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Five Year Carbon Footprint of a Textile Industry: A Podium to incorporate Sustainability

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ABSTRACT

The world is experiencing deteriorating climatic changes which are significantly resulting from the increased emission of greenhouse gases. This research highlights the major activities of a textile industry that release greenhouse gases and then focuses on calculating the carbon foot print of the industry for last 5 years. Further, this study also links up the calculated carbon footprint with the environmental sustainability. The methodology adopted to calculate carbon footprint was in accordance to the GHG protocol guidelines. The study emphasizes the different emission sources including scope 1 emission which take into account direct emissions resulting from industry owned activities. The scope 2 are indirect emissions that emit due to the purchase of electricity, natural gas and the biogas emissions resulting from waste disposal. Scope 3 emissions were not accounted in the current study based upon its complexity. Scope 1 emissions were found to contribute greatest in total carbon footprint. The results symbolized an ascending trend in the carbon footprint of the industry over past five years. This ascending trend also denoted that very less environmental sustainability has been achieved by the industry in last five years. Carbon footprint calculated for the base year 2014 was 42867.72tCO_2e.

INTRODUCTION

Greenhouse gases basically find their way into the environment through multiple activities that the industries are involved in. Industrialization in this era of largely distributed population is increasing at a higher rate. Hence, the concentrations of greenhouse gases into the environment are expected to be even high (Gillen 2012). The progress of industrialization and the technology has made GHGs evident in the atmosphere. Nearly all the facilities are contributing in polluting the atmosphere to some extent whether on a minor or major basis. Likewise textile sector is also playing its role in this regard (Parry et al. 2007).

Since the scope of a textile industry is surely large enough, the output of atmospheric pollutants is also high. Fabric though seems not to pollute the environment but actually many of its production and finishing processes end up in the emission of GHGs. According to a rough estimate out of every 19.8 tons of the total carbon-dioxide one ton is released from textile industries. Majorly, the direct emission of GHGs in a textile industry comes from the fossil fuel burning on site while the indirect emissions result from the purchase and consumption of electricity. Natural gas is a primary fossil fuel in textile sector which is utilized in the process of heating boilers to make steam available for drying the fabric (USEPA 2006).

Carbon footprint is basically the calculation of the total amount of the emissions in terms of carbon-dioxide of a specific activity, population or system, in view of all the comprising storage and sink within the spatial and temporal edge of the system, activity or population under study. A global warming potential of 100 year (GWP 100) is used to calculate carbon footprint as carbon-dioxide equivalent (CO_2e) (Kemp et al. 2011).

The methodology adopted to calculate the total carbon foot print commences from the gathering of data from three sources including activities involving combustion of fossil fuels, non-combustion activities and purchased electricity and natural gas. Data regarding fossil fuel combustion are obtained by “manufacturing energy combustion survey (MECS)” this estimated value is then multiplied with a fuel specific emission factor in order to convert the data into carbon-dioxide release. Non combustion activities are basically those activities that are taken up on site but are other than combustion of fossil fuels or purchase of electricity.

Data from electricity purchase are calculated in kilowatt hours then applying carbon-dioxide emission factor to it (in Ibs/ kWh). The estimated data are then combined to provide the desired result. Only an assumption is to be made that all the emissions from fossil fuel consumption and electricity purchase comprise of carbon-dioxide only and no other GHG (USEPA 2008).

Usually greenhouse gas protocols are used to estimate the carbon footprint of any facility. Greenhouse Gas Protocol lays down guidance and standards for the industries for quantifying their carbon emissions and also promotes the ways to manage the GHG emissions for government co-operations as well as for the business class frontrunners. These standards further facilitate the industries to formulate their GHG inventory which predominantly includes emissions of gases like, carbon dioxide (CO_2), per fluorocarbons (PFCs), methane (CH_4), sulphur hexafluoride (SF_6), nitrous oxide (N_2O) (Ranganathan et al. 2004).

