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SUSTAINABLE MANAGEMENT FOR CARBON FOOTPRINT REDUCTION IN HEALTH CARE AS SHEFAA AL-ORMAN HOSPITAL, LUXOR, EGYPT

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ABSTRACT:

Climate change confronts the health care sector with a dual challenge. Carbon footprint is defined as the total greenhouse gases resulting from industrial, service, or personal emissions, and its measurement is to reduce the negative effects of those emissions. Hospitals account for 3% of US greenhouse gas (GHG) emissions with 54% derived from supply chain goods and services. Reducing greenhouse gas (GHG) emissions, which are responsible for the effects related to climate change, is one of the biggest challenges facing our society. Reducing the carbon footprint of healthcare requires direct action to reduce waste and energy use, but also requires radical reform of care pathways so that the only patients who come to or stay in hospital are people whose healthcare cannot safely be delivered closer to home. Our goal in this study is to assess the carbon footprint of Shefaa Al-Orman Hospital (SOH). This study is based on evaluating the emissions from the hospital's main energy sources (electricity, diesel, LPG, waste-water system, and fugitive emissions).

Key words : *Carbon footprint, Shefaa Al-Orman, Egypt*

1. INTRODUCTION:

Climate change is happening now, it is increasing presently, it is affecting us even more, and it will have a massive impact on us unless immediate and systemic action is taken to reduce and respond to its devastating consequences. One of such actions is the management of carbon emission from the construction industry, as it is one of the major sectors that contributes a substantial amount of greenhouse gases into our environment [1]. Climate change confronts the health care sector with a dual challenge.

Accumulating climate impacts are putting an increased burden on the service provision of already stressed health care systems in many regions of the world. At the same time, the Paris agreement requires rapid emission reductions in all sectors of the global economy to stay well below the 2 °C target [2]. Healthcare is a large contributor to greenhouse gas (GHG) emissions around the world, given current power generation mix.[3]. Hospitals account for 3% of US greenhouse gas (GHG) emissions with 54% derived from supply chain goods and services.

Most hospitals are striving to reduce these emissions and targeting supply chain points and replacing disposable products with reusables are among the recommendations to achieve this [4]. Reducing greenhouse gas (GHG) emissions, which are responsible for the effects related to climate change, is one of the biggest challenges facing our society [5-8]. Building sector is a major contributor to the emissions of pollutant gases, which are responsible for health-damaging effects of climate change. The higher emissions for the metal-structured building, with 621.234 t CO_2/t material compared to 446.707 t CO_2/t material for the concrete building [9]. Reducing the carbon footprint of healthcare requires direct action to reduce waste and energy use, but also requires radical reform of care pathways so that the only patients who come to or stay in hospital are people whose healthcare cannot safely be delivered closer to home [10]. To reduce these emissions, measures related to the replacement of the previously selected materials, by other materials with lower emission rates and identical functionality were presented, such as the replacement of metal building roof polyurethane, or the composition of cement for the concrete building. Both actions represented a reduction of 84.61% CO_2 emissions for metal envelope building and 31.765% for the concrete structure [11-14]. According to The Kyoto Protocol was an international treaty which extended the 1992 that commits state to reduce greenhouse gas emissions there is a main six greenhouse gases (carbon dioxide (CO_2), Methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6). Comparing these data obtained with another health care hospital was occurred [15]. Mean CO_2e emissions were 17.5 kg/scan for MRI; 9.2 kg/scan for CT; 0.8 kg/scan for CXR; 0.5 kg/scan for MCXR; and 0.5 kg/scan for US. Emissions from scanners from standby energy were substantial. When expressed as emissions per additional scan (results of consequential analysis) impacts were lower: 1.1 kg/scan for MRI; 1.1 kg/scan for CT; 0.6 kg/scan for CXR; 0.1 kg/scan for MCXR; and 0.1 kg/scan for US, due to emissions from standby power being excluded. Our main goal in this study is to determine the value of the carbon footprint of our activities according to the first & second scopes and to try to determine the emissions arising from the third scope. the measures that help us to reduce those emissions were taken.

