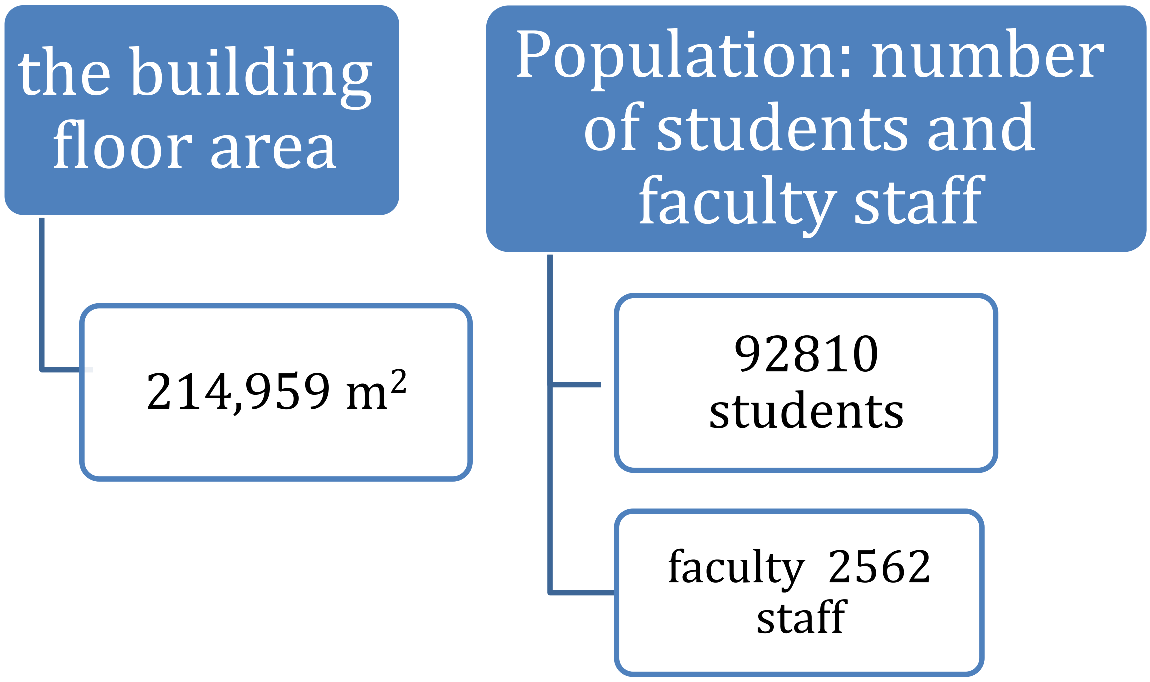
Climate change was first viewed as an international concern by the United Nations in 1992 because of its substantial negative effect on the world. As climate change worsens, dangerous weather events are becoming more frequent or severe. Hence, there are ongoing discussions on the steps required to mitigate it. As the world has become more conscious about reducing the impacts of how we live and work, universities have lead change by reducing their own carbon footprints. It’s worth noting that different greenhouse gases last in the atmosphere for different lengths of time, and they also absorb different amounts of heat. The “global warming potential” (or “GWP”) of a GHG indicates the amount of warming a gas causes over a given period of time (normally 100 years).

The most notable regulatory framework for accounting Green House Gas (GHG) emissions is the GHG Protocol (2004), which defines the carbon footprint (CF) as the total amount of GHG emissions generated directly or indirectly by the activities carried out by the institution, usually expressed by the carbon dioxide equivalent (CO_2 e). To help specify emission sources, improve transparency and better manage the full spectrum of GHG risks and opportunities, three "scopes" (scope 1, scope 2 and scope 3) are defined for GHG accounting and reporting purposes. According to the GHG Protocol (2004), Scope 1 (direct GHG emissions) accounts for GHG emissions from sources owned or controlled by the organisation, Scope 2 (electricity indirect GHG emissions) accounts for GHG emissions from the generation of purchased electricity consumed by the organisation and Scope 3 (other indirect GHG emissions) is an optional reporting category that includes emissions that are a consequence of the activities of the organisation but occur from sources not owned or controlled by the organization.

Beni-Suef University is a public sector university currently educating more than 92,000 students at three campuses and different separated institutes and faculties. The current report involves measurement of the carbon footprint of BSU to quantify and assess its activities of emitting green-house gasses (GHGs). The intention is to reduce the emissions, by reviewing the way of operation and activities, and setting targets and metrics and continuously follow up on progress, where various actions are taken to achieve a net-zero society. The assessment enables BSU to benchmark performance indicators and evaluate progress over time. This report presents the carbon footprint from the July 2020 to the June 2021.