The emissions of carbon around the world are quite high but the contribution of Pakistan is also alarming. The rapid industrialization and population growth together has raised the amount of carbon emissions and it is continuing to do so. A few years back Pakistan produced around nine million metric tons of carbon emissions in 1980 however, this figure has multiplied by four today ending up to around 30 million metric tons. Energy sector of the country is making up a total of 53% of carbon in the atmosphere. Hence, Pakistan is continuing to make efforts to guarantee reduction in climatic drifts by ratifying the "Framework Convention", "The Kyoto protocol", "The Montreal Protocol" and "The Desertification Convention". Since climatic changes' leading towards warmer world is a global issue, it won't be possible to counter it independently. Consequently Pakistan is in commitment with clean mechanism strategies formulated by ministry of climate change which calls for a collaborative action and efforts of all the civil societies, individuals, industrialists, stakeholders and so on.

This study highlights the entire activities undertaken by the industry that are associated with carbon emissions which facilitated in providing the total carbon footprint of the facility. This study, therefore, ends up in the introduction of environmental sustainability in the facility.

STUDY AREA

This study is centered upon a textile facility situated in Faisalabad, Pakistan. This industry has certainly marked the trends and captured the interest of customers all around the world. The most attractive lot of products includes curtains, panel prints, terry towels, bed in bags, embroidery, table and sofa covers etc.

MATERIALS AND METHODS

The study was aimed to calculate the carbon footprint of a textile industry in order to get an insight of the contribution of textile sector in the emissions of greenhouse gases and also towards global warming. Along with it another factor i.e., sustainability index of the industry was also estimated. This was done by calculating and comparing the carbon footprint of last five years.

Selection of base year: 2014 was selected as the base year. This was the year with which comparisons of carbon footprint of last five years were made to assess the sustainability pattern of the industry over the years.

Scope of analysis: The scope of analysis was defined by adopting a tactful approach that brought into account all the areas of the industry that were made part of the study and led to the setting up of system boundaries. The boundaries were aligned according to the three scopes that were considered, on behalf of which the sources of emissions were identified. Those scopes and sources are:

Scope 1: Direct GHG emissions*:* In light of the GHG protocol, all those activities which were controlled by industry or organization itself and were resulting in direct release of emissions into the atmosphere were regarded as part of scope 1. Broadly the sources of direct emissions were classified as stationary combustion sources and mobile combustion sources.

- Stationary combustion sources majorly included the boilers and generators present in the industry which required the combustion of fuel for the production of steam and energy respectively to trigger processes like singeing process which is part of grey godown stage, batching, curing and calendaring.
- Mobile combustion sources include the industry owned vehicles which run by burning either petrol or diesel and ends in releasing a major proportion of GHG emissions.

Scope 2: Indirect GHG emissions*:* As per the GHG protocol within Scope 2, indirect emissions, the focus was on the emissions that fallouts from the purchase and use of electricity as well as from the purchase of natural gas for various purposes such as heating, cooling etc. These are activities which are not owned by the industry itself. Electricity is one such factor which is required for the functioning of entire machinery. Therefore, it was recognized that widely all processes fall under scope 2.

However, the prominent sources of indirect emissions within the industry were identified as those resulting from processes like dyeing, printing, cutting, wadding plant, quilting, stitching and quality control process which required the input of electricity and natural gas.

Scope 3: Miscellaneous GHG emissions: All other indirect emissions which did not fall in the category of scope 1 and scope 2 were considered as scope 3 emissions. More specifically these are emissions which are neither owned by the industry nor come under scope 2. In fact these are the emissions which result from all the upstream and downstream activities. Examples that can be quoted here include emissions from business travels and waste disposal. These activities were neither owed by the organization nor controlled. It is optional to include scope 3 emissions in calculating and estimating the carbon footprint of the industry. Hence, the focus was retained over scope 1 and scope 2 emissions in the current study.