2. METHODOLOGY:

Shefaa Al-Orman Hospital (SOH) emission calculations are premised on the methodology provided by United Nation Climate Change, IGES (Institute for Global Environmental Strategies). The greenhouse gases (GHGs) which estimated at this study were:

- **Carbon Dioxide (CO_2), The main unit of measure is metric tons (MT) of carbon dioxide equivalents (CO_2e), Carbon dioxide equivalents of any gases are based on the global warming potential (GWP) of each gas – which compares the amount of heat trapped by a similar mass of carbon dioxide, Carbon dioxide equivalents (CO_2e) are used here to express the relative global warming impact of each of greenhouse gases through a single unit of measure.**

- The group of greenhouse gases (GHG) established in the Kyoto Protocol also includes three types of fluorinated gases: hydrofluorocarbons(HFC),perfluorocarbons (PFC) and sulfur hexafluoride (SF6). Fluorinated gases are used in different types of products and applications, specifically, and depending on the type of gas. HFC are the most common group of fluorinated gases. They are used in different sectors and applications, such as refrigerants, in stationary refrigeration systems, air conditioning and heat pumps, blowing agents for foams, fire extinguishing products, aerosol propellants and solvents.

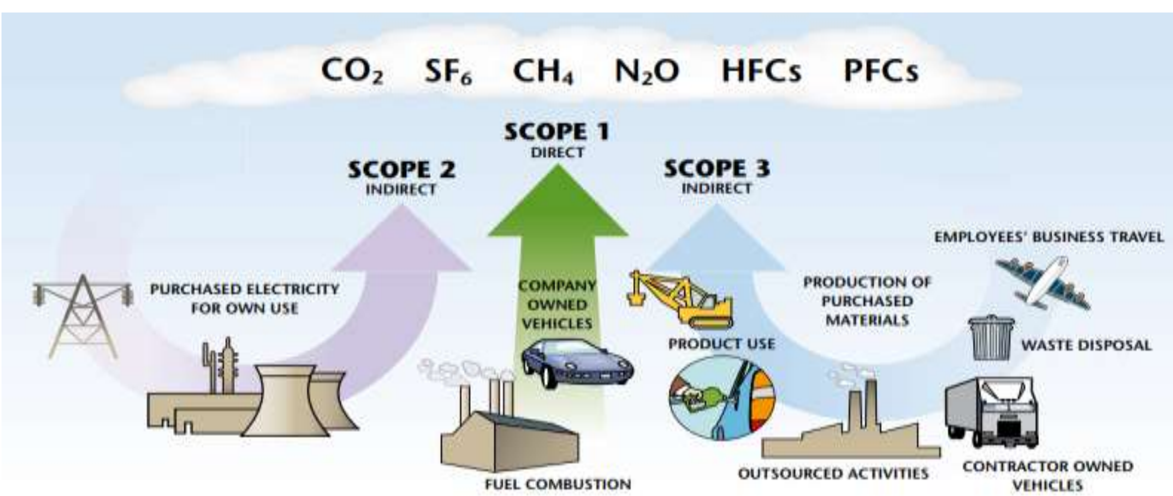
Firstly, we are collecting the required data which involved in the calculation process, containing (electricity consumption, LPG consumption, Diesel, water consumption and waste generation rate) as the Average for the last nine months. Secondly, applying the UNCC emission factors, to calculate the GHG emission in the different units. Finally, converting the previous different units of calculation to CO2e, and calculate a total carbon footprint of SOH. The emission factor which used in this study shown in table1.

Table1: indicates the emission factor which used in this study.

Consumption	Emission Factor	Unit	Scope
Diesel	2.705	Kg of CO2e	1
LPG Liquid Petroleum Gas	1.557	Kg of CO2e	1
Fuel Diesel Car	0.165	Kg of CO2e	1
SOH owned Vehicles	0.165	Kg of CO2e	١
HFC R-134a	1430	Kg of CO2e	1
Electricity	0.4059	Kg of CO2e	2

3. RESULTS AND DISCUSSION

3-1. Scope of emissions:



Source: Bhatia and Ranganathan, 2004

Scope 1: **The first category is for emissions generated by the Hospital. Because these emissions are directly controlled by the organization, they are often the first to be measured and targeted for reduction. At SOH scope 1 sources include on-site fossil fuel combustion at our generator, boilers, emissions from our vehicles, Recharging equipment that operates with a single type of fluorinated gas HFCs and Anesthetic gases.**

Scope 2: **The second category is for indirect emissions from the generation of electricity by the organization. Although these emissions are not directly produced by the organization, the purchase records make them easy to measure, this often involves agreements between the organization and the utility surrounding whether the energy will be produced from renewable or fossil fuel sources, At SOH scope 2 sources include emissions that result from the electricity That we purchase. Scope 1 &2 Carbon Emissions at SOH showed in fig.1**

