CARBON FOOTPRINT ANALYSIS IN WATER AND WASTEWATER TREATMENT PLANTS.

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Abstract : This study has been undertaken to investigate the emission of Greenhouse Gases (GHG) mainly constituting Carbon dioxide (CO_2), Methane (CH_4) and Nitrous oxide (N_2O) from water & Wastewater treatment plants Particularly Sewage treatment plants which are considered as sources of GHGs (greenhouse gases) production mainly methane, carbon dioxide, and nitrous oxide which are produced during the biological sewage treatment process, and offsite electricity production which is a major source of carbon dioxide generation using the Steps and guidelines suggested in IPCC 2006[1] as well as RTI USEPA[2]. To analyze the carbon footprint of the treatment plants. The Study include energy utility consumption, Wastewater parameters before and after its treatment and sludge. The study is one in 3 different treatment plants in Ahmedabad. For the monthly time series data has been arranged from Jan 2020 to Dec 2020. The analytical framework contains Scope 1 and Scope 2 emissions As per WRI GHG Protocols**.**

Keywords: wastewater treatment, (SBR)sequential batch reactor, (GHG) greenhouse gas, (GWP) Global warming Potential, USEPA (US Environment Protection Agency), (IPCC) Intergovernmental Panel on Climate Change Activated Sludge Process, (MCF) Methane Correction Factor, (CO_2) Carbon Di Oxide, (CH_4) methane, (N_2O) nitrous oxide, sustainability, WW(wastewater),WTP (Water Treatment Plant), WWTP(Wastewater Treatment Plant), OD (Oxygen Demand), Ml (Million Liters), MLD (Million liters per day).

I. INTRODUCTION

Greenhouse gas (GHG) accounting has assumed increasing attention worldwide with increasing awareness of climate change and consequential environmental impacts of human activity. As the importance and awareness of climate-sensitive and 'green' practices continues to grow worldwide, making a business or operation as 'carbon-neutral' and green as possible is becoming a high priority from environmental management, economic and public relations & marketing perspectives. A carbon footprint analysis, also known as a greenhouse gas (GHG) emissions assessment, evaluate the greenhouse gas emissions caused by the manufacture of a product or any given activity that contributes to global warming. The Intergovernmental Panel on Climate Change (IPCC) has identified that global warming and climate change as one of the most important issues in the domain of environment caused by the excessive emission of Greenhouse Gases (GHG) mainly constituting Carbon dioxide (CO_2), Methane (CH_4) and Nitrous oxide (N_2O). Water treatment plants Particularly Sewage treatment plants are considered as sources of GHGs (greenhouse gases) production mainly methane, carbon dioxide, and nitrous oxide which are produced during the biological sewage treatment process, and offsite electricity production which is a major source of carbon dioxide generation. Reducing the greenhouse gases from the sewage treatment plants is a major concern. The municipal water treatment plants receive effluents or raw water for treatment and finally discharges the treated effluent. The emissions of GHG during the treatment of discharge water as well as during the treatment process of sludge and also for energy generation are known to be on-site GHG emissions. Off-site GHG emissions include emissions generated due to transportation and disposal of sludge, off-site energy, and chemical production. In this study, it has been attempted to evaluate the emissions of greenhouse gases from some of the Water and Wastewater treatment plants of Ahmedabad.

I.1. DEFINITION OF CARBON FOOTPRINT

Carbon footprint is defined as the total set of greenhouse gas emissions caused by an activity or product expressed as carbon dioxide equivalent (CO_2e). It is a measure of the total amount of carbon dioxide (CO_2), methane (CH_4) and Nitrous Oxide (N_2O) emissions of a defined system or activity. Global warming potential is calculated as Carbon dioxide equivalent using the relevant 100-year global warming potential (GWP100).