Prevalent sources of scope 3 emissions in textile industry were mainly the emissions from transport and other business travels which include transport of grey (raw material) to the industry, delivery of goods to the party/customers, systems for inventory control.

Data collection: Collection of the required data was the main target so as to make the related calculations to achieve the objective. In addition ambient air monitoring was carried out within the industry. Monitoring was done near some sources which included the boilers and generators, car park area and near the main gate. The emission data were collected for carbon dioxide and methane. The instrument used for monitoring purpose was Haz-Scanner HIM- 6000. For the estimation of carbon foot print, CO_2, CH_4 and NO_2 were monitored by Haz-Scanner.

However, in addition, similar data of last five years were also obtained from the industrial documents. Documents such as the monthly bills of electricity and natural gas consumption were also reviewed in order to assess the average consumption. Along with this, observation was also made to keep a record of the incoming and outgoing vehicles in the industry; this assisted in estimating the vehicular fuel consumption in a day.

Carbon footprint calculation approach: All the information and data gathered in the earlier steps were used to accurately calculate the carbon footprint of the facility. This called for expressing the result of carbon footprint in terms of CO_2e, which required the conversion of GHGs into CO_2e figure. The method adopted for the calculation of carbon foot print is as follow.

- The data were converted into greenhouse gas emission, which was done by the multiplication of emission factor with the activity data. This then laid down the GHG emissions per functional unit of product.
- Further, the individual figures of GHG emissions were multiplied by the relevant global warming potential (GWP) factor in order to convert them into CO_2e emissions.

Recent ICPP GWP factors were essentially applied for the calculations. The most common factors were:

1kg of methane (CH_4) = 25kg of CO_2 e

1kg of nitrous oxide (N_2O) = 298kg of CO_2 e

The approach or methodology elaborated in the Fig. 1 was adopted to calculate total carbon dioxide emissions. The data obtained from primary data collection for each activity was multiplied with the respective CO_2 and CH_4 emission factor. This provided with kg of CO_2 emitted. This was then converted into tones of CO2 by dividing the values by 1000. These were then added to obtain total carbon dioxide emissions in tones. Lastly emissions for each scope were added to compute the total carbon foot print (Saif et al. 2015). This was done for each of the last successive year.

RESULTS

Scope 1 emissions: The graphs (Figs. 2-3) are the representation of the collected data for stationary combustion and mobile combustion sources that collectively results into scope 1 emissions.

Table 2 shows the complete calculations for scope 1 emissions i.e., stationary and mobile combustion fuels. The prominent stationary sources identified within the textile facility were wood, diesel, coal and LPG. These fuels were being consumed by the industry to run the boilers to generate steam which was in turn utilized for various purposes including the generation of power.

Fig. 2 supports the fact that textile production involves various processes which requires the burning of fuel for producing heat. LPG is the fuel which is being used by the facility since many years however, its consumption per metric tons in last five years is very low. The industry has shifted to other fuels like coal, wood and diesel in addition to LPG since 2012. The reliance over other fuels initiated as the energy crises began in the country. So to ensure continuous

Table 1: Scope-wise categorization of emissions.

Scope 1	Scope 2	Scope 3
Singeing process	Dyeing	Transportation of grey to the industry
Curing	Printing	Delivery of goods to the party
Batching	Cutting	Inventory control systems
Calendaring	Quilting	Stack emissions
	Stitching	Miscellaneous emissions
	Quality control	