Scope 3: **The third category is essentially the catchall for all other indirect emissions that result from an organization's activities. Scope 3 emissions are often more challenging to measure and reduce because they are not under the organization's direct control. At SOH scope 3 sources include emissions that result from purchased goods and services, commuting, and waste disposal.**

Table2: Scope 1 emissions at SOH Hospital (Direct Emissions)

1. Diesel Fuel Carbon footprint Calculations				
Months	**Generator Consumption**	**Boiler Consumption**	**Total Consumption**	**CO_2 Emissions**
January – September	10558.5	59097	69655.5	188.453 tons of CO_2e
2. LPG Carbon Footprint Calculations				
Months	**No of cylinders**	**Cylinder Capacity**	**Total Capacity of Cylinders**	**CO_2 Emissions**
January – September	643	49 L	31507 L	48.98 tons of CO_2e
3. SOH owned Vehicles Carbon Footprint Calculations				
Months	**No of cylinders**	**Cylinder Capacity**	**Total Capacity of Cylinders**	**CO_2 Emissions**
January – September	643	49 L	31507 L	48.98 tons of CO_2e
4. SOH owned Vehicles Carbon Footprint Calculations				
Months	**Fuel**	**Vehicles consumption rate**	**Distance Km**	**CO_2 Emissions**
January – September	Diesel	15480 L	121050	19.97 tons of CO_2e
5. Fugitive emissions HFC (Leakage from air-condition) Calculations				
Months	**Substance Name**	**Chemical Formula**	**Amount Kg**	**GWP Factor**
January – September	HFC-134a	CH2FCF3	450 gm.	1430
6. Emissions from anesthetics gases (Isoflurane & Sevoflurane) Calculations				
Months	**Substance Name**	**Chemical Formula**	**Amount Kg**	**GWP Factor**
January – September	**Isoflurane**	CF 3 CHClOCHF2	1.9 L	510
	Sevoflurane	(CF 3) 2 CHOCH 2 F	4.625 L	130
Total First Scope CO_2 Emissions		260.3295 tons of CO_2e		

Table 3: The following table shows the result of electricity consumption for nine months of 2021 from (January to September) compared to the same period in 2022.

Months	Consumption by Kilowatts during 2021	Consumption by Kilowatts during 2022
January	337954	310574
February	374917	280760
March	457524	358688
April	559696	428522
May	676817	545900.6
June	710575	685188
July	757478	442734
August	814895	569557
September	814895	790221
Total	5504751	4437531

Table4: Scope 2 emissions at SOH Hospital (Indirect Emissions)

1. Electricity Carbon footprint Calculations		
Month	**Electricity Consumption**	**CO_2 Emissions**
January – September	**4437531 kW/h**	**1801.1 tons of CO_2e**
Total Second Scope CO_2 Emissions		**1801.1 tons of CO_2e**
Sum Scope 1 & 2 CO_2 Emissions		**2061.33 tons of CO_2e**
Type	**Carbon Emissions**	**Percent**
Electricity	**1801**	**87.37%**
LPG	**48.98**	**2.38%**
Fuel Car	**19.97**	**0.97%**
Diesel	**188.45**	**9.14%**
HFC	**0.6435**	**0.03%**
Anesthetic gas	**2.283**	**0.11%**
Total	**2061.3265**	