The Global Warming Potential (GWP) of a GHG is the ratio of heat trapped by one unit mass of the gas compared to one unit mass of CO_2 over a specified time period (typically 100 years).

$$CO2e = \sum_{i=1}^{n} GHGi * GWPi \qquad (1.0)$$

Where,

GHG = greenhouse gas emissions (Ton/yr.)
GWP = global warming potentials
i = Source industrial Sector[1]

Table 1: *Global Warming Potential (GWP) for three GHGs*

GHGs	Chemical Formula	Global Warming Potential (GWP) for 100 years	
		IPCC 2006	USEPA
Carbon Di Oxide	CO_2	1	1
Methane	CH_4	23	21
Nitrous Oxide	N_2O	296	310

I.2. CARBON CREDIT SCHEME IN WASTEWATER TREATMENT

Carbon credit is a generic scheme where governments make tradeable certificates or permits which will allow the buyer country to emit 1 tonne of CO_2 or equivalent amounts of Greenhouse gas in the atmosphere. Wastewater treatment can be a source of GHGs whether treated aerobically or anaerobically. It emits CO_2 when treated aerobically by the oxidation of organic matter in the activated sludge process and some through the primary clarifiers and CH_4 when treated anaerobically. It can also be a source of N_2O emissions in aerobic and anoxic conditions when treated effluent is discharged into the environment [3]. In recent years The GHG emissions from wastewater treatment operations and processes have become a concerning factor for authorities and hence are paying attention increasingly towards measurements and also assessments while determining economic opportunities from a treatment system. In a WWTP a variety of processes take place: energy is consumed, chemical reagents are used, sludge is generated, and atmospheric pollutants are emitted either directly or indirectly during the treatment processes. These plants produce the three important GHGs named carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). The gaseous by-products such as CO_2, CH_4, and N_2O result in direct emissions, and the indirect emissions are caused due to the use of energy and ancillary activities. Although not all wastewater treatment technologies are equally sustainable from an environmental point of view therefore necessity to choose appropriate technology rises. So here The greenhouse effect of major greenhouse gases, carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) all produced in certain wastewater treatment operations, are compared against their global warming potentials (GWP).

I.3. GHG EMISSIONS

Both aerobic and anaerobic process are responsible for GHG emissions in a wastewater Treatment Plant. The methodology adopted to estimate the emissions are Based upon the guidelines suggested in [1][2]

I.3.1. *Carbon dioxide (CO_2):* the major contributors of CO_2 in wastewater is the treatment process itself and its electricity consumption. CO_2 is released from the oxidation of organic matters in the aeration tanks of the aerobic processes such as in activated sludge process or SBR. During anaerobic process the organic matter is converted in to biomass and again in to CO_2 and CH_4 through endogenous respiration. The other source of CO_2 is from sludge digestion and combustion of the gas harvested in digester. Carbon dioxide (CO_2) emissions from wastewater are not considered in the IPCC guidelines because these are of biogenic origin which means obtained from food which eventually will be taken up back by crops and should not be included in national total emissions. as such, returning the carbon in this material to the atmosphere as co_2 represents no net flux to the system.[4][5]

I.3.2. *Methane (CH_4)*: Sewage and Sludge if undergo any kind of anaerobic process will release CH_4. The extent of emission of CH_4 will depend on the type of treatment system, the temperature, and the quantity of degradable organic material in the wastewater. The rate of CH_4 emission increases with the increase in temperature. When the temperature is below 15˚C the methanogens become inactive and there is almost no production of CH_4.[6]

I.3.3. *Nitrous Oxide (N_2O):* The major sources of N_2O is generated from the degradation of nitrogenous components in the wastewater, e.g., urea, nitrate (NO_3–) and protein. Domestic wastewater includes human sewage mixed with other household wastewater, which may include effluents from sink drains, shower drains, washing machines, etc. Direct emissions of N_2O may be generated during both nitrification and denitrification process (NDN). Nitrification is an aerobic process during which the ammonia and other nitrogen compounds are converted into nitrates (NO_3–) and Denitrification is the process which occurs under anoxic conditions in which the nitrate is converted in to nitrites (NO_2) and again in to nitrogen gas N_2. Both processes can occur in the plant and in the water body receiving the effluent. With regard to each GHG source the N_2O emitted is generated by nitrification and denitrification processes used to remove nitrogenous compounds from wastewater. Its production occurs mainly in the activated sludge units (90%) while the remaining 10% comes from the grit and sludge storage tanks. N_2O gas is an intermediate of biological processes such as heterotrophic denitrification and nitrification. It is formed during denitrification operated at low pH values and toxic compounds or low dissolved oxygen (DO) concentrations are present in the media. Nitrifying bacteria are able to produce N_2O under aerobic or anoxic conditions. In anoxic conditions, both ammonia- and nitrite-oxidizing bacteria are able to produce it, while only ammonia-oxidizing bacteria do it in aerobic conditions. In the latter case, the production is stimulated by the presence of low DO concentrations and presence of nitrite (NO_2-) or organic matter in the liquid media. Nitrous oxide can be produced also from chemical reactions taking place in the presence of hydroxylamine and nitrite.[3]