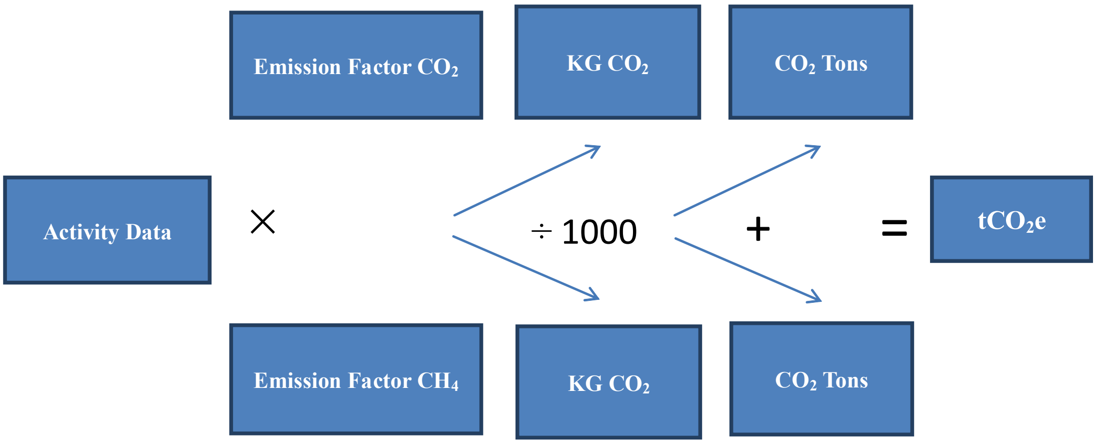

Fig. 1: Carbon foot print calculations.

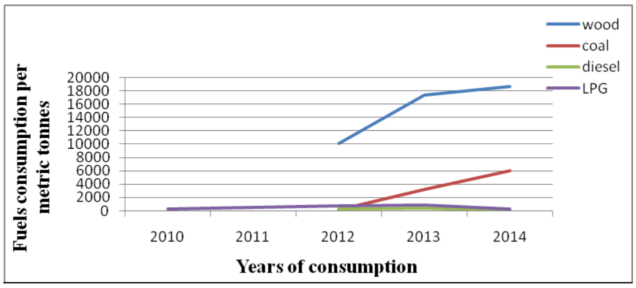

Fig. 2: Stationary fuel consumption.

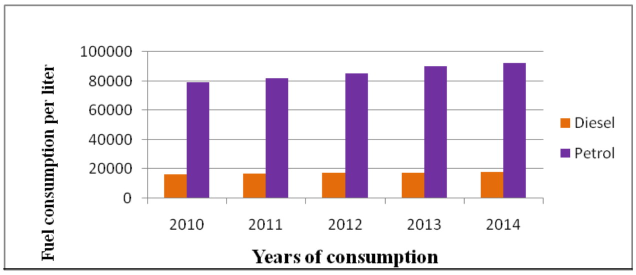

Fig. 3: Mobile fuel combustion.

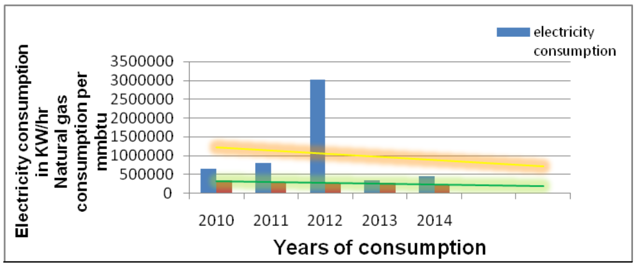

Fig. 4: Consumption of electricity and natural gas over the years.

supply of electricity and production the industry opted to increase the dependence over multiple fuels. The consumption of coal and wood is increasing in the facility. On the contrary diesel is the least prioritized fuel in the industry.

However, in accordance to the emission factors of each of the combustion fuel, wood consumption must be kept as minimum as possible as its CO_2 and CH_4 emission factor is highest while diesel with the lowest emission factor is the most environmentally favourable fuel. Hence, to avoid deteriorating the environment and stabilize environmental sustainability within the facility, it is advisable to continue the consumption of LPG, wood, coal and diesel in ascending order.

