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"It is not enough to do your best; you must know what to do, and then do your best"
W. Edward Deming

2024

Axosomatic | Organizational Sustainable Intelligence

GHG Inventory Report
2022 – 2023

Calculated and Prepared by Axosomatic

For
Mohamed Bin Rashid University of Medicine and Health Sciences

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This report describes the GHG emissions accounting inventory calculated by Axosomatic for Mohamed Bin Rashid University of Medicine and Health Sciences (MBRU). The GHG Inventory Data and related information in this report are confidential and may be shared by MBRU for accreditation and ranking purposes.

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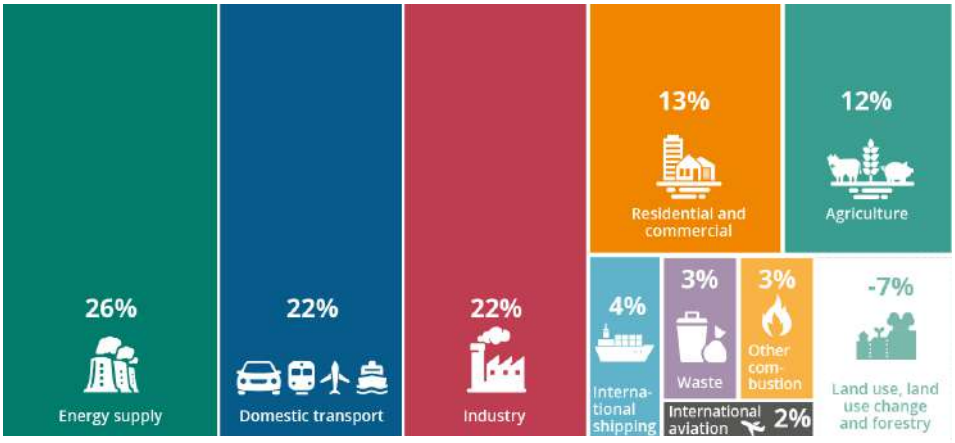

Sources of Greenhouse Gases (GHG) Emissions

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List of Acronyms and Abbreviations

BEIS	Department for Business, Energy, and Industrial Strategy
BSI	British Standards Institute
CDP	Carbon Disclosure Project
CO_2e	Carbon Dioxide Equivalent
EPA	Environmental Protection Agency
EV	electric vehicles
GHG	Greenhouse Gases
GJ	Gigajoule
GRI	Global Reporting Initiative
GWP	global warming potential
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
kg	kilogram
km	kilometer
kWh	kilowatt-hour
LPG	liquefied petroleum gas
m^2	Square Meters
m^3	Cubic Meters
MW	Megawatt
MWh	Megawatt-hour
passenger.km	passenger-kilometer
SBT	science-based target
SBTi	Science-Based Target initiative
t	metric ton
tCO_2e	metric ton carbon dioxide equivalent
T&D	Transmission and Distribution
UAE	United Arab Emirates
WBCSD	World Business Council for Sustainable Development
WRI	World Resources Institute

EXECUTIVE SUMMARY

This Greenhouse Gases (GHG) inventory report is the outcome of the assessment phase of Axosomatic Net-Zero Carbon Intelligence solutions framework conducted at Mohamed Bin Rashid University of Medicine and Health Sciences (MBRU). It presents the GHG emissions (Scope 1, Scope 2, and Scope 3) attributed to the educational activities at MBRU for the period from Sep 2022 to Aug 2023 (2022 – 2023). Throughout this report, the period 2022 – 2023 indicates the baseline year.

The objectives of the report to:

1. Develop an accurate and rigorous approach to carbon accounting and reporting, based on the GHG Protocol Standards.
2. Include all GHG emissions from MBRU, including those upstream and from employee and student commuting.
3. Compare the GHG emissions with international universities.
4. Provide MBRU with expert recommendations on how to reduce its GHG emissions.
5. Improve MBRU national and international ranking.

The GHG Protocol represents the most rigorous approach to emissions accounting and has been adopted by many private and public sectors worldwide in line with the Paris Agreement.

Calculation of GHG emissions is based on GHG protocol, BEIS, BSI, CEDA, CDP, EPA, GRI, GWP, IPCC, ISO, SBT, SBTi, WBCSD, WRI, and local data.

Summary of Sustainability Indicators for the Performance Year[1]

The following table summarizes the GHG emissions attributed to MBRU in the baseline year:

2022 – 2023 (Baseline Year)		
Description	GHG Emission (tCO_2e)	% of Total
Scope 1: Direct GHG Emission	26.27	0.51%
Scope 2: Indirect GHG Emission	1,101.84	21.26%
Scope 3: Indirect GHG Emissions	4,054.40	78.23%
Certified Green Energy[2]	0	0
Purchased Emission Reduction[3]	0	0
Total Scope 1 and Scope 2	1,128.11	21.77%
Total Baseline Year	5,182.51	100%
Total GHG Emissions/m^2		0.023
GHG/FTEE and FTSE[4]		0.873
Weighted Campus User (WCU)[5]		968.75
GHG (Scope 1 and Scope 2)/WCU		1.160
Required Average Annual Reduction Until 2035		10%
Projected average annual saving in AED till 2033[6]		**121,924**
Projected total saving in AED by 2033[6]		**1,219,239**

Table 1. Summary of sustainability indicators in the baseline year.

[1] Details are described in sections 1 to 5 of this report
[2] Certified green energy refers to energy that is generated from renewable sources, or sources that minimal environmental impact.
[3] Purchased emission reduction refers to purchase of carbon offset or carbon credit.
[4] Full-Time Equivalent of employees and students according to CHEDS formula.
[5] A metric developed by AACHE to assess the effectiveness of a university in reducing its emissions.
[6] Related to Scope 1 and Scope 2 only.

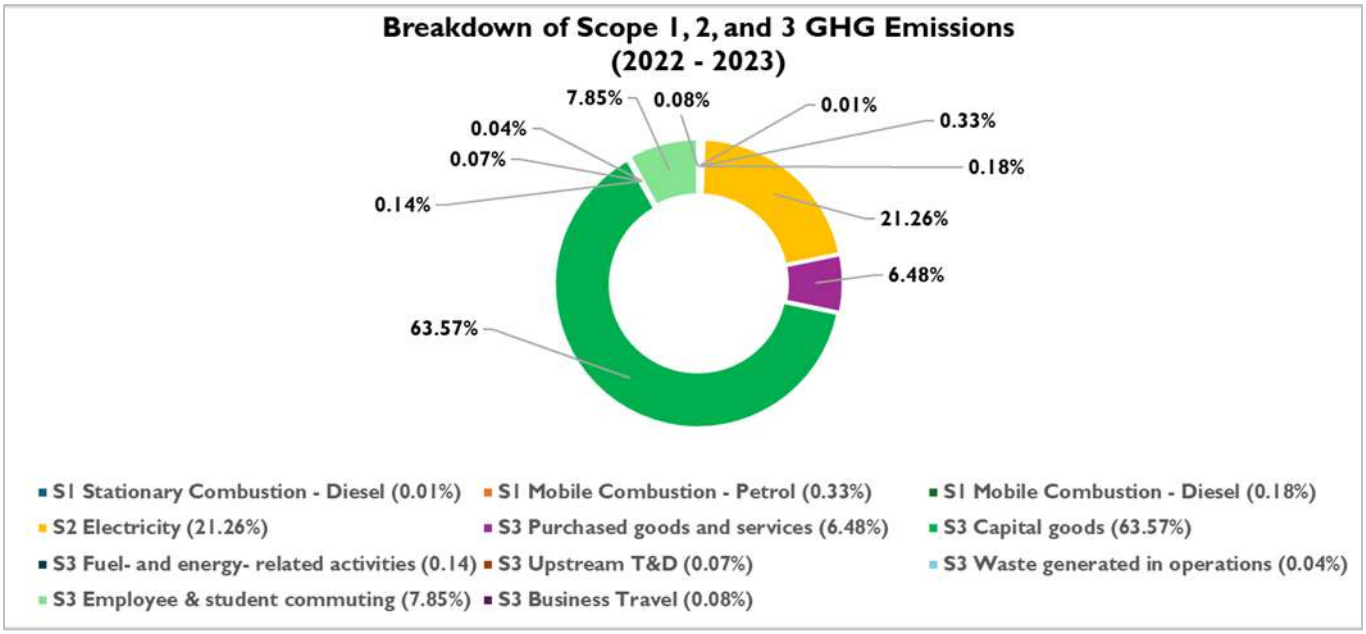

Figure 1. Breakdown of Scope 1, 2, 3 emissions.

Comments:

1. During the year 2022 – 2023, the Scope 1 and 2 GHG emissions related to MBRU activities are, respectively, 26.27 and 1101.84 tCO_2e (metric ton of carbon dioxide equivalent).
2. Scope 1 Direct GHG Emissions consists of the following:
    a. Emissions related to the consumption of diesel in generators and fire pumps.
    b. Emissions related to the consumption of petrol and diesel in vehicles leased by MBRU.
3. Scope 2 Indirect GHG emission is related to the consumption of purchased electricity.
4. The approximate Scope 3 Indirect GHG emission is 4,054.40 tCO_2e, which constitutes 78.23% of the total emissions. This is due to the approximate emissions attributed to purchased goods (IT equipment, furniture, and medical equipment). This emission includes manufacturing and transportation to MBRU campus and is depreciated with time.
5. The emission related to the consumption of electricity is the second highest emission.
6. **Required Average Annual Reduction**
    a. To meet the 1.5C target by 2050, MBRU is required to reduce its Scope 1 and Scope 2 emissions by an average of 10% (6% to 17%), as of 2024 to 2035.
7. **Monetary Savings**
    a. If MBRU reduces Scope 1 and Scope 2 emissions by 6% during 2024 and aims for 20% annual reduction from 2025 to 2027, and 30% from 2028 to 2030, and then 50% from 2031 to 2033, it will reduce its general and administrative costs and make an average monetary saving of AED **121,924** per year, and a total of AED **1,219,239**, by the end of 2033.