II- INVENTORY BOUNDARIES

1. <u>Institutional boundaries for BSU</u>



2. Operational boundaries

The operational boundaries for BSU's 2020-2021 CFP report include the following:

Scope 1	Scope 2	Scope 3
• Stationary combustion (Fuel burning on-site) • Mobile combustion (University fleet) • Fugitive emissions (Leakage of referigerants)	• Purchased energy (Purchased Electricity)	• University commutes • Purchased goods and services • Waste generated in operations • water usage and wastewater treatment

III- METHODOLOGY

The Greenhouse Gas Protocol Guidelines, ISO 14064-1:2019 and 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for Greenhouse Gas Inventories (with 2019 Refinements) are the three major guidelines used to ensure the uniformity and accuracy of the report.

Calculation Approach

As required by best practice in organizational GHG accounting and the chosen WBCSD/WRI GHG Protocol, all seven Kyoto Protocol greenhouse gases have been included in the assessment where applicable and material. Global warming potentials (GWPs) are factors describing the radiative forcing impact of one unit of a specific greenhouse gas (e.g. methane) relative to one unit of carbon dioxide. They are used in GHG accounting to convert individual greenhouse gas emissions to a standardized unit for comparison; carbon dioxide equivalent (CO_2e). BSU applied 100-year GWPs to all emissions data in this inventory in order to calculate total emissions, in metric tons carbon dioxide equivalent ($mtCO_2e$). The Kyoto Protocol GHGs and their respective GWPs are listed in the table below:

Table 1. Kyoto Gases (IPCC 2007 2).

Greenhouse Gas	Global Warming Potential (GWP)
Carbon dioxide (CO_2)	1
Methane (CH 4)	27
Nitrous oxide(N2O)	273
Hydrofluorocarbons (HFCs)	124 – 14,800
Perfluorocarbons (PFCs)	7,390 – 12,200
Sulfur hexafluoride (SF 6)	25,200
Nitrogen trifluoride (NF3)	17,400

Hence, the guidelines illustrated by the GHG Protocol Corporate Accounting and Reporting Standard were used to calculate BSU's carbon footprint. The unit of the GHG Emissions is metric tons carbon dioxide equivalent ($mtCO_2e$). The unit CO_2e refers to an amount of a GHG, whose atmospheric impact has been standardized to that one-unit mass of carbon dioxide (CO_2), based on the global warming potential (GWP) of the gas. The general formula could be applied for each activity to obtain its emissions. Activities included in the current assessment were calculated for the academic year, 2020-2021. Thus, the emissions accounted for, were those of the total value for each activity in a single year

The general calculation approach for the emissions, counted in $mtCO_2e$, is multiplying the activity with its corresponding emission factor.The following equation was applied throughout the report:

$$A \times EF = E$$

Where, (A) is the activity data and and EF is emission factors of GHG_g. Activity data is a measure of the level of activity that results in GHG emissions (either directly or indirectly). For example, activity data could be the amount of fuel, or the amount of paper consumed. To then convert this activity data into emissions for that gas (E) (CO_2 emissions), an emission factor (EF) is used. Emission factors (EF) are representing the quantity of GHGs released to the atmosphere caused by a certain activity. The emission factor is usually expressed as the carbon dioxide equivalent (CO_2e) emissions generated by a unit weight, volume, distance, or duration of the activity, e.g., CO_2e / liter fuel consumed, CO_2e / km driven or CO_2e / kWh of purchased electricity etc.

As regards to the country specific grid electricity emission factor, the emission factor is derived based on the Egyptian Electric Utility and Consumer Protection Regulatory Agency (Egypt ERA) published reports of monthly data of the grid electricity, where the emission factor is based on Egypt's actual fuel mix and power generation. The emission factor for water supply and wastewater treatment is calculated using a conversion formula, provided by the Holding Company for Water and Wastewater (HCWW). Based on the amount of energy consumed in each process, the corresponding emission factor could be obtained.