The other division of direct emissions is the emissions resulting from mobile fuel combustion sources. These emit from the industry owned vehicles. Automobiles are the most noticeable source of production of carbon emissions. Hence it is important to keep an account of industry owned vehicle in order to calculate the total carbon footprint of the industry (Ranganathan 2004). The industrial survey and the checklist helped in gaining the data represented in Fig. 2. The figure shows the different types of vehicles and their quantities owned by the industry. It also shows the two types of fuel i.e. diesel and petrol used in respective vehicles. As the amount of carbon emitted by the burning of the fuel depends upon the type of fuel burned (USEPA 2008).

Fig. 3 demonstrates the two types of fuels consumed in each of the last five years. The figure connotes that the consumption of the fuels is increasing year by year. Petrol is more consumed as compared to diesel. This ascending sequence of consumption of fuels is meant to happen as the industry is growing year by year and so does the transportation activities.

Table 2: Data calculated for scope 1 emissions.

			Scope 1 Emissions						
			Fuel Type	Activity Data	Unit Type	Emission Factor	kg CO_2	CO_2 Tonnes	tCO_2e
Direct Emis-	2014	Stationary Fuel	Wood	18666	Tones	CO_2 1747.2	32613235.2	32613.2352	32700.59
sions		Combustion				CH_4 4.68	87356.88	87.35688	
			Coal	6408	Tones	CO_2 1201.9	7701775.20	7701.77520	7702.54
						CH_4 0.119	762.55	0.76255	
			Diesel	46400	Liters	CO_2 2.67	123888	123.888	123.8880288
						CH_4 0.000361	16.7504	0.0167504	
			LPG	225	Tones	CO_2 2984.63	671541.75	671.54175	76.59
						CH_4 0.2365	53.21	0.05321	
		Mobile Fuel	Petrol	92146	Liters	CO_2 2.271	209263.566	209.263566	209.29378989
						CH_4 0.0003278	30.223888	0.030223888	
		Combustion	Diesel	17310	Liters	CO_2 2.67	46217.70	46.21770	46.22
						CH_4 0.000361	6.25	0.00625	
									40859.12
	2013	Stationary Fuel	Wood	17318	Tones	CO_2 1747.2	30258009.6	30258.0096	30339.06
		Combustion				CH_4 4.68	81048.24	81.04824	
			Coal	3154	Tones	CO_2 1201.9	3790792.60	3790.79260	3791.17
						CH_4 0.119	375.33	0.37533	
			Diesel	425053	Liters	CO_2 2.67	1134891.51	114.89151	115.04495413
						CH_4 0.000361	153.444133	0.153444133	
			LPG	908	Tones	CO_2 2984.63	2710044.04	2710.04404	2710.26
						CH_4 0.2365	214.74	0.21474	
		Mobile Fuel	Petrol	89982	Liters	CO_2 2.271	204349.122	204.349122	204.3786181
						CH_4 0.0003278	29.4960996	0.0294960996	
		Combustion	Diesel	17001	Liters	CO_2 2.67	45392.67	45.39267	45.398807361
							CH_4 0.000361	6.137361	0.006137361
									37205.31238
	2012	Stationary Fuel	Wood	10076	Tones	CO_2 1747.2	17604787.2	17604.7872	17651.94
		Combustion				CH_4 4.68	47155.68	47.15568	
			Coal	112	Tones	CO_2 1201.9	134612.80	134.61280	134.63
						CH_4 0.119	13.33	0.01333	
			Diesel	252318	Liters	CO_2 2.67	673689.06	67.68906	67.780146798
						CH_4 0.000361	91.086798	0.091086798	
			LPG	705	Tones	CO_2 2984.63	2104164.15	2104.16415	2104.33
						CH_4 0.2365	166.73	0.16673	
		Mobile Fuel	Petrol	85431	Liters	CO_2 2.271	194013.801	194.013801	194.04180528
						CH_4 0.0003278	28.0042818	0.0280042818	
		Combustion	Diesel	16892	Liters	CO_2 2.67	45101.64	45.10164	45.107738012
						CH_4 0.000361	6.098012	0.006098012	
									20197.82969
	2011	Stationary Fuel	Wood	-	Tones	CO_2 1747.2			
		Combustion				CH_4 4.68			
			Coal	-	Tones	CO_2 1201.9			
						CH_4 0.119			
			Diesel	-	Liters	CO_2 2.67			
						CH_4 0.000361			
			LPG	528	Tones	CO_2 2984.63	1575884.64	1575.88464	1576.00951
						CH_4 0.2365	124.87	0.12487	
		Mobile Fuel	Petrol	82127	Liters	CO_2 2.271	186510.417	186.510417	186.53733823
						CH_4 0.0003278	26.9212306	0.0269212306	
		Combustion	Diesel	16305	Liters	CO_2 2.67	43534.35	43.53435	43.540236105
						CH_4 0.000361	5.886105	0.005886105	
									1806.0870843
	2010	Stationary Fuel	Wood	-	Tones	CO_2 1747.2			
		Combustion				CH_4 4.68			
			Coal	-	Tones	CO_2 1201.9			
						CH_4 0.119			
			Diesel	-	Liters	CO_2 2.67			