Emissions by Scope and Greenhouse Gases

Table 2 provides the approximate emissions of greenhouse gases associated with Scope 1, 2, and 3 activities at MBRU, during the period 2022 – 2023. It should be noted that, because of the rounding of digits, the figures may not add up exactly to the total tCO_2e in table 1.

As described in section 4 in Annex I, these gases have a stronger warming effect on the environment, compared to CO2. Their effects can be reduced by using renewable energy, increasing environmental awareness among employees and students, and replacing existing vehicles with EVs and/or hybrid cars.

2022 – 2023			
	Scope 1	Scope 2	Scope 3
Carbon dioxide (CO2)	26.00	1,090.58	4,530.03
Methane (CH4)	0.03	4.15	0
Nitrous oxide (N2O)	0.24	7.11	0.01
Hydrofluorocarbons (HFCs)	0.00	0.00	0.80
Perfluorocarbons (PFCs)	0.00	0.00	0
Sulphur hexafluoride (SF6)	0.00	0.00	0
Total (tCO_2e)	26.27	1,101.84	4,530.84

Table 2. Emissions by Scope and greenhouse gases (2022 – 2023).

The report contains 6 sections and 2 annexes. Section 1 describes the institutional boundary, institutional indicators, data assumption and methodology. Sections 2 and 3 describe, respectively, Scope 1 and Scope 2 GHG emissions for 2022-2023. Section 4 describes the approximate Scope 3 GHG emissions. Section 5 provides benchmarking with institutions in the UAE and Europe that offer medical and health sciences programs similar to those at MBRU. Section 6 describes the target reduction plan that MBRU is suggested to follow, based on SBTi, and Axosomatic recommendations based on national and international best practices.

Annexes I and II present, respectively, a brief introduction to GHG emissions, and the Global Warming Potentials related to GHG emissions.

1. INTRODUCTION

This section describes an overview of MBRU, the institutional boundary, the institutional parameters, data assumption and methodology.

1.1 Institutional Description[7]

Named after His Highness Sheikh Mohammed Bin Rashid Al Maktoum, Vice President and Prime Minister of the UAE, and Ruler of Dubai, Mohammed Bin Rashid University of Medicine, and Health Sciences (MBRU) is a medical university located in the emirate of Dubai, United Arab Emirates. The university offers ten accredited undergraduate and postgraduate degrees through its three colleges: Hamdan Bin Mohammed College of Dental Medicine, the College of Medicine, and the College of Nursing and Midwifery.

MBRU is part of the Dubai Academic Health Corporation, Dubai's first integrated academic health system. The Corporation strives to advance health for humanity through its mission to impact lives and shape the future of health through the integration of care, learning, and discovery. By living its core value of Patient First, the Corporation aims to set the global standard of patient outcomes for generations to come. MBRU is located in Dubai Medical City Free Zone.

1.2 Institutional Boundary

Descriptive information	Company response
Company name	Mohammed Bin Rashid University of Medicine and Health Sciences (MBRU)
Description of the company	Higher Education Institution
Chosen consolidation approach (equity share, operational control or financial control)	Operational Control
Description of the businesses and operations included in the company's organizational boundary	Providing undergraduate and graduate programs degrees in medicine, dental medicine, and nursing through its colleges.
The reporting period covered	Sep 2022 – Aug 2023
A list of Scope 3 activities included in the report	Upstream
A list of Scope 1, Scope 2 and Scope 3 activities excluded from the report with justification for their exclusion	All Scope 1 and Scope 2 are included. Upstream Scope 3 activities are included, excluding Upstream leased assets. All Downstream are excluded. Reason for exclusion: activities are not applicable to MBRU.
The year chosen as Baseline year and rationale for choosing the Baseline year	2022 - 2023
Carbon reduction plan and target by at least 2050.	MBRU is in the process of implementing a solution framework to optimize its operations and reduce GHG emissions by 50% by 2030.

Table 3. Institutional Boundary.

[7] Source: MBRU website.

1.3 Institutional Indicators[8]

Organizational Indicators		
Item	**Descriptions**	**Baseline year (2022 – 2023)**
1	Number of campuses owned	0
2	Number of buildings rented	3
3	Number of buildings	3
5	Total FT Faculty	68
6	Total PT Faculty	346
7	Total FT Staff	159
8	Total PT Staff	94
	Total Employee	667
	Employee FTE[9]	374
9	Total FT Students	914
10	Total PT Students	12
	Total Students (TS)	926
	Student FTE[10]	918
11	Total Students in dormitories	0
12	Total campus area (m^2)	220,879
13	Total area occupied by buildings	220,879
14	Total green area (m^2)	476
15	Number of trees	40
16	Total grass area (m^2)	387

Table 4. Institutional indictors.

1.4 Data Assumption & Estimation

The following table provides information about the data submitted by MBRU for the 2022 – 2023 performance year, and methods used by Axosomatic to estimate the missing data:

Scope	Source	Comments/Recommendations
Scope 1 Stationary Combustion	Consumption of diesel, LPG, and Refrigerant Leakage	• MBRU provided data of diesel consumption in generators and fire pumps. The provided data was used to calculate the emissions due to stationary combustion of diesel. • MBRU does not use LPG in its operation. • Because MBRU is located in a Free-Zone, it does not have data about the refrigerant leakage.
Mobile Combustion	Petrol and Diesel.	• MBRU does not own vehicles and does not provide transportation services for employees or students. • MBRU rents 2 vehicles : one diesel-operated and one petrol-operated. • Data for diesel and petrol consumption was provided. • The data for diesel consumption was provided in the form of monetary values in AED for 5 months. Axosomatic applied conservative approach to determine the data for the baseline year.

[8] Source: MBRU.
[9] Employee Full-time Equivalent based on CHEDS Formula.
[10] Student Full-time Equivalent based on CHEDS formula.

Scope	Source	Comments/Recommendations
Scope 2	Purchased Electricity	MBRU provided complete data for the electricity consumption in its building.
Scope 3	Categories 1 to 7	MBRU is located in Dubai Health City free zone and the most the data are approximate. At the time of preparing this report, MBRU did not have all the data required for Scope 3. Axosomatic, with the approval of MBRU, applied conservative approach and benchmarking to calculate the Scope 3 emissions.

Table 5. Data Assumption and Estimation.

1.5 Methodology

The GHG accounting and reporting procedure adhere to the foundations outlined in the 'The Greenhouse Gas Protocol: GHG Protocol: A Corporate Accounting and Reporting Standard – Revised Edition' (referenced hereafter as the 'GHG Protocol') and its supplementary guide, the 'Corporate Value Chain (Scope 3) Accounting and Reporting Standard'. These standards represent the preeminent global accounting frameworks, endorsed by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD), that are utilized by both governmental entities and corporate leaders as trusted tools to effectively comprehend, quantify, and manage greenhouse gas (GHG) emissions. The development of these standards was a collaborative effort between the aforementioned institutions, reflecting the collective wisdom and expertise in the field of GHG emissions measurement.

The accounting process was meticulously executed upon key principles encapsulated within the 'GHG Protocol', as outlined below:

1. Relevance: This involves the establishment of an inventory boundary that accurately represents the GHG emissions attributable to the company and caters to the informational needs of its user base, thereby facilitating informed decision-making.
2. Completeness: The execution of thorough and all-encompassing accounting that encapsulates every emission source that lies within the delineated inventory boundary. Any emissions not included are explicitly acknowledged and justified as to why they are not covered within the Scope of the inventory.
3. Consistency: Ensuring that the GHG emissions information is comparable over distinct time periods and that any modifications to the collected data are methodically documented, maintaining a clear and consistent historical record.
4. Transparency: Upholding a standard of clarity and sufficiency in the data inventory that involves a coherent and systematic approach to handling and addressing pertinent issues.
5. Accuracy: Striving to minimize uncertainties and actively preventing the systematic overstatement or understatement of GHG emissions, thus achieving a high level of confidence in the reported figures.

1.6 Emission Factors

Axosomatic used a database of 20k global emissions factor and UAE location-based emissions factor for Scope 1 and Scope 2, and Scope 3.

2. SCOPE 1: DIRECT GHG EMISSIONS

MBRU is located in a Free-Zone area in Dubai and rents 3 buildings for its campus. In this report, the buildings are denoted by B12, B14, and B34. Because of its location in the free zone, MBRU does not have control over the refrigerant leakage.

2.1 Scope 1 Data and GHG Emissions

The Scope 1 GHG emissions attributed to MBRU, are related to the stationary combustion of diesel fuel in generators and fire pumps in B14 and B34; and to the mobile combustion of petrol and diesel in its rented vehicles (2 cars).

The tables below list, respectively, the consumption data provided by MBRU for Scope 1 and the attributed GHG emissions for the baseline year 2022 – 2023:

Scope 1 Direct GHG Emissions 2022 - 2023	
Source	Consumption
Stationary Combustion	
Diesel (liters)	148.80
Heating Oil	Not Applicable
Propane/LPG	Not Applicable
Refrigerant Leakage	Not Applicable
Mobile Combustion	
Petrol (Liters)	3,736.35
Diesel (Liters)	6,434.68

Table 6. Summary of Scope 1 Data provided by MBRU..

Scope 1 Direct GHG Emissions 2022 - 2023		
Source	GHG Emissions (tCO_2e)	% Total
Stationary Combustion		
Diesel (liters)	0.40	1.51%
Heating Oil	Not Applicable	---
Propane/LPG	Not Applicable	---
Refrigerant Leakage	Not Applicable	---
Sub-Total	0.40	1.51%
Mobile Combustion		
Petrol	8.76	33.35%
Diesel	17.11	65.14%
Sub-Total	25.87	98.49%
Total Scope 1 GHG Emissions	26.27	100.00%

Table 7. Summary of Scope 1 GHG Emissions.

