Carbon Footprint Assessment of Textile Industry

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Abstract-

Global warming and climate change have recently risen to the forefront of the international community's concerns. Calculating one's carbon footprint (CFP) is an important first step in reducing emissions in a quantitative way since it shows how individuals, organizations, nations, and the entire planet respond to global warming. A person, organization, event, or product's carbon footprint is a measurement of their overall GHG emissions, which are expressed as a carbon dioxide equivalent. To understand how much the company contributes to global warming and to find measures to lessen that contribution, it is essential to calculate its carbon footprint. Finding solutions to lessen the company's impact on global warming and learning about the possibility for energy saving potential it is necessary to assess the company's carbon footprint. Additionally, customers are showing an increasing amount of interest in openness on the environmental effects of the companies and products they use. The idea of a carbon footprint, its importance, the effects it has on the environment, and carbon management for the textile sector are all covered in this paper. CFP reduction can be accomplished by making investments in clean, low-carbon technologies such as renewable energy sources, energy efficient equipment, employee awareness, and others. In this study carbon footprint assessment is carried out of Baldev Textile Mills Pvt. Ltd. Located in Hatkanangale, India. This study also suggests further carbon footprint reduction methods for the industry.

Key Words: **carbon footprint, GHG emissions, life cycle assessment, net zero emissions, carbon neutral**

1. INTRODUCTION

The world has recently been witnessing worsening climate shifts, which are largely due to an increase in greenhouse gas emissions. A long-term change in the typical weather patterns that have come to characterize local, regional, and global climates on Earth is referred to as climate change. The world's average temperature is rising, extreme weather events are getting worse, ocean levels are rising, and there is acidification. These environmental dangers are all a result of human activities. Current climate change encompasses both the effects of global warming on the planet's weather patterns. Global warming is the gradual warming of the Earth's surface that has been seen since the pre-industrial era (between 1850 and 1900), and is attributed to human activity, particularly the burning of fossil fuels, which raises the levels of heat-trapping greenhouse gases in the atmosphere. The idea that human activity is mostly to blame for the current warming is backed by substantial data. The assessment of industrial sustainability and the formulation of sustainable development policies revolve around the issues of climate change and carbon footprint.

According to researchers, the main factor causing global warming is greenhouse gas emissions.The different climate models estimate that earth surface temperature will increase in the range of 1.6 up to 5.8°C by end of this century in line with current rates of population growth and GHG emissions [4]. Six greenhouse gases have been named by the Kyoto Protocol, an international accord on climate change: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6). According to this list, CO_2 is regarded as the primary cause of the problems associated with climate change. Carbon accounting has thus become a crucial component of evaluating anthropogenic activity and, consequently, of lowering GHG emissions. As a result, the idea of a carbon footprint emerges to measure GHG emissions as a result of particular processes or activities. It is impossible to deny the dramatic and obvious connections between greenhouse gas emissions and climate change.

Amongst the various measures of environmental impacts affecting our planet, the concept of 'carbon footprint' is considered to be one of the most significant. A carbon footprint is a way of assessing the impact of an activity on the environment, specifically the production of gases such as carbon dioxide (the so-called 'greenhouse' gases [GHGs]) that have been linked to climate change. Governments around the world have begun to make it mandatory for many industries to disclose the carbon footprint of a product or process.

1.1 Concept of Carbon Footprint

Carbon footprint is frequently used in analyses of carbon emissions at many sizes, including those of items, people/households, companies, cities, and nations. The term "carbon footprint" refers to the entire amount of carbon dioxide emitted by an activity. It simply involves calculating the entire quantity of carbon dioxide emissions from a particular activity, population, or system while taking into account all of the stores and sinks that are present within the spatial and temporal boundaries of the system, activity, or population under consideration. It can be characterized as a measurement of the overall GHG emissions created directly and indirectly by a person, a group of people, an occasion, or a product, and it is expressed as a carbon dioxide equivalent (CO_2e). By measuring a product's carbon footprint, one may determine the overall quantity of greenhouse gas emissions that it produces during its entire life cycle, from the production of the raw materials used in manufacturing it through the disposal of the finished product (excluding in-use emissions).The generalized formula to calculate CFP can be given as,