I.4. EMISSION CATEGORIES

I.4.1. *Scope 1* - Direct GHG emissions: CO2 emissions from WWTP are not considered in the IPCC Guidelines because these are of biogenic origin (that is it was initially drawn down from the atmosphere in the production of food crops) and should not be included in national total emissions in scope 1 three gases i.e. CO2, CH4 and N2O are calculated for STP.

I.4.2. *Scope 2* - Indirect GHG emissions: The Scope 2 includes the emissions that occur from the use of electricity and the generation of purchased electricity bought and consumed and the emissions from Scope 1.

I.4.3. *Scope 3* - includes the emissions from Scopes 1 and 2 and the emissions that occur during the production of the chemicals, transport etc. that are used in the pants.

II. RESEARCH METHODOLOGY

First of all Deciding an organization and decisions on the method to be followed are selected which are provided in their relevant codes and standards then recognizing their organizational and operational boundaries. After boundaries are understood Factory visit and Data Collection takes place. After collection, Analysis of the Wastewater, effluent and Sludge characteristics from the treatment plant is done. After appropriate data is recovered, calculations estimation are drawn of Treatment Plant's Energy Consumption and Carbon footprint. At the end Verification of all the results and recommendations are produced.

III. CALCULATION METHODOLOGY

By Incorporating Guidelines suggested in IPCC 2006 we apply the combination of tier 1 and tier 2 method application and Scope 1 and Scope 2 emissions for the study.
Step 1: Use Equation for TOW to estimate organically degradable material TOW in wastewater prior to treatment. Use equation for TOWj to estimate total organics in domestic wastewater for each wastewater treatment/discharge pathway or system, j (TOWj).
Step 2: Use Equations for $S_{aerobic}$ to estimate the amount of organic component removed in sludge, S, from aerobic treatment plants.
Step 3: Select the pathway and systems (Figure 6.1 [1]) according to country activity data. Use Equation for EF or the updated Table 6.3 [1] to obtain the emission factor for each domestic wastewater treatment/discharge pathway or system.
Step 4: Use Equation $CH_{4emission}$ to estimate emissions and adjust for possible sludge removal and/or CH_4 recovery of treatment/discharge pathway or system, j, in inventory year. After that sum the emissions across all treatment/discharge pathways or systems.
Step 5: Use Equation for CH_4 and N_2O emissions from Sludge given in [6] and subtract recovery or recycle values if used.

IV. STUDY AREA

Ahmedabad is an industrial city situated on the banks of Sabarmati River in north-central Gujarat. It covers an area of 205 km^2, with a population of 8,059,441 in the year 2020. Ahmedabad Municipal Corporation (AMC) operates and maintains 9 Sewage Treatment Plants, 45 Sewage Pumping Stations and approximately 2500 Kms. Long Sewage Network throughout the city area. This Study includes analysis in a Sewage Treatment Plants in Ahmedabad in Vasna (Western Side) of 48 MLD, an industrial wastewater treatment Plant at Vatva of 25 MLD and a water treatment facility in Kotarpur having a capacity of 850 MLD.

IV.1. ORGANISATIONAL DESCRIPTION

IV.1.1. Vasna STP 48 MLD SBR

This STP is an SBR technology plant located in Vasna near Hotel Vishala in Ice Factory Road Ahmedabad. There are no anaerobic processes taking place in the facility. The sludge is treated by polymers then sundried. This station is a SCADA automated by Toshiba treatment plant.