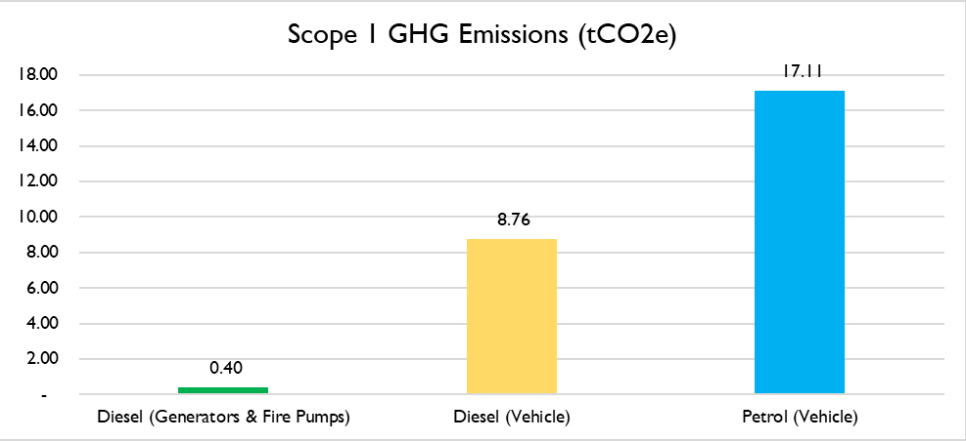

Figure 2. Breakdown of Scope 1 GHG emissions by source.

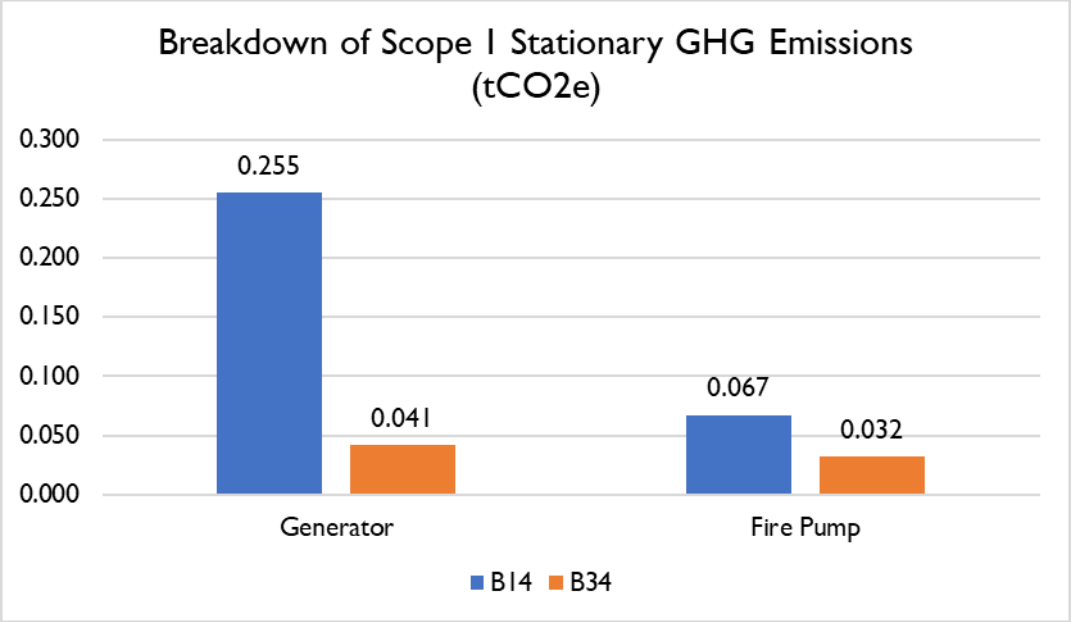

Figure 3. Breakdown of stationary GHG emissions by source.

2.2 Summary of Scop 1 Direct GHG Emissions

From the previous 2 tables and charts, the following can be observed:

1. The GHG emissions from the mobile combustion of petrol and diesel are higher than that from stationary combustion of diesel.
2. The emissions related to mobile combustion of petrol are higher, compared to other Scope 1 sources.
3. The GHG emissions related to the use of generators are higher in building 14, and those related to the use of fire pumps are almost identical.

3. SCOPE 2: INDIRECT GHG EMISSIONS

Scope 2 indirect GHG emissions attributed to MBRU operations are related to the consumption of purchased electricity.

MBRU receives the utility bills direct from DEWA that includes electricity and water consumptions for the buildings B12, B14, and B34. The emissions associated with water consumption will be included in Scope 3.

3.1 Scope 2 Data and GHG Emissions

The following tables list the electricity consumption (kWh) and GHG emissions expressed in metric tons of CO_2 equivalent (tCO_2e), related to MBRU operations during the period of 2022 – 2023:

Scope 2 GHG Emissions 2022 - 2023			
Source	Consumption	$kgCO_2e$	tCO_2e
Electricity (kWh)	2,754,391.82	1,101,842.95	1,101.8

Table 8. Scope 2 GHG Emissions 2022-2023.

Scope 2 GHG Emissions by Building				
	B12	B14	B34	Total
GHG Emissions (tCO2e)	152.49	824.09	125.26	1,101.84
% Total	13.84%	74.79%	11.37%	

Table 9. Breakdown of Scope 2 GHG Emissions 2022-2023.

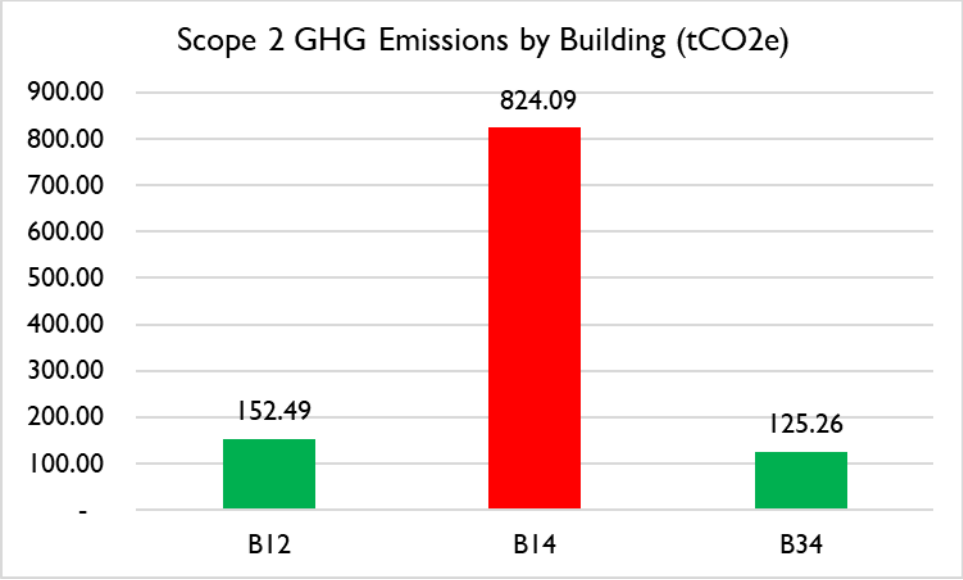

Figure 4. Breakdown of Scope 2 GHG Emissions 2022-2023.

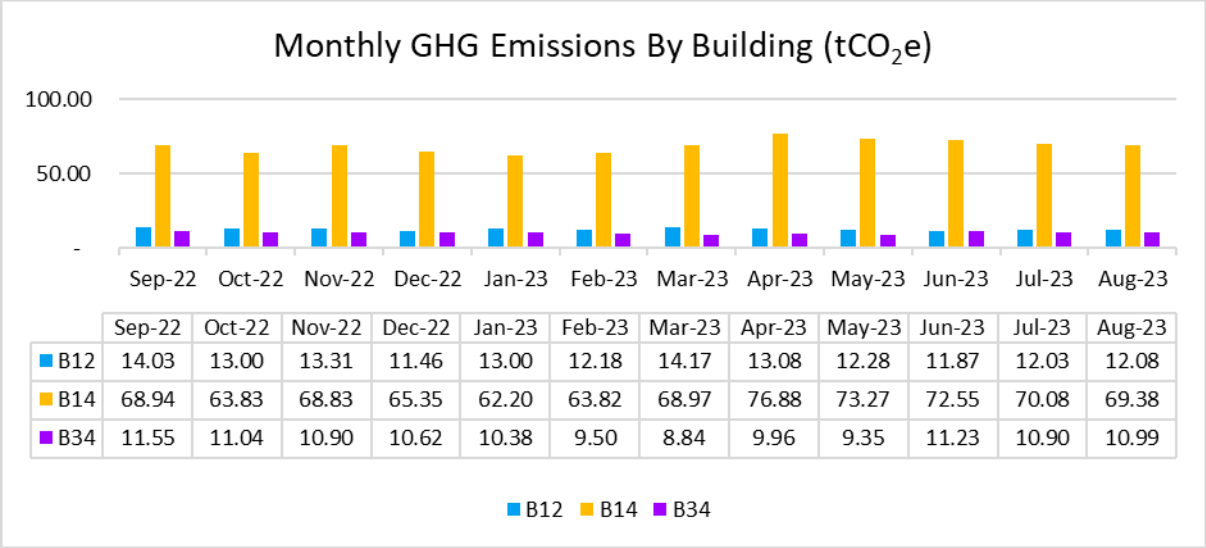

Figure 5. Monthly Emissions by Building.

Breakdown of Scope 2 GHG Emissions in B14 (2022-2023)												
B14	**Sep-22**	**Oct-22**	**Nov-22**	**Dec-22**	**Jan-23**	**Feb-23**	**Mar-23**	**Apr-23**	**May-23**	**Jun-23**	**Jul-23**	**Aug-23**
LV Panel 1	7.77	7.19	6.96	6.33	7.95	8.57	16.18	15.87	14.01	7.67	7.28	5.85
LV Panel 2	33.73	29.43	34.00	32.46	27.35	28.29	27.98	33.43	31.74	34.74	33.58	35.35
LV Panel 3	7.79	7.68	7.79	7.56	7.56	7.82	6.86	7.74	7.90	8.05	8.31	7.97
LV Panel 4	9.64	9.64	10.19	9.74	10.10	10.10	9.10	10.01	9.55	10.19	9.92	9.74
LV Panel 5	2.75	2.41	2.49	2.21	2.01	2.03	1.93	2.20	2.27	2.58	2.59	2.60
3F - LW SCHOOL	1.54	1.60	1.57	1.44	1.50	1.50	1.44	1.63	1.60	1.76	1.57	1.50
3F - RW SCHOOL	1.63	1.82	1.80	1.73	1.70	1.56	1.56	1.87	2.06	2.16	1.73	1.44
4F - LW SCHOOL	1.98	1.92	1.98	1.86	2.21	2.11	2.14	2.11	2.27	3.20	3.14	3.14
RESTAURAN	2.10	2.13	2.05	2.03	1.82	1.84	1.76	2.02	1.86	2.21	1.95	1.79
Total	68.94	63.83	68.83	65.35	62.20	63.82	68.97	76.88	73.27	72.55	70.08	69.38
Average	7.66	7.09	7.65	7.26	6.91	7.09	7.66	8.54	8.14	8.06	7.79	7.71

Table 10. Breakdown of GHG Emissions in B14.