$$E = Q \times E.F.$$

Where; E= emissions from the emissions source in kg CO_2-e per year

Q = activity data

E.F. = emission factor

In order to find solutions to lessen a company's impact on global warming and to learn about the possibilities for energy savings, calculating its carbon footprint is a critical first step. Additionally, it might result in long-term financial gain and lessen the impact of climate change. Additionally, customers are showing an increasing amount of interest in openness on the environmental effects of the companies and products they use. The idea of a recognizable label to show that the items have been manufactured with a commitment to assessing and reducing their carbon impact is supported by consumers. Therefore, firms can increase consumer satisfaction and create a favorable brand image by estimating carbon footprint and publicly releasing CFP specifics of their products.

Many governments are taking action to lower GHG emissions through national policies that include the implementation of emissions trading schemes, voluntary initiatives, carbon or energy taxes, rules and standards on energy efficiency and emissions, among other things. In order to maintain long-term success in a cutthroat business environment and to be ready for future national or regional climate legislation, businesses must be able to comprehend and manage their GHG risks. The Indian government promised to fully support carbon footprint reduction plans at the 2009 Copenhagen climate change summit. Also at the COP26 Summit in Glasgow, besides governments, many businesses pledged to go carbon-free in the coming years. Reliance Industries, one of the top exporters of software services from India, stated that it will become carbon-free by 2030. TCS, the country's second-largest exporter of software services, promises to cut greenhouse gas emissions by 2025. By 2030, Indian Railways also aspires to have the first carbon-free rail system in the entire globe.

1.2 Carbon Footprint Reduction

What is carbon neutrality?

To be carbon neutral, one must strike a balance between generating carbon and absorbing it in carbon sinks. Carbon sequestration is the process of removing carbon dioxide from the atmosphere and storing it later. All global greenhouse gas (GHG) emissions must be offset by carbon sequestration in order to reach net zero emissions. To offset emissions from one sector with emissions from another is another strategy to cut emissions and work toward carbon neutrality. This can be accomplished by making investments in clean, low-carbon technologies such as renewable energy, energy efficiency, and others.

The term "net zero" is increasingly used to denote a broader and more thorough commitment to decarbonization and climate action, moving beyond carbon neutrality by including more activities under the scope of indirect emissions and frequently including a science-based target on emissions reduction rather than relying only on offsetting. Some climate scientists claim that the idea of net zero "has authorized a recklessly careless "burn now, pay later" strategy that has seen carbon emissions continue to rise." We can lessen our carbon footprint and transition to a low-carbon economy by switching to energy sources and industrial activities that produce fewer greenhouse emissions. Greenhouse gas emissions are decreased by using more nuclear power and renewable energy sources like solar, wind, and geothermal energy. Carbon emissions are produced during the production of energy from both renewable and non-renewable sources, although these emissions are extremely low or nonexistent when it comes to renewable sources.

The following steps are typically followed to attain carbon neutrality, though they may differ depending on who is implementing the strategy: individuals, businesses, organizations, cities, regions, or nations.