Table conti...

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					CH_4 0.000361			
		LPG	253	Tones	$CO_2$2984.63	755111.49	755.11149	755.1713245
					CH_4 0.2365	59.8345	0.0598345	
	Mobile	Petrol	79311	Liters	CO_2 2.271	180115.281	180.115281	180.14127915
	Fuel				CH_4 0.0003278	25.9981458	0.0259981458	
	Combustion	Diesel	16014	Liters	CO_2 2.67	42757.38	42.75738	42.763161054
					CH_4 0.000361	5.781054	0.005781054	
								978.0757647

Table 3: Data calculated for scope 2 emissions.

		Scope 2					
		Energy Consumption Type	Activity Data	Conversion Factor Unit Type	Emission Factors (CO_2)	kg/CO_2	tCO_2e
Indirect Emissions	2014	Electricity	453692	KWH	0.475	215503.7	215.5037
		Natural Gas	226074	MMBTU	53.02	1198644.43	1198.64443
							1414.14813
	2013	Electricity	353791	KWH	0.475	168050.725	168.050725
		Natural Gas	286676	MMBTU	53.02	15199561.52	15199.56152
							15367.612245
	2012	Electricity	3026381	KWH	0.475	1437530.975	143.7530975
		Natural Gas	282614	MMBTU	53.02	14984194.28	14984.19428
							15127.947378
	2011	Electricity	812122	KWH	0.475	385757.95	385.75795
		Natural Gas	283676	MMBTU	53.02	15040501.52	15040.50152
							15426.25947
	2010	Electricity	653614	KWH	0.475	310466.65	310.46665
		Natural Gas	347860	MMBTU	53.02	18443537.2	18443.5372
							18754.00385

Table 2 gives a combined layout of calculations of five years of stationary and mobile fuel combustion to estimate the total scope 1 emissions collectively. This is achieved by multiplying the yearly consumption of each fuel denoted as activity data by its corresponding CO_2 and CH_4 emission factors. This gives the values in kg of CO_2. These values are then converted into tones. Further, CO_2 tones of each fuel were added to obtain the total carbon dioxide emissions in tones. This finally showed up the total scope 1 emissions of the industry for year 2014. The same methodology was followed for year 2013, 2012, 2011 and 2010 to obtain their total scope 1 emissions.

Scope 2 Emissions: Fig. 4 shows the consumption of electricity and natural gas over last five years. Table 3 represents the calculations for scope 2 emissions.