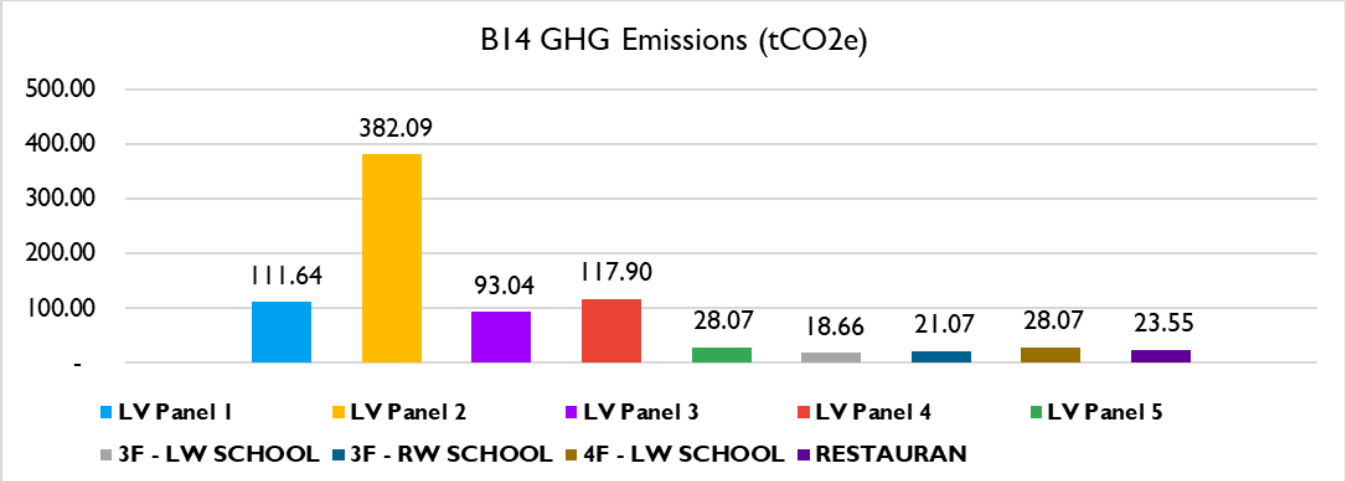

Figure 6. Breakdown of GHG Emissions in B14.

3.2 Summary of Scope 2 Indirect GHG Emissions

a. The total Scope 2 indirect GHG emissions related to the consumption of purchased electricity during 2022 – 2023 is 1101.8 tCO_2e, distributed by building as follows:
    a. The GHG emission related to consumption of electricity in B12 is 152.49 tCO_2e.
    b. The GHG emission related to consumption of electricity in B14 is 824.09 tCO_2e.
    c. The GHG emission related to consumption of electricity in B34 is125.26 tCO_2e.
b. The GHG emission in B14 is the highest.
c. In B14, the area associated with LV Panel 2 has the highest GHG emissions related to the consumption of purchased electricity, compared to other areas in B14.
d. The weighted average of GHG emissions in B14 is 7.63 tCO_2e.
e. The values highlighted in Yellow in table 10 have indicate the area in B14 with emissions above the weighted average.

4. SCOPE 3: INDIRECT GHG EMISSIONS

Scope 3 indirect GHG emissions attributed to MBRU, occurred from the consumptions of Upstream Activities (categories 1 to 7), listed in the following table:

Category	Emission Sources	Status
1. Purchased goods and services	Food & Beverages, Printing Papers, Toilet Papers, Tissue Papers, Water, and Cloud Services.	Included
2. Capital goods	IT Equipment, Office Furniture, Medical Equipment	Included
3. Fuel- and energy-related activities	Transmission and Distribution (T&D) losses of purchased electricity.	Included
4. Upstream T&D	T&D of Purchased Good and Capital Good	Included
5. Waste generated in operations	Wastewater, General Waste, Medical Waste, Food Waste, Paper Waste.	Included
6. Business travel	Travel and accommodation of employees/contractors.	Included
7. Employee commuting	Employee commuting from and to MBRU.	Included
8. Upstream leased assets	Operation of assets leased by MBRU (lessee) in the reporting year and not included in Scope 1 and Scope 2.	Not applicable
9. Downstream T&D	T&D of products sold by the organization.	Not applicable
10. Processing of sold products	Processing of intermediate products sold by the organization.	Not applicable
11. Use of sold products	Use of sold goods that require energy to operate.	Not applicable
12. End-of-life treatment of sold products	Waste disposal and treatment of sold products.	Not applicable
13. Downstream Leased Assets	Emissions from the operation of assets that are owned by MBRU company and leased to other entities.	Not applicable
14. Franchises	Emissions from the operation of franchises to sell or distribute another company's goods or services within a certain location.	Not applicable
15. Investments	Emissions associated with MBRU's investments.	Not applicable

Table 11. List of Scope 3 Categories.

4.1 Axosomatic Comments

MBRU is located in Dubai Health City free zone and most of the data are approximate. At the time of preparing this report, MBRU did not have all the data required for Scope 3. Axosomatic, with the approval of MBRU, applied a conservative approach and benchmarking to calculate the Scope 3 emissions.

4.2 Summary of Scope 3 Emissions Breakdown

The below table presents the approximate emissions related to MBRU Scope 3 activities. Please note that because of the lack of local data, the WTT data does not include emissions related to purchased electricity.

Total Scope 3 Emissions (2022 – 2023)				
Category 1	Unit	Consumption	tCO2e	% of Total Scope 3
Food & Beverages	USD	-	-	0.00%
Food & Beverages	ton	-	-	0.00%
Drinking Water	ton	6.30	23.32	0.58%
Printing Papers	ton	5.63	5.17	0.13%
Toilet Papers	ton	10.88	10.00	0.25%
Tissue Papers	ton	2.81	2.59	0.06%
Water Supply	m3	3,413.35	0.93	0.02%
Cloud Services	Euros	320,308.51	293.71	7.24%
		Total Category 1 GHG Emissions	**335.71**	**8.28%**
Category 2				
Capital Assets	Unit	Consumption	tCO2e	% of Total Scope 3
IT Equipment	Quantity	685	429	10.59%
Furniture	Euros	687,530	630	15.55%
Medical Equipment	Euros	2,437,205	2,235	55.12%
		Total Category 2 GHG Emissions	**3,294.74**	**81.26%**
Category 3 & 4				
T&D Loss and Upstream T&D	Unit	Consumption	tCO2e	% of Total Scope 3
T&D Loss - Purchased Electricity	MWh	2,060	0.014	0.0003%
T&D - Purchased Good	KM	17,224	3.391	0.0836%
Well-To-Tank (WTT)[1]			7.17	0.1768%
		Total Category 3 & 4 GHG Emissions	**10.57**	**0.2608%**
Category 5				
Waste	Unit	Consumption	tCO2e	% of Total Scope 3
Wastewater	m3	3,242.68	0.88	0.022%
General Waste	ton	51.10	1.09	0.027%
Plastic Waste	ton	4.16	0.09	0.002%
Medical Waste	ton	10.66	0.23	0.006%
Food Waste	ton	1.27	0.03	0.001%
		Total Category 5 GHG Emissions	**2.31**	**0.057%**
Category 6				
Business Travel - Air	passenger.km	2,436,007.04	404.47	9.98%
Business Travel - Land	passenger.km	710.98	2.44	0.06%
		Total Category 6 GHG Emissions	**406.91**	**10.04%**
Category 7				
Commuting	Unit	Consumption	tCO2e	% of Total Scope 3
Employee Commuting	KM	9,490.75	2.47	0.06%
Student Commuting	KM	6,673.14	1.68	0.04%
Total Category 7 GHG Emissions		**99,942.89**	**4.15**	**0.10%**
		Total Scope 3	**4,054.40**	

Table 12. Total Scope 3 Emission.

4.3 Category 1: Purchase Goods

The activities included in Category 1 include the items listed in the below table. Since MBRU does not provide cafeteria and restaurant services (Food & Beverages), these items are "Not Applicable" to MBRU emissions. The below table lists the approximate emissions related to Category 1:

Source	Unit	Consumption	tCO_2e	% Total
Food & Beverages	USD	Not Applicable	-	-
Food & Beverages	ton	Not Applicable	-	-
Drinking Water	ton	6.300	23.318	6.95%
Printing Papers	ton	5.625	5.172	1.54%
Toilet Papers	ton	10.875	9.998	2.98%
Tissue Papers	ton	2.813	2.586	0.77%
Water Supply	m3	3,413.351	0.928	0.28%
Cloud Services	Euros	320,308.505	293.709	87.49%
		Total	335.712	100.00%

Table 13. Category 1 Emissions.

4.4 Category 2: Capital Goods

The activities included in Category 2 include the items listed in the below table, along with the related emissions:

Source	Unit	Consumption	tCO_2e	% Total
IT	Quantity	685	429.361	13.03%
Furniture	Euros	687,529.50	630.465	19.14%
Medical Equipment	Euros	2,437,204.69	2,234.915	67.83%
		Total	3,294.740	100.00%

Table 14. Category 2 Emissions.

4.5 Categories 3&4: Energy Related Activities

The following table lists the emissions related to energy related activities that are not accounted for in Scope 1 and Scope 2. It includes emissions from the Transmissions and Distribution (T&D) Loss of purchased electricity, Upstream T&D Loss of purchased good, and WTT of Upstream T&D. WTT is described in detail in section 4.9.