Influent Parameters:

BOD Range = 99 to 211 mg/L

COD Range = 288 to 375 mg/L

Avg TKN = 22 mg/L

IV.1.2. Vatva CETP 25 MLD ASP

The CETP and associated facilities are set up on the land area measuring 24328 sq. m. Variety of effluents from industries are treated daily such as, Pharmaceutical Products, Dyes,, Pigments, Fine Chemicals Textile Process Houses, Rolling Mills and other Non-Chemical Process Industries. The CETP was designed to treat 25000 m^3 of effluent/day (25 MLD) making use of ASP at present, they mix the Primary and secondary sludge and feed into the Decanter. Thereafter the dewatered sludge goes to the SLF (Secured Landfill Facility) site in Vinzol Village for disposal.

Influent Parameters:

BOD Range = 180 to 382 mg/L

COD Range = 923 to 1224 mg/L

Avg TKN = 17.5 mg/L

IV.1.3. Kotarpur WTP 850 MLD RSF

Kotarpur water treatment plant has a 650 MLD and a 200 MLD capacity treatment units accumulating raw water from Narmada by gravity flow and from Sabarmati by water pumping. It treats using conventional water treatment with declining rate filtration & disinfection. The Kotarpur WTP provides up to 1100 MLD water supply for consumption of Ahmedabad city and is Asia's largest Water treatment plant in capacity. The Electricity Supply in this facility is being offset by Renewable sources from wind mills in Ukheda and Nakhatrana in Gujarat.

V. EQUATIONS AND CALCULATIONS

Following are Equations and descriptions available in [1] [2] for each GHG

V.1. CO_2 ESTIMATIONS

With respect to CO_2 its production is attributed to three main factors biological treatment process, methane oxidized to CO_2 during biogas combustion, electricity consumption.

Wastewater (USEPA):

$$CO_2 = 10\text{-}6 * Qww * OD * Eff_{OD} * CF_{CO2} * [(1\text{-}MCF_{ww} * BG_{CH4})\ (1\text{-}\ \lambda)] \qquad (1.1)$$

Where,

$$\lambda = \frac{Qs * MLVSSs * CFs}{Qww * OD * Eff * CFc} \qquad (1.2)$$

Sludge (USEPA):

$$CO_2 = 10\text{-}6 * Qs * MLVSS * CFs * \frac{44}{12} * (1\text{-}MCFs * BG_{CH4}) \qquad (1.3)$$

Electricity (GHG Protocol WRI):

$$CO_2 = E_{Consumed} * EF \qquad (1.4)$$

Where,

CO_2 = CO2 emission rate (Mg CO_2/hr)

Q_{ww} = Wastewater influent flow rate (m^3 /hr)

OD = Oxygen demand of influent wastewater to the biological treatment unit determined as either; BOD5 or COD (mg/L = g/m3)

Eff_{OD} = Oxygen demand removal efficiency of the biological treatment unit

CF_{CO2} = Conversion factor for maximum CO_2 generation per unit of oxygen demand (1.375 for BOD5 or COD in India)

MCF_{WW} = methane correction factor for wastewater treatment unit (0 for well managed Aerobic treatment process)

BG_{CH4}= Fraction of carbon as CH4 in generated biogas (default is 0.65)

V.2. CH_4 ESTIMATIONS

Collection systems provide an environment conducive to the formation of CH_4. The main sources of methane detected were related to the sludge line units where anaerobic digestion is carried out. The primary sludge thickener, the centrifuge, the exhaust gas of the cogeneration plant, the buffer tank for the digested sludge, and the storage tank, contribute to around 72% of CH_4 emissions. Remaining emissions come from the biological reactors and can be mainly attributed to the CH_4 dissolved in the wastewater.

Wastewater (USEPA, IPCC):

$$CH_4 = 10\text{-}6 * Qww * OD * Eff_{OD} * CFCH4 * [(MCFww * BG_{CH4}) (1- \lambda)] \qquad (2.1)$$

Domestic WW:

$$CH_4 \text{ Emissions } j = [(TOW_j - S_j) * EF_j - R_j] \qquad (2.2)$$

$$S_{aerobic} = (S_{mass} * K_{rem} * 1000) \qquad (2.3)$$

Where,

$$\mathbf{TOWj = \sum[TOW * Ui * Tij * Ij]} \qquad \mathbf{(2.4)}$$

$$TOW = P * BOD * 0.001 * 365 \qquad (2.5)$$

Industrial WW:

$$CH_4 \text{ Emissions } = \sum[(TOWi - Si) * EFi - Ri] \qquad (2.6)$$

Sludge (USEPA, IPCC):