IV- CARBON FOOTPRINT RESULTS

1. Scope 1(Direct GHG emissions)

Emissions from sources that are owned or controlled by ADIB include**:**

- **First: STATIONARY COMBUSTION (Fuel Burning: Diesel)**

During the reporting period, BSU consumed 15000 liters of diesel in its generators, which resulted in 39.75 $mtCO_2e$ of direct emissions. Carbon footprint equation is described as following:

$$\text{Diesel emissions } (mtCO_2e) = \text{Fuel consumption (L) x EF } (mtCO_2e/L)$$

- **Second: MOBILE COMBUSTION (University fleet)**

This refers to the universityity-based vehicles utilized in commuting either inside or outside the vicinity of the university. The observed vehicles at the main campus in the reporting period consumed a total of 140,809 L of both diesel and gasoline over the academic year. The overall emissions amounted to a total of 332.5 $mtCO_2e$.

For BSU's owned vehicles, the database was used to determine fuel type and fuel consumption in liters. These data were used to calculate the emissions using the below equation:

Owned vehicles emissions ($mtCO_2e$) = Fuel consumption (L) x EF ($mtCO_2e$/ L)

- **<u>Third: Refrigerant Leakage</u>**

Cooling the facility requires refrigerant fluids. Each year, refrigerants (in this case both type R-22 and HFC-227ea were used to re-charge the cooling systems used in each building in order to compensate for the leakage that happened during the operating year. Total refrigerants used during the reporting period were 420 kg and 60 kg of HCFC-22 and HFC-227ea refrigerant, respectively. This resulted in a total emission of 760.38 and 192.69 $mtCO_2e$, respectively. Refrigeration fluids are fluids which are used to cool a space in refrigeration cycles. Some estimation was made by BSU to provide refrigerant data.

Refrigerants leakage emissions ($mtCO_2e$) = Refrigerant leakage (kg) x EF ($mtCO_2e$/kg)

2. Scope 2- Indirect emissions

PURCHASED ELECTRICITY

Scope 2 accounts for GHG emissions from the generation of purchased electricity consumed by the organization.

The electricity consumption data for the past four years were collected from the university electric bills and used to calculate CO_2 emissions. Figures 1 and 2 are a representation of these results. In the academic year 2020–2021 the annual electricity consumption at BSU was 9,532,715 kWh (9,532.715 MWh). This equates to 4,063 $mtCO_2e$ (CO_2 emissions). Over the past four years including the year 2017 – 2018 as a base year, there was a gradual decrease in emissions, which correlates to a decrease in electricity use. This was due to the International Ranking and Sustainability Development office's continuous work through awareness programs and continuous recommendations to try and educate students, employees and faculty members on the importance of resource conservation..

Emissions from purchased electricity are the product of the national grid emission factor and the annual electricity consumption. The electricity consumption in the main campus of BSU was obtained from the database in kWh. The total electricity consumption of the year was calculated using the formula below:

Purchased Electricity Emissions ($mtCO_2e$) = Electricity Consumption (kWh) x EF ($mtCO_2e$/kWh)