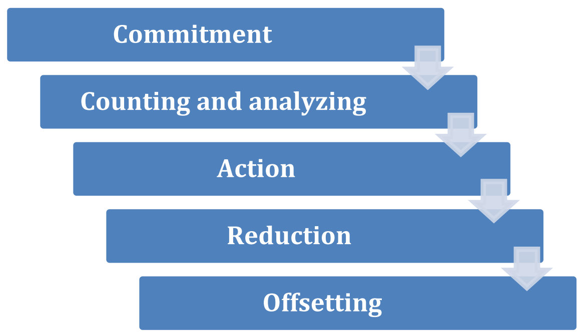

Fig -1: Steps to achieve carbon neutrality

2. CARBON FOOTPRINT ASSESSMENT

According to a review of recent literature on carbon footprint studies, it is first important to decide if the CFP assessment is to be carried out for a single product or a certain organization in order to measure carbon footprint. The notion of life cycle assessment provides the foundation for calculating a product or organization's carbon footprint. A widely used method for calculating the environmental effects of items or processes is life cycle assessment (LCA). LCA is a method for addressing environmental issues and potential environmental impacts across a product's life cycle, from raw material acquisition to manufacture, consumption, end-of-life treatment, recycling, and final disposal, according to the definition given by ISO 14044. (i.e. cradle-to-grave).Determining the scope of the system to be examined, or which activities should be included in the assessment, is a significant difficulty in carbon footprint estimation (as in LCA generally). Numerous options are available, some more pertinent than others depending on the nature of the study and the question(s) it is intended to address.

The carbon footprint assessment for "Baldev Textile Mills Pvt. Ltd.," Hatkanangale, is done in this study. It is situated in Hatkanangale, India, at Laxmi Sahakari Audyoik Vasahat. This textile business uses cutting-edge infrastructure to produce shirting from yarn-dyed textiles. The industry's carbon footprint is evaluated for the period 2019–20 utilizing the four stages below.

2.1 Study area:

In this study, the carbon footprint assessment is done for “Baldev Textile Mills Pvt. Ltd.”, Hatkanangale. It is located at LaxmiSahakariAudyoikVasahat at Hatkanangale. Plot No. II/D/24, Shri LaxmiSahakariAudyogikVasahat Limited, Hatkanangale, Shri Laxmi Co-op. Industrial Estate, Maharashtra 416118.

Observations during visit to study area:

- Industry name: Baldev Textile Mills Private Limited
- Address: H No 5975, Gat A1/1A - 3 Laxmi Process Rd, B/h M.S.E.B Ichalkaranji, 416115, India

- Sector: Consumer Discretionary
- Industry category: Consumer Discretionary Products
- Sub-industry: Apparel& Textile Products
- Incorporated: 05/25/2005
- No. of employees (2019-20): 152
- Website: www.baldevgroup.com

This textile company is engaged in manufacturing of textile yarn dyed shirting with state-of-the-art infrastructure. It manufactures export quality fabrics and garments. The company policy includes quality production as well as sustainable development considering environmental impacts. The industry itself is interested and supports the idea of reduction of carbon footprint. It is a textile company who engaged in manufacturing of textiles yarn dyed shirting with state-of-the- art infrastructure. It all began when a group of three masters from different fields of textiles came together with a vision and entrepreneur with proficiency in every sphere of textiles. Mr. Hari Shankar Panchloriya, Mr. LaxmikantPurohit and Mr. Subhash Kumar Sonthalia brought together with them 35 years of experience in yarns, fabrics, processing, wholesaling and retailing and gave birth to a company named Baldev Textile Mills Pvt. Ltd. Earlier the company was selling the grey fabric in the market decided to come into finished product and the quality of the ultimate product lead the organization to brand it as "TEXIDORIA" which means fabric with value of gold.

The company in its statement states that they are committed to customer satisfaction along with improvement in the environment & quality through system & process reliability, employees' involvement &training and targets & objectives monitoring.