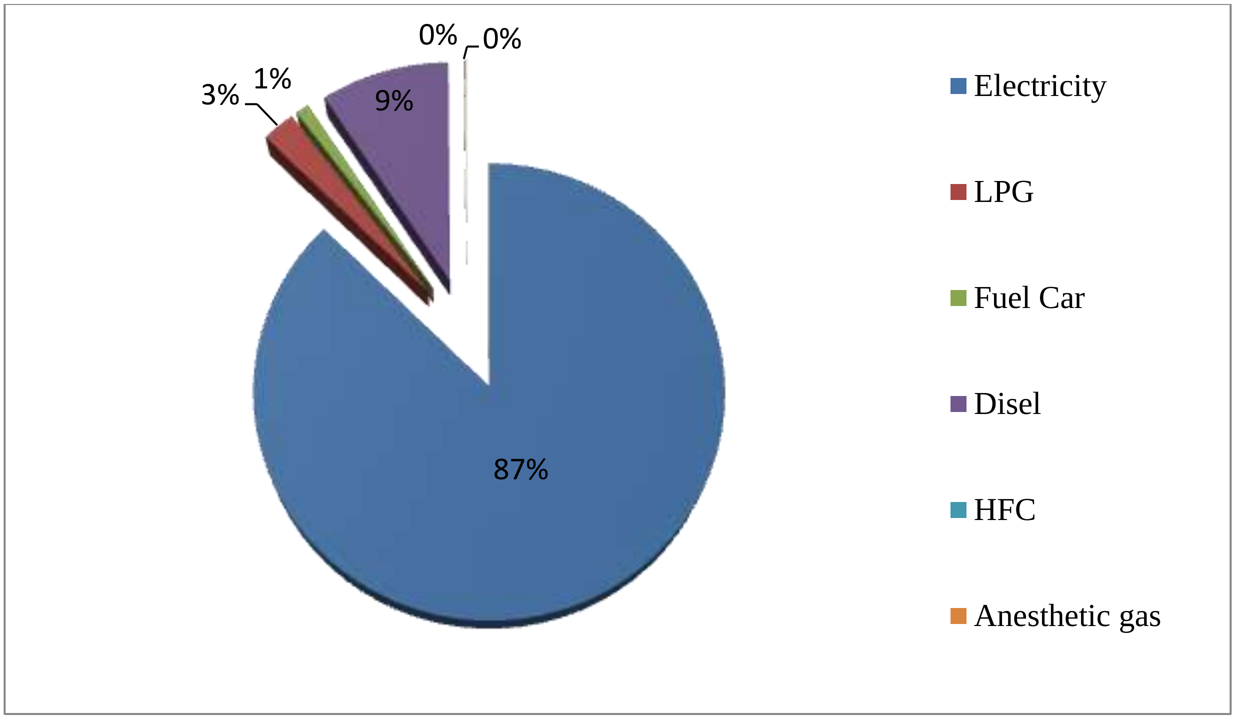


Figure1. Scope 1 &2 Carbon Emissions at SOH

3.1.1. Installation of Solar Power Stations in Shefaa Al-Orman Hospitals

- **The use of "solar energy" saves electricity consumption, as it is a safe source of sustainable and renewable energy and protects the environment from greenhouse gas emissions.**
- **The solar energy cell project has been implemented, which in its first phase saves 900 kilowatts, i.e., more than 25% of consumption.**
- **Solar energy (as showed in fig. 2) saves about 502 tons of gas emissions annually.**
- **Implementation of the efficiency program by rationalizing consumption by more than 20%.**
- **Implementation of the facility mechanism to control all external lighting units according to the state of natural lighting and the dates of sunrise and sunset.**

Figure2. Solar Power Stations in Shefaa Al-Orman Hospitals

3.1.2. Cultivation of Cactus on Shefaa Al Orman Rooftops

- **Planting cacti on rooftops (shown in fig. 3) to reduce the thermal impacts of climate change and maintain the purity of the environment.**
- **Drought-resistant plants contribute significantly to preserving the environment and reducing thermal impacts.**

Figure3. Cultivation of Cactus on Shefaa Al Orman Rooftops

3-2. Total value of the reduction in carbon emissions after the measures that were followed by the Maintenance and Projects Department during 2022

Control procedures have been applied by the Maintenance and Projects Department by automatically adjust the central air conditioning system at a temperature of 25 degree as a maximum, to reduce the volume of electricity consumption.This resulted in a decrease in the value of carbon emissions (CO_2) during the first

three quarters of 2022 (as 1801.1 tons) , compared to the same period during 2021 (as 2234.38 tons), by 433.28 tons of CO_2e.

By calculating the value of the reduction in the amount of carbon emissions resulting from reducing electricity consumption, it will be as table 4, GEF Factors KgCO2 0.4059 And this shown in fig.4

Table5: value of the reduction in the amount of carbon emissions resulting from reducing electricity consumption

Year (From January to September) Three quarters	CO2 Emissions by ton
2021	2234.38
2022	1801.1
The amount of carbon emissions reduction	433.28