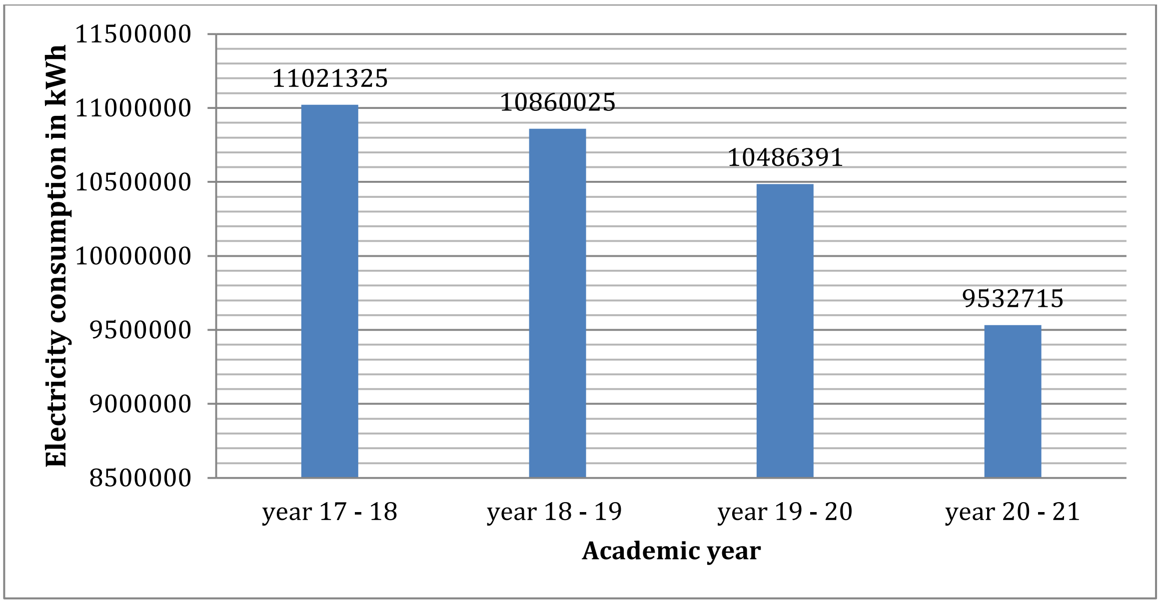


Figure 1. Electricity consumption for past 4 academic years

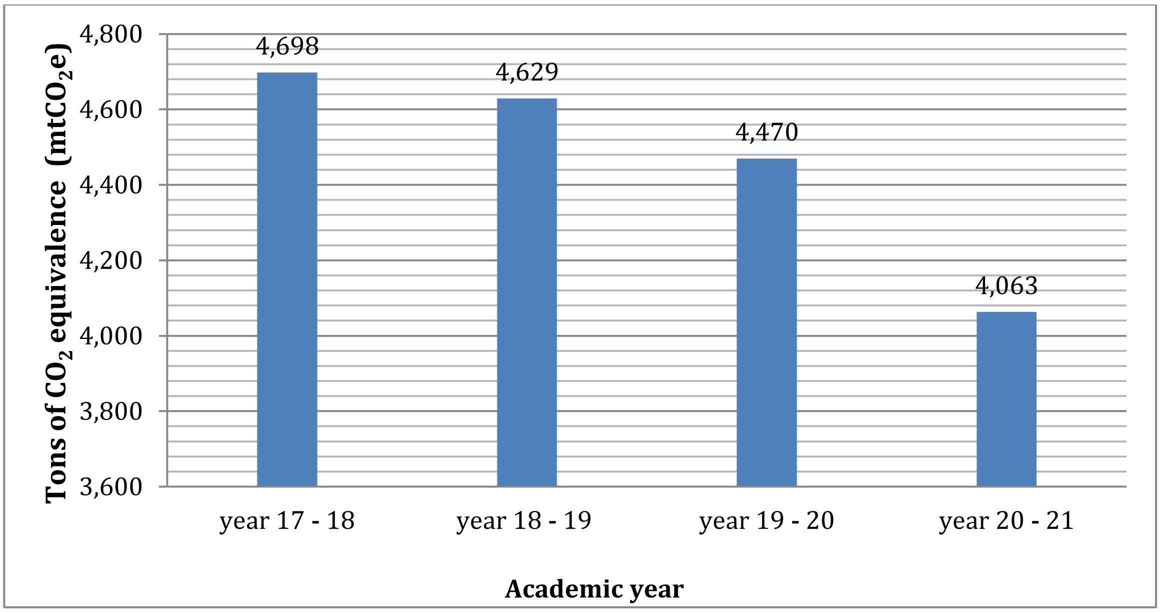


Figure 2. Scope 2 (CO_2 emissions due to electricity consumption for past 4 academic years)

3. Scope 3- Indirect GHC Emissions

First: Emissions from university commutes

This section shows the carbon footprint due to daily university commutes of faculty members, staff, and students. Most of the faculty members reside on campus; therefore, their projected emissions due to university commutes would be rather negligible and were not accounted for in the study. On the other hand, most students and staff used different means of transportation to commute to and from university. The estimated distance traveled by faculty staff and students was 12,710,500 km that resulted in 1,559.20 $mtCO_2e$ fuel burning emissions.

Data were calculated by estimating the distance traveled by the employees, based on the office geographical locations and surveys on the average distance between the employees' homes and their worksite. The traveling distance percentages for commuting were estimated for 15 different distances from 5 km to 100 km and then multiplied by the number of working days in a year to get the total distance travelled.

University commute emissions ($mtCO_2e$) = Travelled distance (km) x EF ($mtCO_2e$/ km)

Second: Water usage and wastewater treatment

In the reporting period of 2020-2021, the total annual water consumption was 600,521 m^3 that led to 88.60 $mtCO_2e$ (CO_2 emissions) attributed to water usage and 1.7 attributed to wastewater treatment. **(Figures 3 and 4)** Similarly to electricity consumption data, the water consumption data for the past 4 years including the year 2017 – 2018 as a base year were collected and used to calculate CO_2 emissions. There was a gradual decrease over the past four years due to the continuous awareness programs and recommendations to try and educate students, employees and faculty members on the importance of resource conservation..