This was then followed up with the calculations of scope 2 emissions or more specifically indirect emissions, which results from the purchase of electricity and natural gas. Fig 4 illustrates the purchase of electricity and natural gas by the facility for various industrial processes in each of the last five years. It shows that the purchase of electricity has remained higher in the facility as compared to natural gas. In year 2012 the facility experienced an unusual peak in the consumption of electricity i.e., it reached at a level of around 3000000 units. However, the steep yellow trend line depicts that the industry is holding on its electricity consumption to a greater extent. On the other hand natural gas consumption in the facility remained below 500000 mmbtu and the green trend line also displays that consumption is reducing over the years and will continue to reduce in the future years. Such reducing trends in the consumption are the sign of efforts towards prompting environmental sustainability and increasing efficiency of the industry.

Table 3 is the broad representation of calculations of scope 2 emissions of last 5 years. The primary data collected from the facility supported that the textile industry purchases the electricity from the well renowned supplier Water and Power Development Authority (WAPDA). The similar methodology for the calculations was adopted for estimating the total carbon dioxide equivalent emissions in successive 5 years as for scope 1.

Biogas emissions: The Table 4 is the illustration of the type of waste that results into biomass emissions and its calculations in terms of carbon dioxide equivalent.

Table 4: Data calculated for biomass emissions.

	Biomass/Industrial Waste Emissions						
	Type of fuel	Activity Data	Unit Type	Emission Factor	kg CO_2	CO_2 Tonnes	tCO_2e
2014	Waste Water	216	Tones	CO_2 2751.84	594397.44	594.39744	594.451872
	Treatment Sludge			CH_4 0.252	54.432	0.054432	
2013	Waste Water	231	Tones	CO_2 2751.84	635675.04	635.67504	635.733252
					CH_4 0.252	58.212	0.058212
	Treatment Sludge						
2012	Waste Water	256	Tones	CO_2 2751.84	704471.04	704.47104	704.535552
	Treatment Sludge			CH_4 0.252	64.512	0.064512	
2011	Waste Water	300	Tones	CO_2 2751.84	825552	825.552	825.6276
	Treatment Sludge			CHh_4 0.252	75.6	0.0756	
2010	Waste Water	256	Tones	CO_2 2751.84	704471.04	704.47104	704.535552
	Treatment Sludge			CH_4 0.252	64.512	0.064512	

Table 5: Total carbon dioxide emissions.

GHG Inventory	Emissions tCO_2e				
	2014	2013	2012	2011	2010
Scope 1	40859.12	37205.31238	20197.82969	1806.0870843	978.0757647
Scope 2	1414.14813	15367.612245	15127.947378	15426.25947	18754.00385
Biomass Emissions	594.451872	635.733252	704.535552	825.6276	704.535552
tCO_2e	42867.72	53208.657877	36030.31262	18057.974154	20436.615167

Another important aspect which should not be excluded is the emissions resulting from the disposal of waste produced in the industry. The monitoring within the facility helped understand that textile industry ends up into huge amount of waste. Not only this, the major waste type in a textile industry is in the form of wastewater. The consumption of water in textile industry is high so approximately 80% of the water ends up as wastewater. Therefore, there is a need for treating this water before its disposal for safe environment. For that it was also discovered that the industry under study has installed an activated sludge technology for treating the effluent of the industry. Likewise, it is worth noting that this process of treating water emits major greenhouse gases including carbon dioxide and methane which enters into the atmosphere affecting the purity of nature. Therefore, while calculating the carbon footprint of the industry it is important to take into account the biogas release. The data collected through the checklist revealed that the only source of biogas in the industry is wastewater treatment sludge.

Total carbon dioxide emissions: The graphs and tables (Figs. 5-6; Tables 5-6) show the total emissions over last five year of the industry. It also shows the emissions as categorized in each scope.

Fig. 5 is the graphical illustration of the calculated carbon footprint of 5 years scope wise. The graph shows that scope 1 emissions has accounted greatest followed up by biogas emissions and then scope 2 emissions. The trend line also shows that scope 1 is increasing year by year which the industry needs to be controlled in the coming years. While the trend line of scope 2 emissions shows a steep descending pattern. Biogas emissions on the other hand have also a slight decreasing trend.