Source	Unit	Consumption	tCO_2e	% Total
T&D Loss Electricity	MWh	2,060.07	28.408	72.90%
Upstream T&D Loss	km	17,224.00	3.391	8.70%
WTT			7.170	18.40%
		Total	38.969	100.00%

Table 15. Categories 3 and 4 Emissions.

4.6 Category 5: Waste

The emission related to category 5 includes the emissions related to the waste produced in operation including wastewater, general waste, plastic waste, medical waste, and food waste. The following table lists an estimate of the waste consumption at MBRU and the related emissions:

Source	Unit	Consumption	tCO_2e	% Total
Wastewater	m3	3,242.68	0.88	38.14%
General Waste	ton	51.10	1.09	47.04%
Plastic Waste	ton	4.16	0.09	3.83%
Medical Waste	ton	10.66	0.23	9.82%
Food Waste	ton	1.27	0.03	1.17%
		Total	2.31	100.00%

Table 16. Category 5 Emissions.

4.7 Category 6: Business Travel

Category 6 includes the emissions related to business travel (by land and by air) and hotel stay paid by MBRU to its employees for academic purposes. The following table lists the approximate emissions attributed to business travel during the year 2022 – 2023:

Business Travel - Land				
	passenger.km	tCO_2e - Hotel Stay	tCO_2 - Drive	Total tCO_2e
Total	710.98	1.53	0.91	2.44
Business Travel - Air				
	passenger.km	tCO_2e - Hotel Stay	tCO_2e - Flight	Total tCO_2e
Total	2,436,007.04	11.04	393.43	404.47

Table 17. Category 6 Emissions.

4.8 Category 7: Employee and Student Commuting

The emissions related to category 7 include the emissions attributed to employees and students commuting to and from MBRU campus. MBRU does not provide transportation to employees or students. The following table lists the approximate emissions attributed to employees and students commuting during the year 2022 – 2023:

Source	Unit	Consumption	tCO_2e	% Total
Employee Commuting	km	9,490.75	2.4702	59.58%
Student Commuting	km	6,673.14	1.6760	40.42%
		Total	4.1462	100.00%

Table 18. Category 7 Emissions.

4.9 Well-To-Tank

In the context of GHG protocol, Well-to-Tank (WTT) is included as part of Scope 3 emissions. It refers to the emissions associated with the entire life cycle of a fuel (petrol, diesel, LPG, etc.) and Refrigerant, including its extraction, production, transportation, and distribution, up to the point where it is stored in a vehicle's fuel tank., or supplied to the reporting organization.

The approximate WTT related emissions are listed in table 19 for the year 2022 - 2023. Please note that the WTT emissions are added to category 3 &4, and category 6 in the respective tables. It should be noted that there is no published local data for WTT for purchased electricity:

WTT Related Emissions	
2022 - 2023	
Scope 1	tCO_2e
Petrol	2.252
Diesel	4.139
Total Scope 1	6.39
Scope 3	tCO_2e
Student Commuting - FTSE[11]	
Own Vehicle - km	0.209
Own Vehicle - pkm	0.092
Public Transportation - pkm	0.013
Total FTSE	0.314
Employee Commuting - FTEE[12]	
Own Vehicle - KM	0.377
Own Vehicle - Passenger.Km	0.058
Taxi	0.030
Total WTT Emissions	7.17

Table 19. WTT Related Emissions.

[11] Full-Time Student Equivalent.
[12] Full-Time Employee Equivalent.

5. BENCHMARKING INDICATORS

GHG emissions benchmarking for universities is based on established indicators, listed in the following table:

Benchmarking Indicators 2022 - 2023	
Description	tCO_2e
Scope 1: Direct GHG Emission (tCO_2e)	26.27
Scope 2: Indirect GHG Emission (tCO_2e)	1,101.84
Scope 3: Indirect GHG Emissions (tCO2e)	4,054.40
Total Scope 1 + Scope 2 (tCO2e)	1,128.11
Total (tCO_2e)	5,182.51
FTEF[2]	374
FTSE[2]	918
GHG/FTEE and FTSE[13]	0.87
Weighted Campus Users (WCU)	968.75
GHG/Weighted Campus Users[14] (tCO_2e)	1.16
GHG/Campus Area	0.023

Table 20. GHG Emissions and Metrics.

The Weighted Campus Users (WCU) indicator is developed by the Association for the Advancement of Sustainability in Higher Education. It is used to measure how intensively a certain institution's population, those who live on campus, use the campus resources.

For example, an institution where a high percentage of students live on campus would witness higher GHG emissions, electricity and water consumptions, wastewater, and waste generation figures than otherwise comparable non-residential institutions.

The indicates (GHG/WCU) is a function of Scope 1 and 2 emissions, total full-time employee equivalent, total full-time student equivalent, and total number of students reside at the in-campus housing owned by the institution. It is used to track an organization's progress in reducing its Scope 1 and Scope 2 emissions. The reduction of (GHG/WCU) in a given year with respect to a baseline year, indicates the effectiveness of the organization's plan in reducing its Scope 1 and 2 emissions.

To illustrate this, from the above table, the value of (GHG/WCU) is 1.16 tCO_2e. If MBRU reduces its Scope 1 and 2 emissions during 2023 – 2024, say by 10%, and assuming all other data are constant, the indicator (GHG/WCU) will be 1.05. This would indicate that MBRU has achieved an emission reduction of 9.4%.

The above indicators form the baseline that will be used to compare the effectiveness of MBRU strategies to reduce its emissions.

[13] FTEE (Full-Time Employe Equivalent) and FTSE (Full-Time Student Equivalent), based on CHEDS formula.
[14] Scope 1 and Scope 2 only.

5.1 GHG Emissions Benchmarking[15]

The following table compares GHG Emissions (Scope and Scope 2) and other indicators, of MBRU to selected international universities. The indicators (GHG/WCU and % Decrease) indicate the effectiveness of the institution's plan to reduce its GHG emissions, during its path to Net-Zero Carbon. The (% Decrease) indicates the percentage reduction of total GHG emissions (Scope 1 and Scope 2) per weighted campus users for the performance year, with respect to the Baseline years. The higher the (positive value of % Decrease), the more effective the plan. The negative %Decrease indicates an increase or insufficient decrease in the emissions (Scope 1 + Scope 2), with respect to the baseline year.

								Performance Year		Baseline Year	
	Scope 1	Scope 2	TFES[16]	TFE[17]	WCU[18]	GHG/WCU[19]	% Reduction[20]	Start	End	Start	End
Loyola U Chicago	9,275	3,234	15,818	2,835	13,573.25	0.92	79.0%	01-Jul-21	30-Jun-22	01-Jul-07	30-Jun-08
Florida State U	17,627	90,606	39,829	7,079	35,538.75	3.05	23.4%	01-Jul-22	30-Jun-22	01-Jul-17	30-Jun-18
University of NC	19,457	37,673	27,599	3,658	23,973.00	2.38	38.6%	01-Jul-21	30-Jun-22	01-Jul-02	30-Jun-03
U Tennessee, Knoxville	80,464	82,493	28,329	7,089	26,565.75	6.13	24.0%	01-Jul-20	30-Jun-21	01-Jul-14	30-Jun-15
MBRU, UAE	**26.27**	**1,101.84**	**374**	**918**	**968.75**	**1.16**	**---**	**---**	**---**	**01-Sep-22**	**31-Aug-23**

Table 21. Benchmarking of MBRU GHG emissions with international HEIs.

[15] Data compiled by Axosomatic (www.axosomatic.com). There are no official data published by other institutions in the UAE.
[16] Total Full Time Equivalent Students.
[17] Total Full-time Equivalent Employees.
[18] Weighted Campus Users.
[19] GHG Emissions per Weighted Campus Users.
[20] All values above 30%, indicate good reductions in the GHG emissions with respect to the Baseline year. It should be noted that it took the listed US universities an average of 10 years to bring down the GHG emissions by an average of 42%.

5.2 Sustainability Benchmarking

The following table provides sustainability benchmarking of some universities in the UAE, UK, and Ireland that provide medical and health sciences programs similar to those at MBRU. The comparison is based on:

1. Having a sustainable goal in its strategy or initiative;
2. Alignment of research, programs, and academic activities with the UN SDGs;
3. GHG Emissions Report; and
4. Commitment to Net-Zero Strategy, published in Race To Net-Zero Universities

HEIs	Sustainable Goal/Initiative	Alignment to UN SDGs	GHG Emissions Report	Commitment to Net-Zero Strategy
Ajman University	Published[21]	Published	Published	Committed and Published
University of Sharjah	Published	Published	Published	Committed and Published
University of Oxford	Published	Published	Published	Committed and Published
MBRU	Pending[22]	Pending	Pending	Pending
Queens University Belfast	Published	Published	Unknown[23]	Unknown
RAK-MHSU[24]	Published	Unknown	Unknown	Unknown
GMU[25]	Published	Unknown	Unknown	Unknown

Table 22. Sustainability Benchmarking.

[21] Indicates that information is published in the university website.
[22] Indicates that the university is in the process of publishing information.
[23] Indicates that there is no information available in the university website.
[24] RAK Medical and Health Sciences University.
[25] Gulf Medical University.

6. TARGET Reduction Plan

MBRU follows the strategy of the Emirate of Dubai, the UAE, and the Paris Agreement, in recognition of the critical importance of addressing climate change and is actively working to establish comprehensive carbon reduction objectives that encompass both Scope 1 and Scope 2 emissions, illustrating a deep-seated commitment to not only acknowledging the immediate necessity for impactful environmental action, but also to taking tangible steps to instigate a meaningful change.

The array of targets planned by MBRU display a variation not only in their numeric emission reduction aspirations, but also in their respective timeframes and underpinning strategies.

Nonetheless, the unifying thread that binds all these initiatives is the steadfast intention to drive forward a transition into a low-carbon education at MBRU, thereby steadily eroding the current reliance on fossil fuels which poses a significant threat to environmental stability.