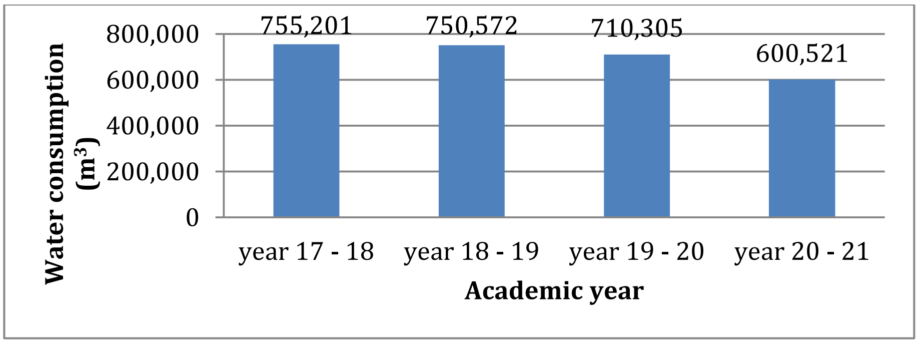


Figure 3. Water consumption for past 4 academic years

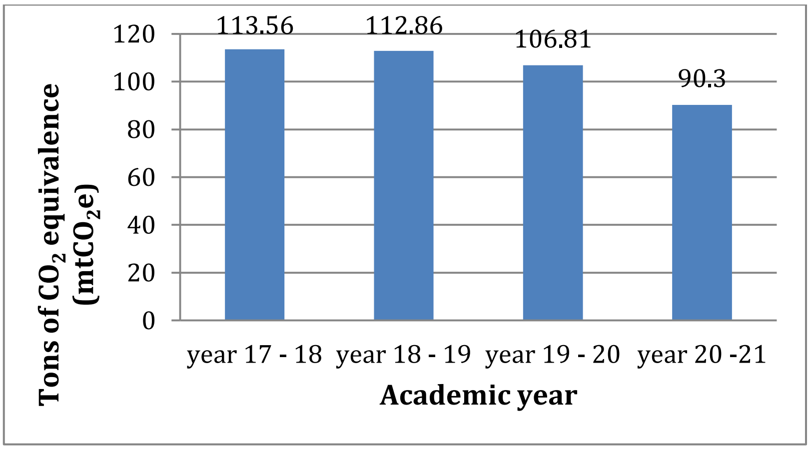


Figure 4. Scope 3 (Co_2 emissions due to water usage and wastewater treatment for past 4 academic years).

The emission factor for water supply and wastewater treatment is calculated by using a conversion formula, provided by Holding Company for Water and Wastewater. The emissions are based on the amount of energy consumed in each process. The emission factors for water supply and wastewater treatment are accordingly calculated by multiplying the conversion factor by the electricity emission factor. At the same time, a unit analysis is performed to make sure the units are conforming.

Energy consumption (Wh) = Water supply/ Wastewater (m^3) x Conversion formula (Wh/m^3)

Water supply & treatment ($mtCO_2e$) = Energy consumption (kWh) x EF ($mtCO_2e$/kWh)

Third: Purchased goods and services

In the reporting period, it was observed that 90,259 A4 sheets of paper were consumed. They were weighing a total of 225,195 kg that resulted in total emissions of 207.011 $mtCO_2e$. BSU also used 15,000 cartridges of ink causing total emissions of 72 $mtCO_2e$.

The yearly amounts of purchased goods per type have been retrieved from the internal data recordings, as units of items. The emissions were obtained by multiplying the emission factor per unit by the weight or the number of items:

- Paper emissions ($mtCO_2e$) = Weight of paper (kg) x EF ($mtCO_2e$/kg)
- Ink emissions ($mtCO_2e$) = Number of cartridges (units) x EF of each cartridge ($mtCO_2e$/unit)

Fourth: Solid waste disposal

In the academic year of 2020–2021, there was total annual consumption of 12,501 kg of solid waste, which amounted to a total of 5.8 mtCO_2e. For paper waste, the highest consumption of paper took place in the main and the administrative buildings; this is most likely due to the greater concentration of administrative offices; hence, greater demand for paper. In general, the comparison of the reporting period to the academic year 2019-2020 , the trend shows a relative decrease in emissions. That correlated to the decrease in the use of solid waste and this was due to the increase in sustainable practices across campus, such as recycling of paper, which in return offset the amount of emissions.