USEPA:

$$CH_4 = 10\text{-}6 * Qs * MLVSS * CFs * \frac{16}{12} * (1\text{-}MCFs * BG_{CH4}) \qquad (2.7)$$

IPCC 2019:

$$CH_4 \text{ Emissions } = \sum[(Mi - EFi) - Ri] \qquad (2.8)$$

CH_4 = CH_4 emission rate (Kg CH_4/hr)
Q_{ww} = Wastewater influent flow rate (m^3 /hr)
OD =Oxygen demand of influent wastewater to the biological treatment unit determined as either as BOD_5 or COD (mg/L = g/m^3)
Eff_{OD} = Oxygen demand removal efficiency of the biological treatment unit
CF_{CH4} = Conversion factor for maximum CH_4 generation per unit of oxygen demand (0.5g CH_4/g oxygen demand)
MCF_{WW} = methane correction factor for wastewater treatment unit (0 for well managed Aerobic treatment process)
BG_{CH4} = Fraction of carbon as CH_4 in generated biogas (default is 0.65)
λ = Biomass yield (g C converted to biomass/g C consumed in the wastewater treatment process)
$S_{aerobic}$ = organic component removed from wastewater (in the form of sludge) in aerobic treatment plants, kg BOD/yr
S_{mass} = amount of raw sludge removed from wastewater treatment as dry mass, tonnes/year
K_{rem} = sludge factor, removal of organic component from wastewater as sludge kg BOD/kg dry sludge (0.8 for Aerobic sludge treatment)
TOWi = total organically degradable material in wastewater from industry i in inventory year, (kg COD/yr)
S = organic component removed from wastewater (in the form of sludge) in inventory year, kg COD/yr
EF = emission factor for industry i, kg CH_4/kg COD for treatment/discharge pathway or system(s) used in inventory year
R = amount of CH_4 recovered or flared in inventory year, kg CH_4/yr

U = fraction of population in income group i in inventory year. (For India urban high: 0.06, Urban Low: 0.23, Rural: 0.71)
T = degree of utilisation of treatment/discharge pathway or system j, for each income group fraction i in inventory year. (For Sewers urban high: 0.67, Urban Low: 0.53, Rural: 0.1)
I = correction factor for additional industrial BOD discharged into treatment/discharge pathway or system j (for collected the default is 1.25, for uncollected the default is 1.00)
P = country population in inventory year, (person)
M = Mass of organic waste treated by biological treatment type i, Kg

V.3. N_2O ESTIMATIONS

N_2O emitted is generated by nitrification and denitrification processes removing nitrogenous compounds from wastewater. Its production occurs mainly in the activated sludge units (90%) while the remaining 10% comes from the grit and sludge storage tanks. It is formed during denitrification when operated at low pH values and toxic compounds or low dissolved oxygen (DO) concentrations are present in the media. Nitrifying bacteria are able to produce N_2O under aerobic or anoxic conditions. In anoxic conditions, both ammonia- and nitrite-oxidizing bacteria are able to produce it, while only ammonia-oxidizing bacteria do it in aerobic conditions.

Wastewater (USEPA, IPCC 2019)

$$N_2O_{wwtp}=Qi*TKN*EF_{N2O}*\frac{44}{28} \qquad (3.1)$$

(Industrial ww): $$N_2O_{plants}=[\sum(\mathbf{Tij}*\mathbf{EFj}*\mathbf{TN})]*\frac{44}{28} \qquad (3.2)$$

(Domestic ww): $$N_2O_{Effluent}=[\sum(\mathbf{U}*\mathbf{Tij}*\mathbf{EFj}*\mathbf{TN})]*\frac{44}{28} \qquad (3.3)$$

Sludge (IPCC2006)

$$N_2O_{Emissions}=\text{Mass} * \text{EF} \qquad (3.4)$$

N_2O_{WWTP} = N_2O emissions generated from WWTP process (g N_2O/hr)