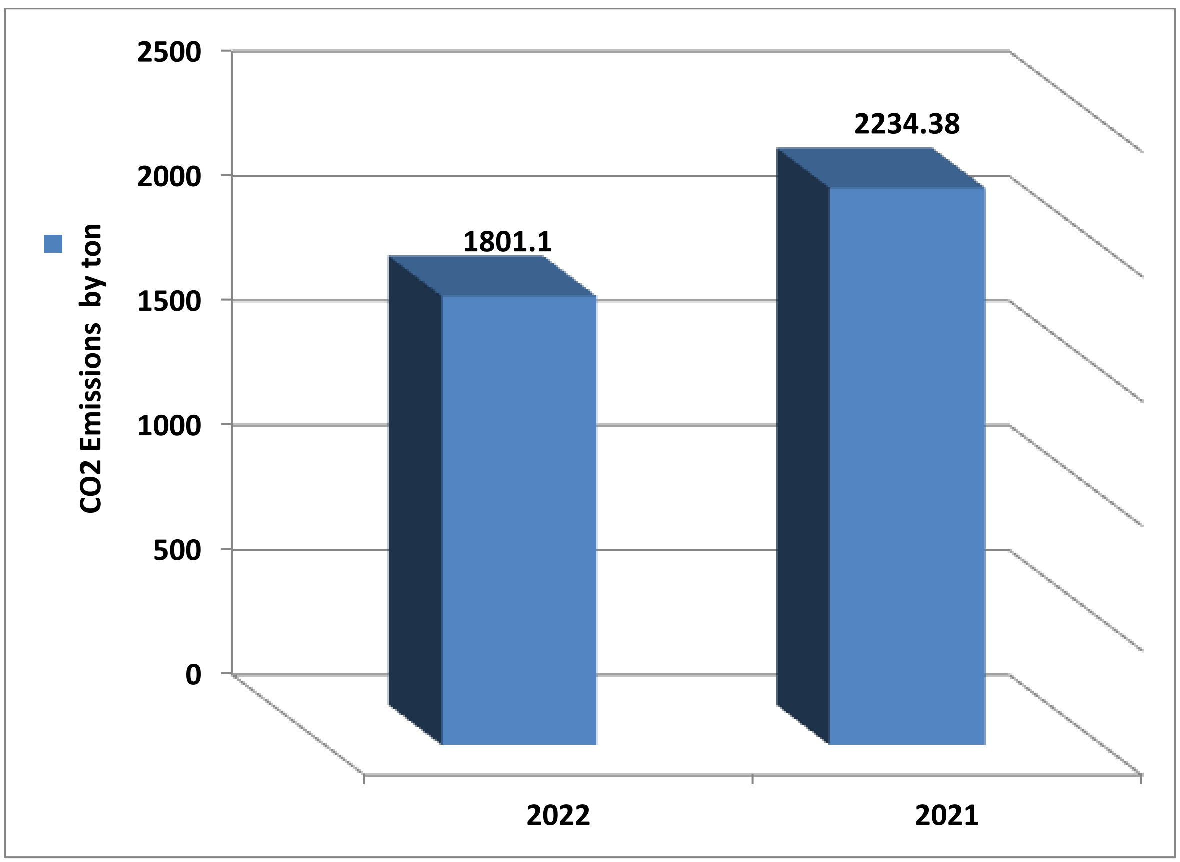


Figure 4: A comparison of the total carbon emissions during the period (January to September) of 2021 compared to the same period during 2022.

3-3. Waste Sterilization and Chopping Machine - Shredding Machine

- **Mince and sterilize healthcare waste with a "waste chopper" and recycle it again safely and then supply it to factories.**
- **Heavy metal deposition non-toxicity test and TCLP test to ensure the sterility of the shredding product.**
- **Shredding and sterilization of Health Care Waste with a "Waste Shredder" in Shefaa Al-Orman Hospitals, fig. 5**

Figure 5: Waste Shredding and Sterilization Machine

3-4. Comparing three quarters of 2022 between the quantities of hazardous medical waste

Total value of the reduction in carbon emissions after the installation of shredding & sterilization unit of medical waste:

- **This will be done by comparing the value of carbon emissions generated during three quarters of the current year 2022 knowing that the hospital operated a shredding and sterilization Unit for hazardous medical waste in September 2022**
- **We notice a decrease in the value of carbon emissions during the third quarter of the year, this is because the reduction of the volume of waste incinerated by nearly 11 tons**
- **The highest carbon footprint was associated with the disposal of waste via high temperature incineration (1074 kg CO2e/ t) according to NHS research.**
- **The following table shows the amount of medical waste which incinerated for nine months of 2022 from (January to September), Carbon footprint of three quarter of 2022 showed in table 5.**

Table 6: the amount of medical waste which incinerated for nine months of 2022 from (January to September) and Carbon footprint of three quarter of 2022 showed in table 5.