Following are the stages of processing units in the industry.

i. First process is to take yarn inward. In this process, raw material i.e. grey yarn or died yarn is taken for further processing.
ii. After this the next process is direct warping or beam warping. The object of this process is to prepare a compact beam with predetermined number of ends and length. The output of this process is warping beam.
iii. After warping, next process is sizing. The object of sizing is to prepare compact beam with chemical (size paste) application to improve strength of yarn with predetermined number of ends and length.
NOTE: To prepare the sized beam, we apply size paste on the warp sheet and after application of paste the warp sheet is immediately dried. For drying, steam is used which is taken from the boiler. The fuel for the boiler is coal. The output of this process is known as sized beam.
iv. The sized beam is now ready for the next process known as weaving. The object of weaving process is to prepare the fabric on the weaving machine (Rapier & Air-jet looms). Then finally the grey fabric is produced i.e. the output of weaving process.
v. Then this grey fabric is then taken to next process i.e. for processing. The object of this process is bleaching or dying the fabric according to requirement. The output of this is finished fabric. Then this finished fabric is provided in local market as per requirement.

2.2 Establishment of the organizational boundary

As a first step in establishing organizational boundaries, a suitable method for comprehending GHG emissions should be chosen. The chosen strategy should then be consistently used to describe all organizational procedures and operations with a view to recording and disclosing GHG emissions. The organizational boundary is established in this study and includes emission sources as well as administrative, development, and service unit activities. In other words, emission sources that are physically a part of the industry are taken into account. Regardless of the strategy employed, the organizational boundary is the same because this industry owns all operations.

2.3 Establishment of the operational boundary

The operational boundary should be established after the organizational boundary has been evaluated. In order to do this, emissions connected to company operations must be identified and divided into direct and indirect emissions. To better define direct and indirect emission sources, increase transparency, and be useful to many organizations and climate policies, GHG emission from various operations will be divided into three "scopes" (scope 1, scope 2, and scope 3).

Scope 1 comprises direct GHG emissions that came from sources that the company owns or controls. Operations falling under scope 1 in this study will be the direct emissions resulting from actions taking place inside the actual boundaries of the textile industry.

GHG emissions from the generation of purchased power used by the organization are included in scope 2 emissions.

Scope 3 emissions result from company operations but come from sources that the company does not own or control. Water use and employee commutes will be covered by scope 3 of this study.

2.4 Data collection

Data collection is an essential component of LCA. The majority of the data will be primary data, which will be gathered from chosen units via interviews, observations, business documents, etc. All actions occurring inside the specified borders will have their activity data recorded for a year. The table below lists the parameters and pertinent sources of the activity data.

Table -1: Parameters and sources of activity data used to calculate CFP

Aspects	Parameters of activity data	Source
Electricity – on site	Electricity consumption Annually (kWh)	Electricity bills
Fuel	Coal consumption (tons)	Purchase bills
LPG –on site	LPG consumption Annually (kg)	Purchase bills
Generator – on site	Fuel consumption annually (l)	Running chart
Employee commuting	Distance travelled annually (km) Average fuel efficiency of Vehicles(l) Type of vehicle No. of days per week travelled No. of weeks per year worked in the office Type of fuel Average No. of persons per vehicle	Questionnaire
Waste generation	Amount of waste generation annually (kg)	Personal communication
Water consumption	Water consumption annually (m3)	Water bills

Activity data are collected from all activities within the defined boundaries for one-year period 2019-20. Specially, commuting data were collected from all employees (152 persons) of the industry as well. Parameters and values of the activity data related to each and every operation are presented in following tables.

Table 2: Annual electricity consumption

Sr. No.	Month	Electricity consumed(kWh)
1	January	574845
2	February	487260
3	March	475930
4	April	493500
5	May	567420
6	June	646320
7	July	347355
8	August	791490
9	September	475170
10	October	519090
11	November	500805
12	December	779160

Table 3: Annual coal consumption

Sr. No.	Month	Coal consumed(Tons)
1	January	103
2	February	152
3	March	82
4	April	145
5	May	154
6	June	165
7	July	161
8	August	119
9	September	114
10	October	102
11	November	104
12	December	157

Table 4: Annual LPG consumption

Sr. No.	Month	LPG consumed(kg)
1	January	56.8
2	February	56.8
3	March	56.8
4	April	56.8
5	May	56.8
6	June	56.8
7	July	56.8
8	August	71
9	September	71
10	October	56.8
11	November	56.8
12	December	71