Qi = Wastewater influent flow rate (m3 /hr)

TKNi = Amount of TKN in the influent (mg/L = g/m3)

EF_{N2O} = N_2O emission factor (g N emitted as N_2O per g TKN in influent), = 0.0050 g N emitted as N_2O/g TKN

N_2O Plants = N_2O emissions from domestic wastewater treatment plants in inventory year, kg N_2O/yr

U = fraction of population in income group i in inventory year. (For India urban high: 0.06, Urban Low: 0.23, Rural: 0.71)

Tij = Degree of utilization of treatment/discharge Pathway or system j for each income group fraction i. (For Sewers urban high: 0.67, Urban Low: 0.53, Rural: 0.1)

VI. RESULTS

CO_2 values have been avoided since IPCC dosent consider CO_2 emissions from Wastewater. CH_4 and N_2O values for WTP is not considered since ther is no bio degradable suldge observed. Since the emissions are from coal fired power plant the emission factor is considered 0.91 as per GHG protocols. Priority is given to the equations given in IPCC guidelines rather than USEPA. Only GWP values are recommended to be used from RTI USEPA[2].

***Fig1**: Monthly Trends in Scope-2 CO_2 Emissions for year 2020*

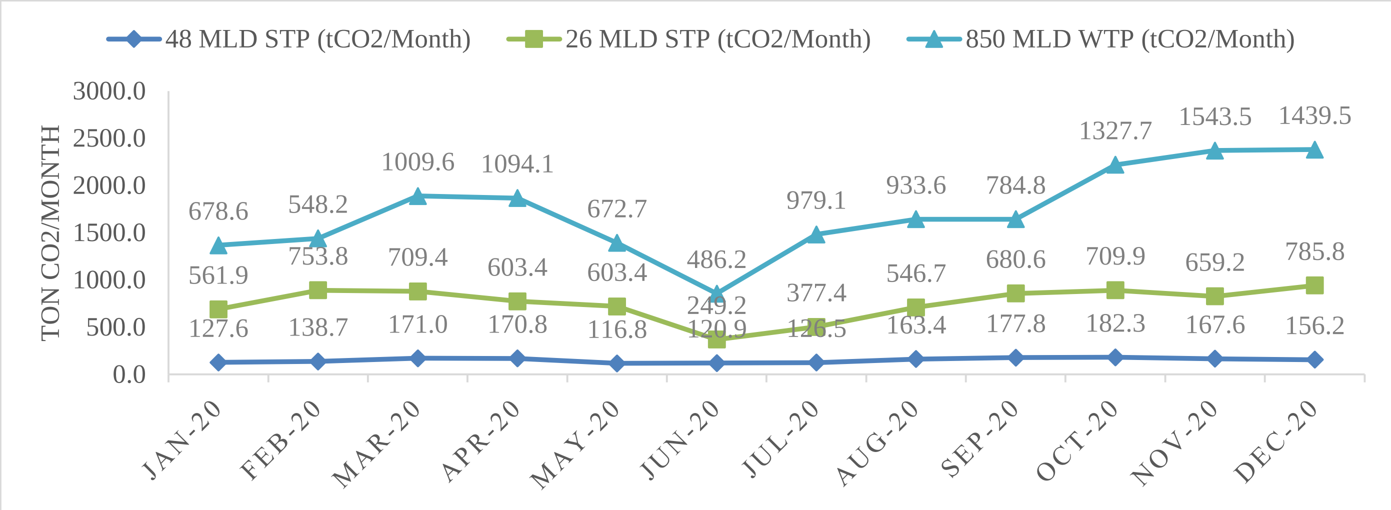

***Table 2**: Total Carbon equivalent Emissions of GHG in CETP (ASP), STP (SBR) and WTP (RSF)*

Treatment Plant	Emissions of GHG (per year)			Emission of GHG equivalent CO_2 (Tons per year)			Total equivalent CO_2 (Tons Per year)
Vasna STP 48 MLD SBR	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O	
	1819.55 (t/Yr)	670.20+65.01 (Kg/Yr)	1.963+0.390 (Kg/Yr)	1819.55	15.43	0.729	1835.709
Vatva CETP 25 MLD	7240.83 (t/yr)	3438.117+36.6 (Kg/yr)	8.717+4.392 (Kg/yr)	7240.83	72.969	4.063	7317.862
Kotarpur WTP 850 MLD RSF	11497.79 (t/yr)	-	-	11497.79	-	-	11497.79