MBRU has set forth the following targets:

a. In pursuance of a Net Zero Emissions status by the year 2050, MBRU is steadfast in its aspiration to neutralize its carbon footprint. This ambitious end goal is to be achieved by ensuring that the university's emissions are either directly mitigated through carbon removal strategies or are effectively counterbalanced by equivalent offsetting practices.
b. MBRU has plans to switch to hybrid or EVs for its rented vehicles, by 2025.
c. Under the regulatory framework of Percentage Reduction Targets, MBRU is determined to halve its Scope 1 and Scope 2 emissions, cutting them down by 50%, by the year 2030, and thereafter, advancing towards a remarkable target of achieving a 100% reduction by the year 2050, in comparison to the baseline year 2022-2023.
d. With an unwavering commitment to Renewable Energy Transition, MBRU has devised a clear-cut incremental plan to switch entirely to renewable energy sources for their electricity needs (Scope 2) by 2035.
e. The Energy Efficiency Improvement objective underscores MBRU's endeavor to elevate the energy efficiency of its infrastructure, aspiring to curtail energy consumption by at least 20% over the forthcoming three years.

6.1 Science Base Target Initiative

To achieve its reduction strategy, Axosomatic proposes that MBRU follows an effective and structured reduction plan, based on the Science Based Target Initiative (SBTi), a universal approach followed by many organizations.

The reduction targets for Scope 1, and 2 are shown in the table and chart in the next page. The baseline year is 2022– 2023, and the Interim Target year is 2030.

It is noted that the average annual reduction till 2030 is 7.5%, and 10.0% and to 2035, for Scope 1, 2, with reference to the baseline year of 2022 – 2023.

SBTi Target Reduction

	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Scope 1 emissions (tCO2e)	26.27	24.69	23.12	21.54	19.97	18.39	16.81	15.24	13.66	12.08	10.51	8.93	7.36
Scope 2 emissions (tCO2e)	1,102	1,036	970	904	837	771	705	639	573	507	441	375	309
Scope 1+2 emissions (tCO2e)	1,128	1,060	993	925	857	790	722	654	587	519	451	384	316
Scope 3 emissions (tCO2e)	4,054	3,910	3,765	3,620	3,475	3,330	3,186	3,041	2,896	2,751	2,606	2,462	2,317
% Annual Reduction		6.0%	6.4%	6.8%	7.3%	7.9%	8.6%	9.4%	10.3%	11.5%	13.0%	15.0%	17.6%

Table 23. Proposed SBTi Target Reduction Plan.

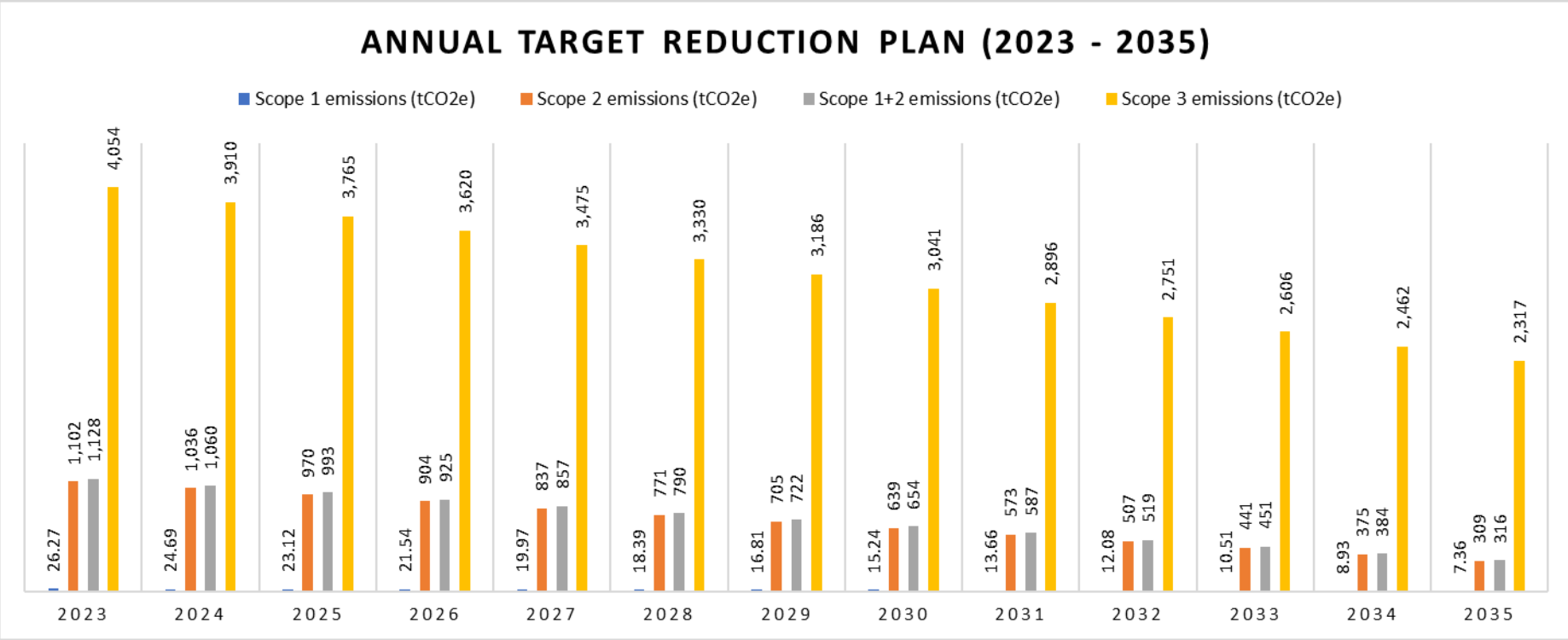

Figure 7. Proposed reduction target for MBRU.

6.2 Monetary Saving

The reduction in Scope 1 and Scope 2 emissions will result in reducing MBRU general and administrative cost, with respect to the consumptions of diesel and petrol, and electricity. The below table and chart present the monetary savings in AED MBRU will make if it reduces the emissions by 6% during 2024; then aims to increase the reduction by 10% annually for the years (2025, 2026, and 2027), and then 20% annually for the years (2028, 2029, and 2030), and thereafter increase the reduction by 30% annually for the years (2031, 2032, and 2033). After 2033, the saving will decrease because of the substantial decrease in consumption. The cumulative saving MBRU would make by the end of 2033 is AED 955,962. This is based on incremental emission reduction and could increase with an aggressive reduction strategy, as shown in the next page.

Monetary Savings in AED[26]											
	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Total Diesel and Petrol Consumption	10,320	9,700.64	9,060.40	8,402.61	7,731.58	6,990.65	6,186.73	5,332.98	4,376.25	3,355.64	2,338.27
Total kWh Consumption	2,754,392	2,589,128.31	2,418,245.84	2,242,681.20	2,063,580.68	1,865,823.61	1,651,256.88	1,423,386.60	1,168,034.60	895,629.36	624,090.85
% Annual Reduction		6.0%	6.6%	7.3%	8.0%	9.6%	11.5%	13.8%	17.9%	23.3%	30.3%
Diesel & Petrol		AED1,780.17	AED1,840.70	AED1,891.13	AED1,929.22	AED2,130.18	AED2,311.25	AED2,454.55	AED2,750.58	AED2,934.27	AED2,924.93
Electricity		AED72,380.99	AED74,841.95	AED76,892.62	AED78,441.23	AED86,612.30	AED93,974.49	AED99,801.08	AED111,837.34	AED119,306.20	AED118,926.60
Total Annual Saving		AED74,161.16	AED76,682.64	AED78,783.75	AED80,370.45	AED88,742.48	AED96,285.74	AED102,255.64	AED114,587.92	AED122,240.47	AED121,851.53

Table 24. Monetary saving in with incremental reductions of 10%, 20% and 30%.

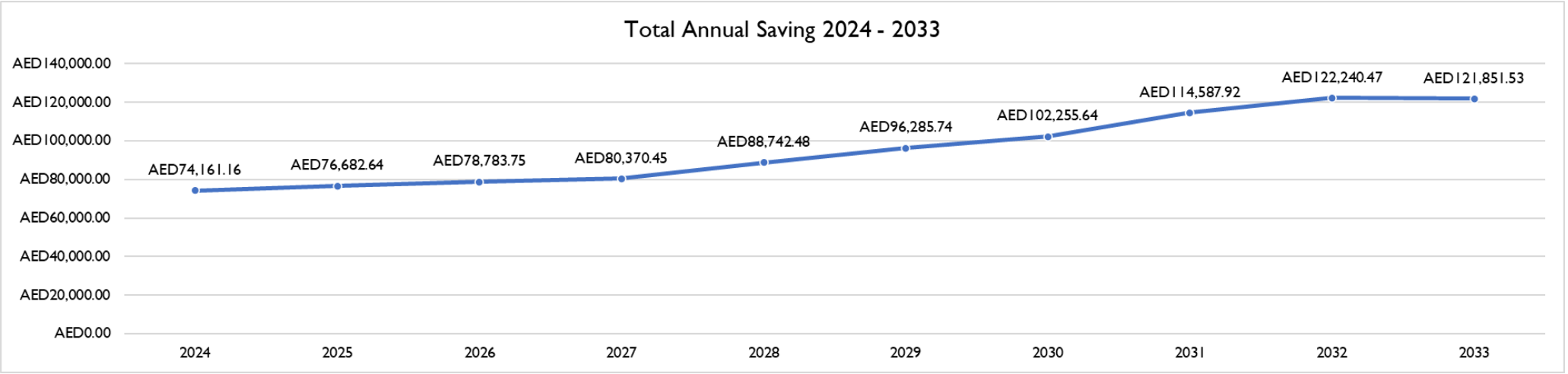

Figure 8. Total Monetary savings with incremental reductions of 10%, 20%, and 30% .

[26] The reduction in general and administrative cost is calculated based on the current average prices of diesel and petrol, and kwh.