The emissions from solid waste disposal are the product of the emission factor for each waste type and the quantity of waste for each type in addition to the waste fate. (i.e., the transportation to the landfill and the landfilling procedure were included in the emission factor of the landfilled waste).

Solid Waste Emissions/ Shredded Paper (mtCO_2e) = Quantity of waste/type (tons) x EF/ type of waste (mtCO_2e/tons)

V- TOTAL CARBON FOOTPRINT

Table 2 provides the overall summary of the total carbon footprint at Beni-Suef University for the academic year of 2020–2021. Figures 5 and 6 demonstrate the relative contribution of different scopes towards carbon footprint.

Table 2: Summary of emission showing the total carbon foot print

SCOPE 1 – DIRECT EMISSIONS ($mtCO_2e$)	**2020 - 2021**		
Stationary combustion	**40**	**0.5%**	**18%**
Mobile combustion	**333**	**4.5%**	
Fugitive emissions	**953**	**13%**	
Total Scope 1 ($mtCO_2e$)	**1326**		
SCOPE 2 – INIRECT EMISSIONS ($mtCO_2e$)	**2020 - 2021**		
Purchased Energy	**4,063**	**56%**	**56%**
Total Scope 2 (mtCO2e)	**4,063**		
Total Scope 1 & 2 Emissions	**5,389**	**$mtCO_2e$**	
SCOPE 3 – INIRECT EMISSIONS ($mtCO_2e$)	**2020 – 2021**		
University commute	**1,559**	**21.3%**	**26%**
Water usage and wastewater treatment	**90**	**1.23%**	
Purchased goods and services	**279**	**3.8 %**	
Waste generated in operations	**6**	**0.08%**	
Total Scope 3 (mtCO2e)	**1934**		
Total Scope 1, 2 and 3 Emissions (Total Carbon Footprint)	**7323**	**$mtCO_2e$**	
Net Carbon Footprint (Carbon intensity) per person per year	**0.08**	**$mtCO_2e$/person**	
Net Carbon Footprint (Carbon intensity) per m^2	**0.03**	**$mtCO_2e/m^2$**	

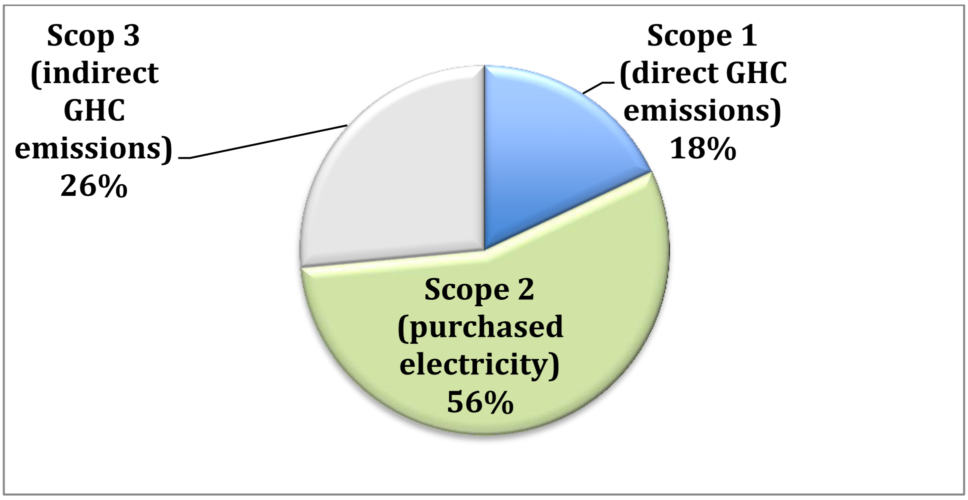


Figure 5: Pie chart showing emission contribution of scopes for the academic year 2020–2021.