No.	Months	Quantity by kg	Period	Quantity by kg for each quarter	Carbon Footprint Kg CO_2e	Carbon Footprint ton CO_2e
1	January	17536	First Quarter (January to March)	51454	55261.596	55.261
2	February	16285				
3	March	17633				
4	April	17439	Second Quarter (April to June)	48446	52031.004	52.031
5	May	15248				
6	June	15759				
7	July	13654	Third quarter (July to September)	35687	38327.838	38.327
8	August	16808				
9	September	5225				

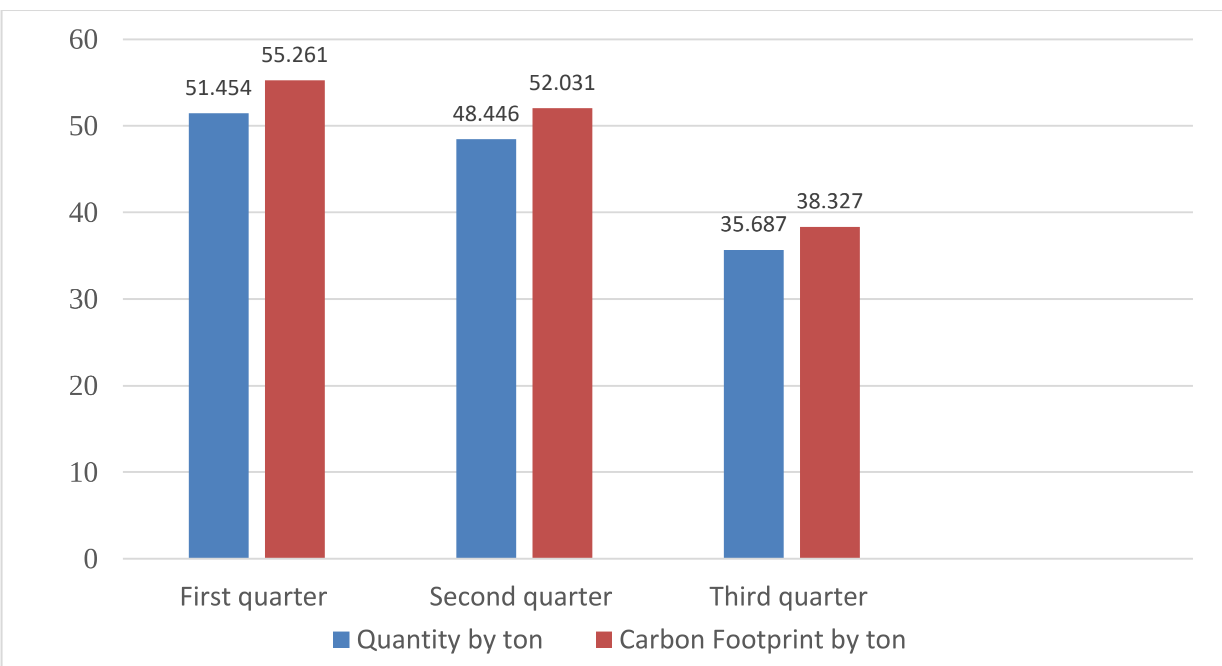


Figure6: Comparing three quarters of 2022 between the quantities of hazardous medical waste which incinerated

It is expected that the volume of waste that will be incinerated during the next and last quarter of this year will decrease by 48 tons due to the full operation of the shredding and sterilization unit during that period (Fig.6).