If MBRU aims to reduce the emissions by 20% during 2025 – 2027, and 35% for 2028 – 2030, and 50% 2031 – 2033, the monetary saving would be as shown in the following table and chart:

Monetary Savings in AED[27]											
	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Total Diesel and Petrol Consumption	10,320	9,700.64	9,002.19	8,224.40	7,371.70	6,339.90	5,141.93	3,830.27	2,364.66	1,007.45	140.10
Total kWh Consumption	2,754,392	2,589,128.31	2,402,711.07	2,195,116.84	1,967,527.12	1,692,136.29	1,372,395.63	1,022,308.92	631,135.17	268,891.18	37,393.51
% Annual Reduction		6.0%	7.2%	8.6%	10.4%	14.0%	18.9%	25.5%	38.3%	57.4%	86.1%
Diesel & Petrol		2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Electricity		AED1,780.17	AED2,008.03	AED2,236.14	AED2,451.53	AED2,966.43	AED3,444.15	AED3,771.03	AED4,213.61	AED3,901.99	AED2,493.63
Total Annual Saving		AED72,380.99	AED81,645.76	AED90,920.72	AED99,678.20	AED120,613.82	AED140,037.85	AED153,328.61	AED171,323.63	AED158,653.18	AED101,389.78

Table 25. Monetary saving with incremental reductions of 20%, 35% and 50%

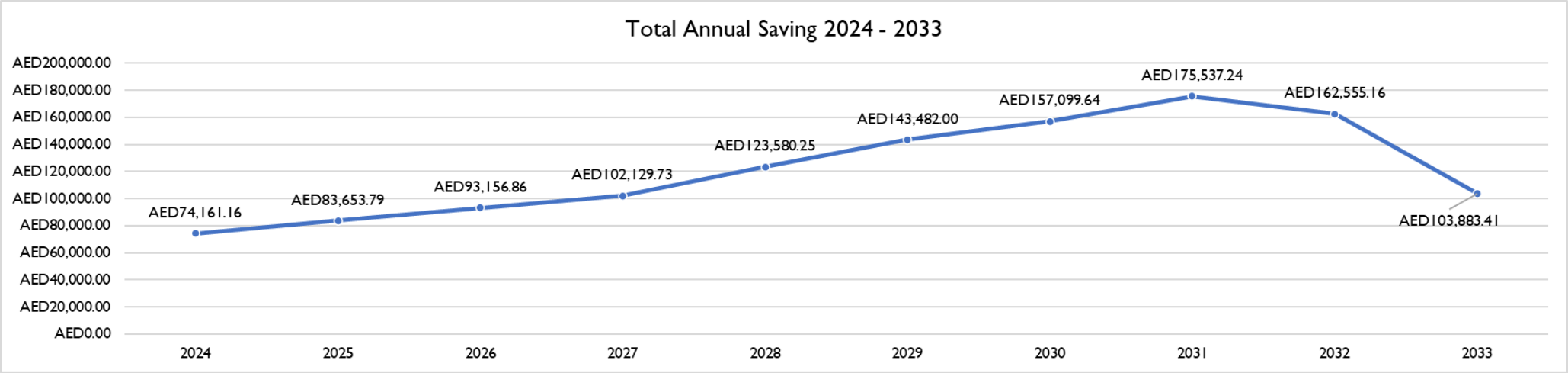

Figure 9. Monetary saving with incremental reductions of 20%, 35% and 50%

With the above-mentioned reductions, MBRU would make an accumulated saving of AED 1,219,239, by the end of 2033. Note that the cutoff year will be 2032 after which the saving will decrease because of the substantial decrease in emissions.

[27] The savings are calculated based on the current average prices of diesel and petrol, and kwh.

6.3 GHG Emissions Reduction Schemes

In its path to reduce the emissions, Axosomatic recommends that MBRU add the following reduction schemes adopted by most organizations, whenever applicable:

GHG Emissions Reduction Schemes		
Mobile and stationary combustion of biomass	Mass	tCO_2e
No Activity	n/a	n/a
Deforestation of two hectares or more	Mass	tCO_2e
No Activity	n/a	n/a
GHG stock liability	Mass	tCO_2e
No Activity	n/a	n/a
Renewable electricity generation & use	kWh generated	tCO_2e avoided
No Activity	n/a	n/a
Types of emission reductions purchased	Amount	tCO_2e
Certified green electricity (tCO2-e)	n/a	n/a
Purchased emission reductions (tCO2-e)	n/a	n/a
Total	n/a	n/a

Table 26. GHG Emissions Reduction Schemes.

6.4. The Next Step

This report described the Scope 1, Scope 2, and Scope 3 GHG Emissions attributed to MBRU activities during the year of 2022 – 2023, which is considered as the baseline year, as shown below:

2022 – 2023 (Baseline Year)		
Description	GHG Emission (tCO2e)	% of Total
Scope 1: Direct GHG Emission	26.27	0.51%
Scope 2: Indirect GHG Emission	1,101.84	21.26%
Scope 3: Indirect GHG Emissions	4,054.40	78.23%
Total GHG Emissions		5,182.51
Required Average Annual Reduction Until 2035		10%

Table 27. Summary of MBRU Emissions.

The reduction in emissions will result in a substantial reduction in the general and administrative costs, based on the annual percentage reductions, as demonstrated in section 6.2

MBRU has an aggressive plan to reduce the Scope 1, 2, and 3 GHG emissions attributed to its operation, with respect to the baseline year of 2022 – 2023, to be in line with the Paris Agreement and to enhance its ranking and reputation.

After thorough analysis of the total GHG emissions for the year 2022-203 calculated by our team, and based on best practices, Axosomatic developed an aggressive GHG Emissions Reduction strategy with goals, Objectives and Key Results (OKR), actions, and KPIs, to assist MBRU reduce its emissions. The plan is submitted to the Office of HSE in a separate file. The following table summarizes the reduction objectives and actions:

Objectives	Actions
1. Reduce energy consumption.	a. Conduct energy audits to identify where and how energy is used across the campus. b. Replace incandescent bulbs with LED or energy-efficient lighting systems. c. Install motion sensors and daylight sensors to reduce lighting in unoccupied spaces and areas with sufficient natural light. d. Use energy-efficient air conditioning (HVAC) systems. e. Conduct regular maintenance of HVAC systems to ensure they operate efficiently. f. Implement smart thermostats to optimize cooling schedules based on occupancy and weather conditions. g. Encourage students and employees to adopt energy-saving habits, such as turning off lights and electronics when not in use. h. Increase awareness campaigns and workshops to educate the campus community about energy conservation. i. Use smart meters and energy management systems to monitor and control energy use across the campus.

Objectives	Actions
2. Install Solar Panels	a. This option requires huge investment and careful planning. b. A 5KW panel cost approximately AED 35,000 and the return on investment could around 6 to 8 years.
3. Reduce stationary consumption.	a. Reduce the consumption of diesel or replace existing generators and fire pumps with eco-friendly solutions.
4. Reduce consumption of petrol and diesel.	a. Replace MBRU rented vehicles with hybrid and/or EVs. b. This would reduce the Scope 1 emissions from mobile sources by approximately 25%.
5. Reduce emissions associated to Upstream activities (Scope 3)	a. Partner with suppliers that are GHG compliant. b. Optimize transportation routes to reduce fuel consumption and emissions. c. Implement waste reduction and recycling programs to minimize waste generation. d. Promote virtual meetings and telecommuting to reduce the need for travel. e. Offset unavoidable travel emissions through carbon offset programs or investments in renewable energy projects. f. Promote carpooling and ridesharing among employees to reduce single-occupancy vehicle trips.

Table 28. Axosomatic Recommendations.

ANNEX I: INTRODCUTION TO GHG EMISSIONS[28]

The GHG emissions consist of gases that trap heat in the atmosphere and contribute to the warming of the Earth's surface, causing climate change. The most common gases monitored are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gases (HFCs, OFCs, and SF_6).

Carbon dioxide enters the atmosphere through burning fossil fuels, solid waste, trees, and other biological materials and certain chemical reactions, and is removed from the atmosphere when it is absorbed by plants as part of the biological carbon cycle.

Methane is emitted during the production and transport of coal, natural gas, and oil, as a result from livestock and other agricultural practices, land use, and by the decay of organic waste in municipal solid waste landfills.

Nitrous oxide is emitted during agricultural, land use, and industrial activities; combustion of fossil fuels and solid waste; as well as during treatment of wastewater.

Fluorinated gases are synthetic greenhouse gases that are emitted from a variety of household, commercial, and industrial applications, and processes. The sources of fluorinated gases are:

1. HFCs gas is used in refrigeration and air conditioning systems, foam insulation, aerosols, fire protection, and solvents.
2. PFCs gas is used in semiconductor manufacturing, aluminum production; production of certain consumer products such as non-stick cookware, stain-resistant textiles, and fire-fighting foam; refrigeration and air-conditioning system.
3. SF_6 is used in magnesium and aluminum production.

1 Scope 1: Direct GHG Emissions

Scope 1 emissions are direct GHG emissions that occur from sources controlled or owned by an organization, such as emissions associated with fuel combustion in boilers, furnaces, vehicles, chemical production, or during research processes.

2 Scope 2: Indirect GHG Emissions

Scope 2 accounts for GHG emissions from the generation of purchased electricity consumed by the company. Purchased electricity is defined as electricity that is purchased or otherwise brought into the organizational boundary. Scope 2 emissions physically occur at the facility where electricity is generated. In another words, the consumption of electricity and water by an organization constitutes Scope 2 indirect GHG emission.

3 Scope 3: Indirect GHG Emissions

Scope 3 is an optional reporting category that allows for the treatment of all other indirect emissions. It is the consequence of the activities of the company but occurs from sources not owned or controlled by the company. Some examples of Scope 3 activities are extraction and production of purchased materials; transportation of purchased fuels; and use of sold products and services, business travel, and employee commuting to and from the organization's premises.

Figures 11 and 12 in the next page provide, respectively, the common sources of Greenhouse Gases and CO2e.