***Table 3:** Emissions of GHG in CETP (ASP),STP (SBR) and WTP (RSF)*

Treatment Plant	Emissions of GHG (per year)			Total Influent in million lits per year	Emission of GHG per Million Liters (Ml)		
Vasna STP 48 MLD SBR	CO_2	CH_4 Wastewater + Sludge	N_2O Wastewater + Sludge	Million Liters/ year	CO_2	CH_4	N_2O
	1819.55 (t/Yr)	670.20 + 65.01 (Kg/Yr)	1.963 + 0.390 (Kg/Yr)	16082	.113 t/ Ml	0.0457 Kg/ Ml	0.1463 g/Ml
Vatva CETP 25 MLD	7240.83 (t/yr)	3438.12+ 36.60 (Kg/yr)	8.717 + 4.392 (Kg/yr)	6109.1	1.18 t/ Ml	0.5687 Kg/ Ml	2.415 g/Ml
Kotarpur WTP 850 MLD RSF	11497.79 (t/yr)	-	-	311100	0.369 t/Ml	-	-

Table 4: *Scope 2 emissions*

Treatment Facility	KWH Electricity/ Kg BOD	KWH Electricity/ Kg COD	Kg CO_2 e Emission/ Million Litres
48 MLD	1.5	.5	105
25 MLD	2	5	801
850 MLD	-	-	37

According to results it can be concluded that total organizational carbon footprint of Vatva CETP is 7317862 $kgCO_2e/yr$ (=7317.862 tCO_2e/yr), Vasna STP is 1835709 $kgCO_2e/yr$ (=1835.709 tCO_2e/yr) and Kotarpur WTP is 11497.79 $kgCO_2e/yr$ (=11497.790 tCO_2e/yr) based on the year 2020.

VII. CONCLUSION

It can be established that Vatva CETP shows the highest Values For GHG Emissions Per Million Litres hence the highest Carbon Footprint. The SBR has the least CO_2e and performs best in terms of GHG emission reduction compared to ASP. The results show that indirect off site emissions (electrical use) were Significantly higher than Direct onsite emissions (OD reduction). But net carbon footprint of these Treatment Plants may be less than calculated value, because the calculations have been done using pessimistic approach i.e. for these plants the values are assumed to be maximum potential values for the conversion factors. Though none of these plants had Anaerobic digestion systems still High quantities of CH_4 were derived even from the Sludge composting and influent Organic matter Contents.

VIII. RECOMMENDATIONS

On considering average light intensity (4.5 kWh) for 10h/day, the power output of this solar module is 0.60 kWh/m2/day. CC earned is computed as 0.33 tonnes/MWh/year, under West Bengal climatic condition as per the norms of the Kyoto protocol. For obtaining 11.86 kg of silicon, which is the raw material of soar cell used in this study, the amount of CO2 production is calculated as 8.70 kg/MWh/year.[7] According to that annually 274.93 tonnes CO_2 from 48 MLD, 1094.082 tCO_2/yr from 25 MLD and 1737.3 tCO_2/yr from 850 MLD could be offset from Electricity through Solar Photovoltaic Cells.
anaerobic wastewater treatment processes are preferred for biochemical oxygen demand (BOD) concentrations of the wastewater more than 300 mg/L as they could reduce GHGs emission by energy recycling in the form of CH_4.
Introducing new concept like 3R concept, sustainable development, green building concept, zero carbon building concept and carbon neutrality. Increase the natural vegetation cover within the premises. If CH_4 is recycled and reused in 25 MLD and 48 MLD i.e. anaerobic treatment processes more than 84 tonnes of CO_2 e from the atmosphere could have been reduced from sludge treatment. The reduced GHGs emission either from the wastewater treatment process improvement or effluent and biomass recycling will generate Certified Emission Reduction (CER) for sale or export.[8] Proper maintenance of the records and Lab results. Calculating organizational carbon footprint in every year and set targets for every section.

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