This is then followed by the calculation of total carbon footprint of the industry by addition of emissions of scope 1, scope 2 and biogas emissions. Table 5 illustrates the total carbon footprint calculated for last five years which is increasing and in the coming years, it is expected to increase even more.

The computed data show that even though the industry is putting efforts to add in environmental sustainability in the industry it has yet failed to achieve it. The average annual production of fabric is around 9899369 kg. Since 2010 the industry has experienced little fluctuations in the production of fabric. There is a positive pattern in the production which clearly depicts that in the coming years the industry would increase its production capacity.

Hence, on the basis of the positive production in the

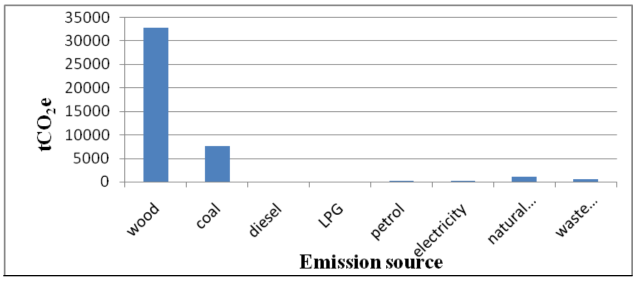

Fig. 6: tCO_2e emissions source-wise.

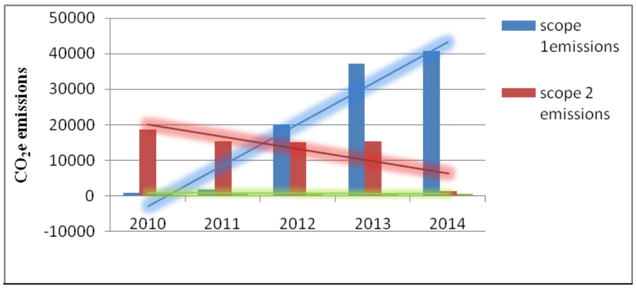

Fig. 5: CO_2e emissions scope-wise.

industry and negative trends in the purchase of electricity and natural gas as well as reducing sludge gas also gives signs of increasing efficiencies in the facility and marks the progressive efforts towards attaining environmental sustainability.

Other prominent efforts of the industry include the installation of activated sludge technology for the treatment of effluent. Installation of boilers for the production of electricity is also an example of industry's effort towards environmental sustainability. However, a better efficiency of the boilers would further enhance and catalyze transition towards the sustainable development in the industry.

CONCLUSION

As per the computations made, it is estimated that carbon footprint of the relevant textile industry is increasing year by year. In 2010 the carbon footprint came up to be 20436.615167 tCO_2e while in 2014 it was nearly 42867.72 tCO_2e i.e. the emissions almost doubled in a period of five years. With respect to scopes it is witnessed that scope 1 emissions has remained as the greatest contributor in the total carbon footprint over the five years. Second contributor being the biogas emissions followed by scope 2 emissions. Amongst all the sources the influence and input of wood has found to be highest in total carbon footprint. It is deemed that continuous determinations towards reducing scope 1 emissions would shape development that is environmentally sustainable and is likely to increase the sustainability index of the facility.

It is also assessed on the behalf of the increasing trends of carbon footprint, that no such environmental sustainability has been achieved by the facility. Consequently it is important for the industrial authorities to take steps to catalyze change over towards sustainable development.

Table 6: tCO_2 emissions by source.

	Source	tCO_2 Emissions
tCO_2 emissions by source in the year 2014	Wood	32700.59
	Coal	7702.54
	Diesel	123.8880288
	Lpg	76.59
	Petrol	209.29378989
	Electricity	215.5037
	Natural Gas	1198.64443
	Wastewater Treatment Sludge	594.451872

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