[28] Overview of Greenhouse Gases | US EPA

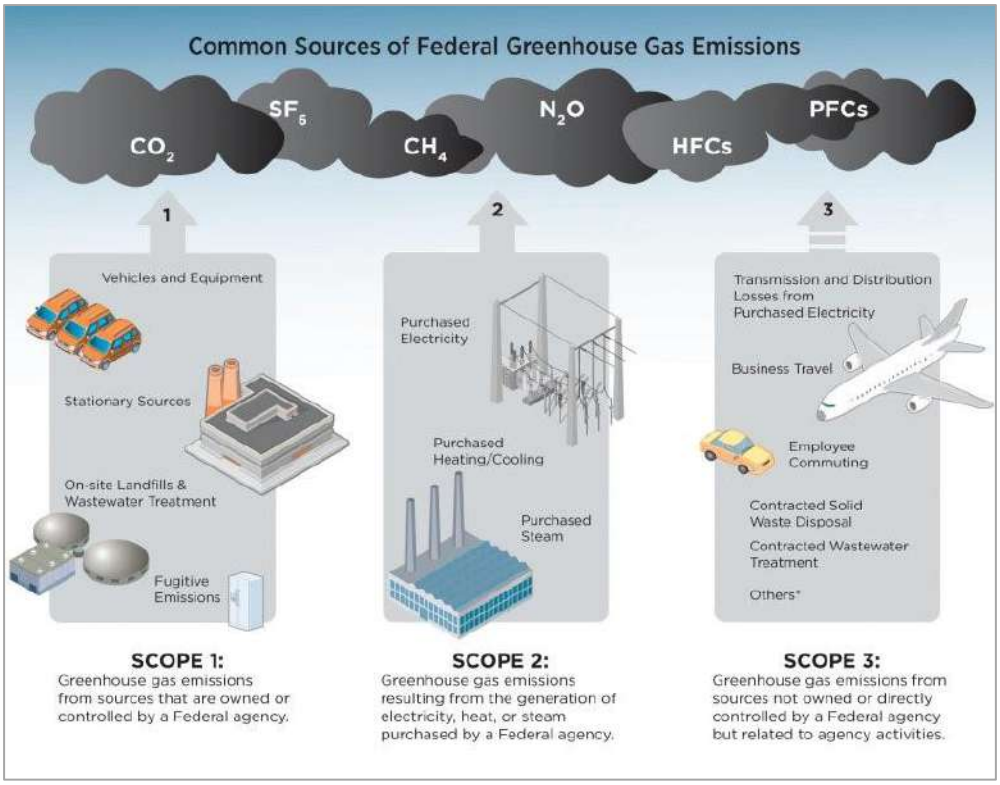

Figure 10. Illustration of sources of GHG gases. Source US EP.

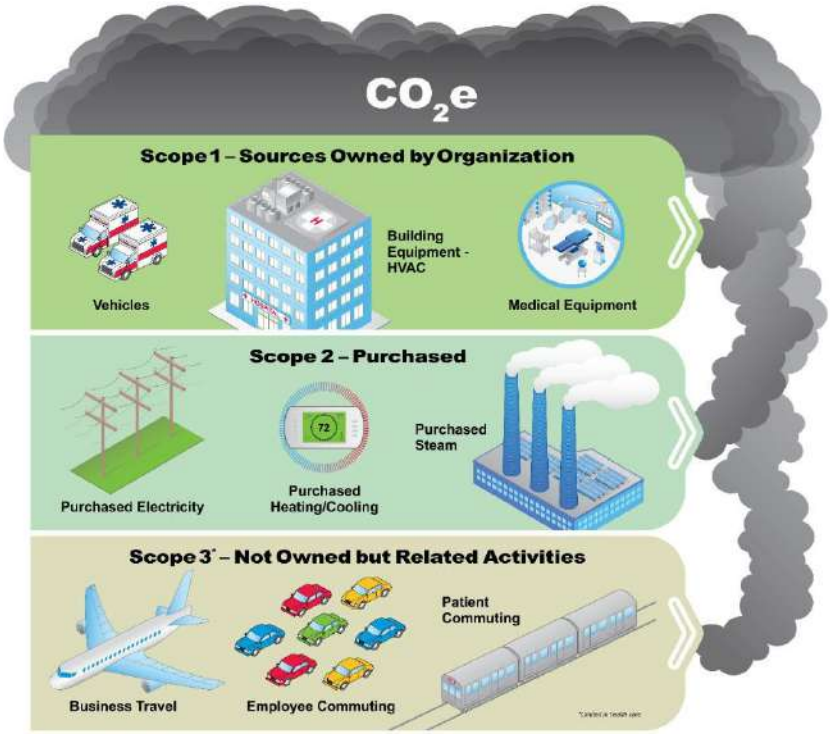

Figure 11. Illustration of CO_2e sources. Source US EPA.

4 Global Warming Potentials[29]

Global warming potential (GWP) is a measure used to compare the impact of different greenhouse gases on global warming over a specific period of time, typically 20, 100, or 500 years. It quantifies how much a particular greenhouse gas can contribute to the greenhouse effect and global warming compared to carbon dioxide (CO2), which is often used as a reference gas with a GWP of 1.

The concept of GWP is important for understanding and addressing climate change because it allows us to assess the relative contributions of various greenhouse gases to the warming of the Earth's atmosphere. Different greenhouse gases have varying abilities to trap heat, and their lifetimes in the atmosphere also influence their warming potential.

Carbon dioxide (CO2) is considered as the reference gas with a GWP of 1. Other greenhouse gases are compared to CO2 in terms of their warming potential. For example, methane (CH4) has a GWP of about 25 over 100 years, which means it is estimated to have 25 times the warming effect of CO2 over that period.

GWP values can be calculated over different time horizons, such as 20, 100, or 500 years. Shorter time horizons emphasize the short-term impact of gases that might have higher warming potential but dissipate more quickly, while longer time horizons consider the longer-term effects of gases with longer atmospheric lifetimes.

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The following table shows the GWP – 100 years for the most common gasses:

GHG	GWP (100 years)
Carbon dioxide (CO_2)	**1**
Methane (CH_4)	**27 - 30**
Nitrous oxide (N_2O)	**298**
Hydrofluorocarbons (HFCs)	See Annex II
Perfluorocarbons (PFCs)	See Annex II
Sulphur hexafluoride (SF_6)	**22,800**

Table 29. List of common gases and their GWP 100 years.

[29] https://www.epa.gov

Annex II: GLOBAL WARNING POTENTIAL

Lifetimes, radiative efficiencies and direct (except for CH4) GWPs relative to CO2. For ozone-depleting substances and their replacements, data are taken from IPCC/TEAP (2005) unless otherwise indicated.

Industrial Designation or Common Name	Chemical Formula	Lifetime (years)	Radiative Efficiency ($W\ m^{-2}\ ppb^{-1}$)	Global Warming Potential for Given Time			
Horizon (years)				SAR‡ (100-yr)	20-yr	100-yr	500-yr
Carbon dioxide	CO_2	See below[a]	[b]$1.4x10^{-5}$	1	1	1	1
Methane[c]	CH_4	12[c]	$3.7x10^{-4}$	21	72	25	7.6
Nitrous oxide	N_2O	114	$3.03x10^{-3}$	310	289	298	153
Substances controlled by the Montreal Protocol							
CFC-11	CCl_3F	45	0.25	3,800	6,730	4,750	1,620
CFC-12	CCl_2F_2	100	0.32	8,100	11,000	10,900	5,200
CFC-13	$CClF_3$	640	0.25		10,800	14,400	16,400
CFC-113	CCl_2FCClF_2	85	0.3	4,800	6,540	6,130	2,700
CFC-114	$CClF_2CClF_2$	300	0.31		8,040	10,000	8,730
CFC-115	$CClF_2CF_3$	1,700	0.18		5,310	7,370	9,990
Halon-1301	$CBrF_3$	65	0.32	5,400	8,480	7,140	2,760
Halon-1211	$CBrClF_2$	16	0.3		4,750	1,890	575
Halon-2402	$CBrF_2CBrF_2$	20	0.33		3,680	1,640	503
Carbon tetrachloride	CCl_4	26	0.13	1,400	2,700	1,400	435
Methyl bromide	CH_3Br	0.7	0.01		17	5	1
Methyl chloroform	CH_3CCl_3	5	0.06		506	146	45
HCFC-22	$CHClF_2$	12	0.2	1,500	5,160	1,810	549
HCFC-123	$CHCl_2CF_3$	1.3	0.14	90	273	77	24
HCFC-124	$CHClFCF_3$	5.8	0.22	470	2,070	609	185
HCFC-141b	CH_3CCl_2F	9.3	0.14		2,250	725	220
HCFC-142b	CH_3CClF_2	17.9	0.2	1,800	5,490	2,310	705
HCFC-225ca	$CHCl_2CF_2CF_3$	1.9	0.2		429	122	37
HCFC-225cb	$CHClFCF_2CClF_2$	5.8	0.32		2,030	595	181
Hydrofluorocarbons							
HFC-23	CHF_3	270	0.19	11,700	12,000	14,800	12,200
HFC-32	CH_2F_2	4.9	0.11	650	2,330	675	205
HFC-125	CHF_2CF_3	29	0.23	2,800	6,350	3,500	1,100
HFC-134a	CH_2FCF_3	14	0.16	1,300	3,830	1,430	435
HFC-143a	CH_3CF_3	52	0.13	3,800	5,890	4,470	1,590
HFC-152a	CH_3CHF_2	1.4	0.09	140	437	124	38
HFC-227ea	CF_3CHFCF_3	34.2	0.26	2,900	5,310	3,220	1,040
HFC-236fa	$CF_3CH_2CF_3$	240	0.28	6,300	8,100	9,810	7,660
HFC-245fa	$CHF_2CH_2CF_3$	7.6	0.28		3,380	1030	314
HFC-365mfc	$CH_3CF_2CH_2CF_3$	8.6	0.21		2,520	794	241
HFC-43-10mee	$CF_3CHFCHFCF_2CF_3$	15.9	0.4	1,300	4,140	1,640	500
Perfluorinated compounds							
Sulphur hexafluoride	SF_6	3,200	0.52	23,900	16,300	22,800	32,600
Nitrogen trifluoride	NF_3	740	0.21		12,300	17,200	20,700
PFC-14	CF_4	50,000	0.10	6,500	5,210	7,390	11,200
PFC-116	C_2F_6	10,000	0.26	9,200	8,630	12,200	18,200

Table 30. GWP 100 years for common gases.