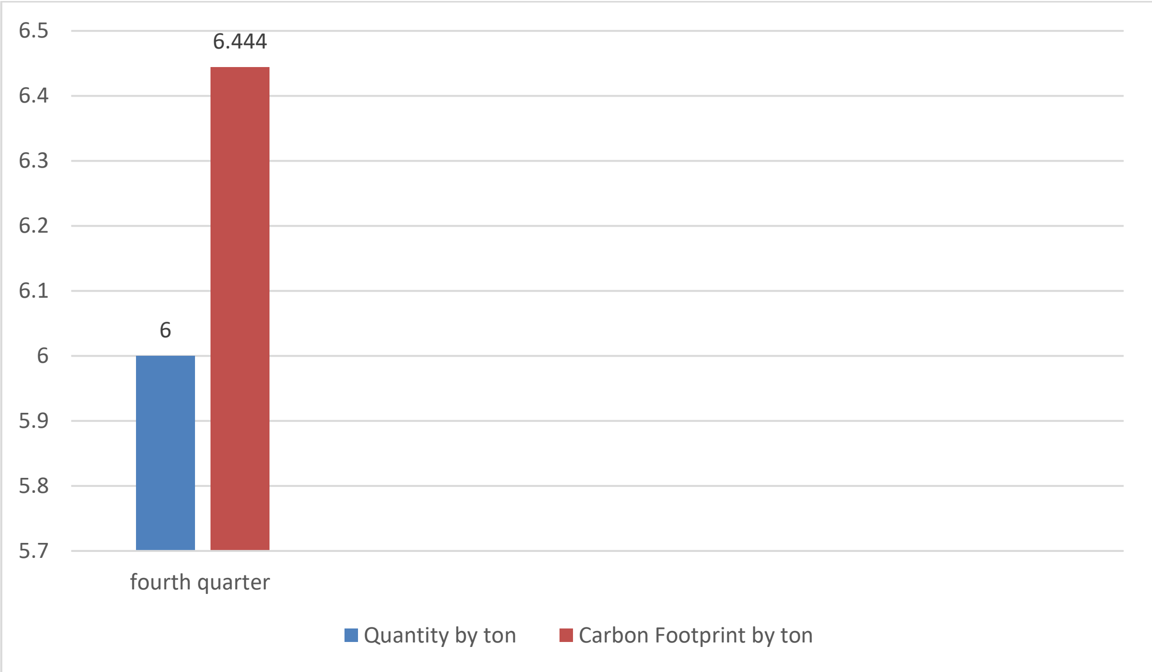


Figure7: The expected amount of carbon emissions during the fourth quarter 2022.

The expected amount of carbon emissions during the fourth quarter 2022of the current year 2022 (fig.7) based on the expected reduction of the amount of waste that will be incinerated during the next three months after the full operation of the shredding and sterilizer.

4. Conclusion

Shefaa Al-Orman hospital emissions was reduced to 87% for scope 1 &2 during study period at 2022 attributable to saving Electricity. While, applying control measures to the HVAC system, it was noticed that the value of electricity consumption was clearly reduced, which resulted decrease in the value of the carbon footprint by 20% about 433 tons of CO2e. Also, it was clearly reduced in the value of carbon footprint which associated with the disposal of waste via high temperature incineration when replaced it by shredding and sterilization technique of medical waste resulted decrease in the value of the carbon footprint by 30 % about 17 tons of CO2e during the third quarter of 2022. It is also expected to reduce carbon footprint by 48 tons During the fourth quarter of 2022.

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الإدارة المستدامة للحد من البصمة الكربونية في مؤسسات الرعاية الصحية مثل مستشفى شفاء الأورمان ، الأقصر ، مصر

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الملخص العربى:

يواجه قطاع الرعاية الصحية تحديا مزدوجا في التغيرات المناخية. تعرف البصمة الكربونية بأنها إجمالي الغازات الدفيئة الناتجة عن الانبعاثات الصناعية أو الخدمية أو الشخصية، والأمثل هو تقليل الآثار السلبية لتلك الانبعاثات. تمثل المستشفيات ٣٪ من انبعاثات غازات الاحتباس الحراري (GHG) مع ٥٤٪ مشتقة من سلع وخدمات سلسلة التوريدات داخل المستشفيات. يعد الحد من انبعاثات غازات الاحتباس الحراري (GHG)، المسؤولة عن الآثار المتعلقة بتغير المناخ، أحد أكبر التحديات التي تواجه مجتمعنا. يتطلب الحد من البصمة الكربونية لمؤسسات الرعاية الصحية اتخاذ إجراءات مباشرة للحد من النفايات واستخدام الطاقة، ولكنه يتطلب أيضا إصلاحا جذريا لمسارات الرعاية الصحية للمرضى الموجودون بالمستشفيات. هدفنا من هذه الدراسة هو تقييم البصمة الكربونية لمستشفى شفاء الأورمان (SOH). تعتمد هذه الدراسة على تقييم الانبعاثات من مصادر الطاقة الرئيسية للمستشفى (الكهرباء والديزل وغاز البترول المسال ونظام مياه الصرف الصحي والانبعاثات الصادرة).