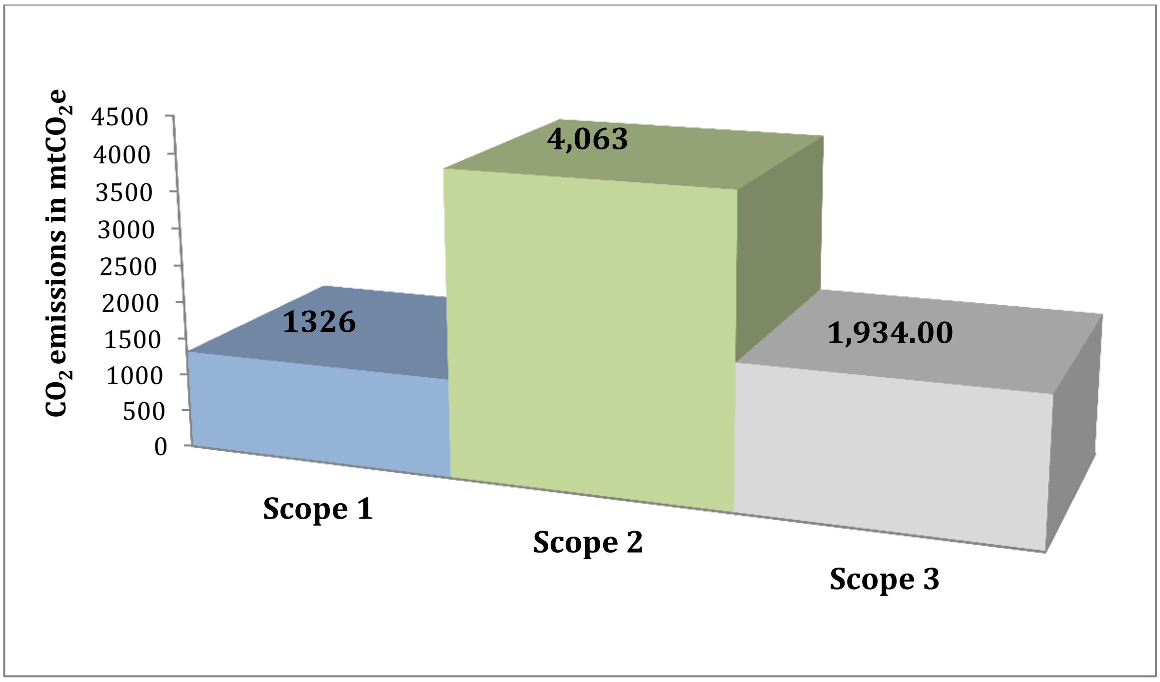


Figure 6: net CO_2 emissions per scope

VI- OUR RECOMMENDED STRATEGIES FOR DECARBONIZATION

1. No doubt that the energy sector is the largest emitter of carbon emissions and is the largest contributor to climate change compared to other sectors in the world in the upcoming periods, so BSU is planning to the following;
   1.1. BSU arranges a budget for energy-saving improvement projects annually and it pays a great attention to rationalize energy consumption
   1.2. BSU is planning to install new roof-mounted photovoltaic panels on the various buildings in 2023 and 2024.
   1.3. Generalizing the use of lamps and lighting poles with light sensors inside all different buildings of the university. This allows the automatic lighting and closing in response to sunlight and hence, energy saving and reducing climate change.
   1.4. Providing different buildings with more modern and energy-saving means such as smart outlets that allow the passage of sunlight with keeping the atmosphere cool leading to a reduction in the use of air conditioners.
   1.5. The university seeks to fulfill the pledge to provide 100% renewable energy through collaboration projects, research projects, and related activities. The related procedures are as follows:
2. Educating students, faculty and staff about climate change, decarbonization and climate resilience.
3. Set specific carbon emission reduction targets with due dates.
4. Continuing launching of different campaigns, initiatives, informative lectures, and sustainability training programs and workshops around the campus is one of the effective methods to decrease carbon emissions. These should aim to raise the awareness of reducing the annual consumption of utilities such as energy, water and paper.
5. Directing to replace petrol and diesel tanks with cars and buses running on natural gas or biofuel.

6. Presence of programs for university waste recycling and reducing the use of paper and plastic in the university.
7. Increasing the awareness with increasing the green space helps facing the climate changes and global warming and planting more trees.

Definition and terminology:

Base year	A base year is a reference year in the past with which current emissions can be compared. In order to maintain the consistency and comparability with future carbon footprints.
Carbon Footprint	The amount of Carbon Dioxide that an individual, group, or organization lets into the atmosphere in a certain time frame.
CO2e	Carbon dioxide equivalent or CO2 equivalent, abbreviated as CO2e, is a metric used to compare the emissions from various GHGs on the basis of their global-warming potential (GWP), by converting amounts of other gases to the equivalent amount of carbon dioxide with the same global warming potential.
Direct Emissions	Greenhouse gas emissions from facilities/sources owned or controlled by a reporting company, e.g. generators, blowers, vehicle fleets.
Emission Factors	Specific value used to convert activity data into greenhouse gas emission values.
Fugitive Emissions	Fugitive emissions are emissions of gases or vapors from pressurized equipment due to leaks and other unintended or irregular releases of gases, mostly from industrial activities. Besides the economic cost of lost commodities, fugitive emissions contribute to air pollution and climate change.
GHG Protocol	Greenhouse Gas Protocol is a uniform methodology used to calculate the carbon footprint of an organization.
Indirect Emissions	Greenhouse gas emissions from facilities/sources that are not owned or controlled by the reporting company, but for which the activities of the reporting company are responsible, e.g. purchasing of electricity.
GWP	Global Warming Potential is an indication of the global warming effect of a greenhouse gas in comparison to the same weight of carbon dioxide.
Operational boundary	Determination of which facilities or sources of emissions will be included in a carbon footprint calculation.
Organizational	Determination of which business units of an organization will be

boundary	included in a carbon footprint calculation.
Refrigerant	A refrigerant is a substance or mixture, usually a fluid, used in a heat pump and refrigeration cycle.
Scope 1	Direct emissions from sources that are owned or controlled by the reporting entity (i.e. any owned or controlled activities that release emissions straight into the atmosphere).
Scope 2	Indirect emissions associated with the consumption of purchased electricity, heat or steam from a source that is not owned or controlled by the company.
Scope 3	Indirect emissions resulting from other activities that are not covered in scope 1 and 2. This includes transport fuel used by air business travel, and employee-owned vehicles for commuting to and from work; emissions resulting from courier shipment; emissions from waste disposal, etc.

References:

1. Brander M, Davis G. Greenhouse gases, CO2, CO2e, and carbon: What do all these terms mean. Econometrica, White Papers. 2012 Aug.
2. Helmers E, Chang CC, Dauwels J. Carbon footprinting of universities worldwide: Part I—objective comparison by standardized metrics. Environmental Sciences Europe. 2021 Dec;33:1-25.
3. Güereca LP, Torres N, Noyola A. Carbon Footprint as a basis for a cleaner research institute in Mexico. Journal of Cleaner Production. 2013 May 1;47:396-403.
4. Wiedmann T, Minx J. A definition of 'carbon footprint'. Ecological economics research trends. 2008 Mar;1(2008):1-1.
5. Weidema BP, Thrane M, Christensen P, Schmidt J, Løkke S. Carbon footprint: a catalyst for life cycle assessment?. Journal of industrial Ecology. 2008 Feb;12(1):3-6.
6. Alvarez S, Blanquer M, Rubio A. Carbon footprint using the compound method based on financial accounts. The case of the School of Forestry Engineering, Technical University of Madrid. Journal of Cleaner Production. 2014 Mar 1;66:224-32.
7. Goldsworthy L, Brennan E. Climate change in the Southern Ocean: Is the Commission for the Convention for the Conservation of Antarctic Marine Living Resources doing enough?. Marine Policy. 2021 Aug 1;130:104549.
8. Li X, Tan H, Rackes A. Carbon footprint analysis of student behavior for a sustainable university campus in China. Journal of cleaner production. 2015 Nov 1;106:97-108.
9. Adenle YA, Alshuwaikhat HM. Spatial estimation and visualization of CO2 emissions for campus sustainability: The case of King Abdullah University of Science and Technology (KAUST), Saudi Arabia. Sustainability. 2017 Nov 17;9(11):2124.
10. Yañez P, Sinha A, Vásquez M. Carbon footprint estimation in a university campus: Evaluation and insights. Sustainability. 2019 Dec 24;12(1):181.
11. Helmers E, Chang CC, Dauwels J. Carbon footprinting of universities worldwide: Part I—objective comparison by standardized metrics. Environmental Sciences Europe. 2021 Dec;33:1-25.

12. Grindsted T. Sustainable universities–from declarations on sustainability in higher education to national law. Environmental economics. 2011 Dec 1;2(2).
13. Simnett R, Nugent M, Huggins AL. Developing an international assurance standard on greenhouse gas statements. Accounting Horizons. 2009 Dec 1;23(4):347-63.
14. Thurston M, Eckelman MJ. Assessing greenhouse gas emissions from university purchases. International Journal of Sustainability in Higher Education. 2011 Jul 11;12(3):225-35.
15. Klein-Banai C, Theis TL, Brecheisen TA, Banai A. A greenhouse gas inventory as a measure of sustainability for an urban public research university. Environmental Practice. 2010 Mar;12(1):35-47.