Table 5: Annual diesel consumption

Sr. No.	Month	Diesel consumed(L)
1	January	1500
2	February	1400
3	March	1600
4	April	1000
5	May	1600
6	June	1400
7	July	1550
8	August	1400
9	September	1600
10	October	1400
11	November	1400
12	December	1650

Table 6: Annualpetrol consumption

Sr. No.	Month	Petrol consumed(L)
1	January	4427.04
2	February	4427.04
3	March	4427.04
4	April	4427.04
5	May	4427.04
6	June	4427.04
7	July	4427.04
8	August	4427.04
9	September	4427.04
10	October	4427.04
11	November	4427.04
12	December	4427.04

Table 7: Annual water consumption

Sr. No.	Month	Water consumed (m^3)
1	January	981.600
2	February	422.200
3	March	1082.700
4	April	976.200
5	May	513.600
6	June	1327.400
7	July	588.800
8	August	641.500
9	September	1740.700
10	October	22.700
11	November	1331.300
12	December	101.500

Annual waste generation:

According to guidelines of Ministry of Housing and Urban Affairs per capita waste generation varies between 0.2 Kg to 0.6 Kg per day. By communicating with operating manager of Baldev Textile Mills, it has been noted that waste generation from manufacturing, operating and other units in the industry is about 2500 to 3000 kg per month. That means the industry generates 30 to 36 tons per year. The composition of MSW generated in the industry is shown below.

Table 8: Annual waste generation

Sr. No.	Category of waste	Amount (%)
1	Waste yarn material	12.83
2	Food waste	28.59
3	Paper waste	22.50
4	Plastic waste	16.20
5	Garden waste	11.20
6	Hazardous and other waste	8.68

Along with solid waste generation, the industry generates waste water from its fabric manufacturing process. The industry has an effluent treatment plant of capacity 10 MLD within its physical boundaries to treat the effluent generated in industry.

2.5 Calculating the CFP

As a result of multiplying activity data by the emission factor, the CFP of each emission source and activity will be determined in kgCO2e/year (EF). These ratios, which relate GHG emissions to a fictitious indicator of activity at an emissions source, have been calculated. A hierarchy of computation methods and procedures, ranging from the use of general emission factors to direct monitoring, is mentioned in the IPCC guidelines (IPCC, 1996). An emission factor, which relates the amount or quantity of a pollutant released into the atmosphere with an associated activity for that pollutant release, is provided as a representative value. Based on the chosen boundaries of the life cycle of a product, emission factors must be investigated and verified for each component and activity connected with the various phases of the life cycle of a product.

3. RESULTS:

In order to understand the carbon footprint of textile industry of one year period, calculations were done by considering relevant emission factor from IPCC guidelines. The scope based carbon footprint assessment values of year 2019-20 of Baldev Textile Mills Private Limited is given below.

Table 9: Calculation CFP of textile industry

Scope	**Activity**	**Emission factor**	**CFP**(kgCO2e/year)	**% CFP**
Scope 1 (Direct emissions)	LPG usage	2.987	2163.185	1.9271
	Coal consumption	6.552	10208.02	
	Diesel consumption	2.738	42155	
	Waste disposal	0.770	5005	
Scope 2	Electricity	0.4368	2908365	94.15045
Scope 3	Commuting	2.243	119158.2	3.925813
	Water usage	0.1871	2006.778	

The CFP under scope 1, 2 and 3 are 1.9271 %, 94.15045 % and 3.925813% respectively as shown in Table 9. In this study scope 2 that is purchased electricity consumption showed highest CFP which is 94.15%. The highest CFP value for scope 3 is arisen due to the complex nature of activities performed by different types of organizations and the varying scales in which they operate.

Except transportation and electricity, all other activities show less contribution for total CFP of the industry. Carbon footprint of food waste accounts 0.77% and water usage accounts 0.19% of the total (Table 9) by representing the lowest impact of this organization.

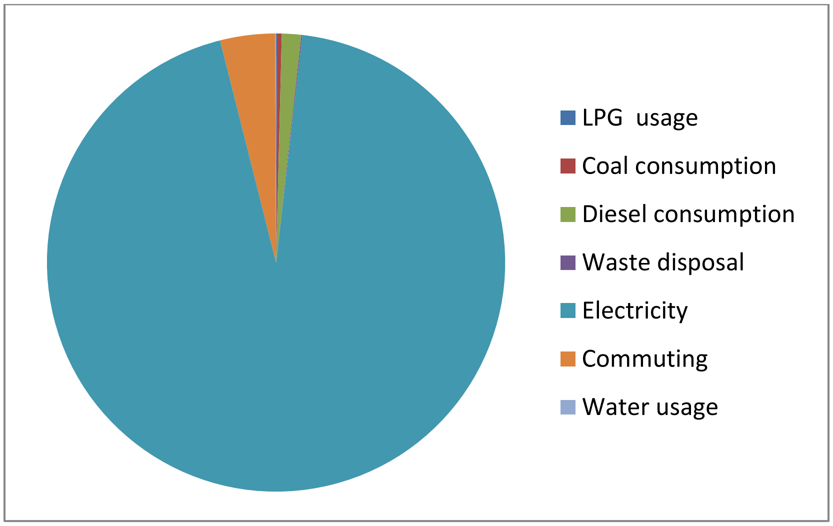

Fig 5.1: Carbon footprint of industrial activities

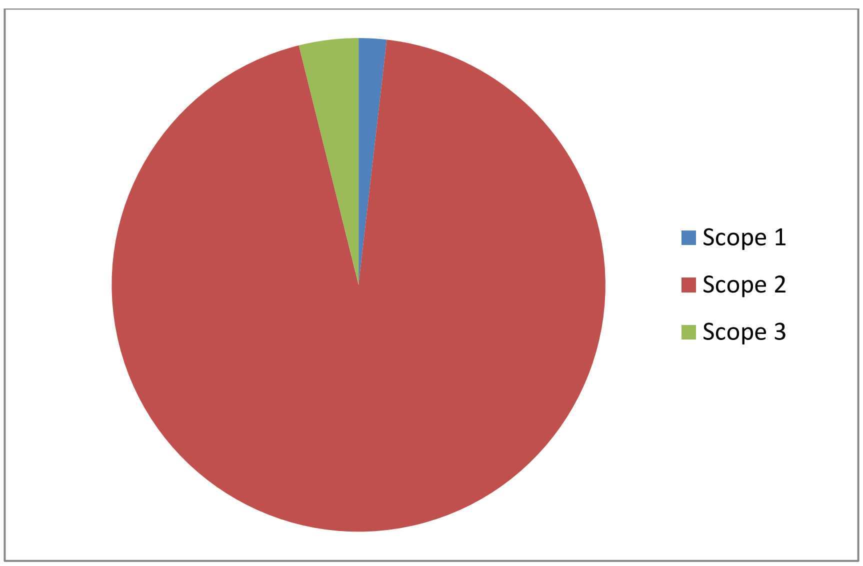

Fig 5.2: Scope based carbon footprint assessment

4. CONCLUSIONS:

1) In this project study, carbon footprint assessment for Baldev Textile Mills Pvt. Ltd. Was done for one-year period (2019-20) in three scopes. The carbon footprint study was done by establishing organizational and operational boundaries to the industry.

2) The carbon footprint the industry under scope 1, 2 and 3 are 1.9271 %, 94.15045 % and 3.925813% respectively.

3) The scope based carbon footprint study shows maximum CFP is from electricity consumption which is 94.12 %. To reduce electricity consumption, the industry should install solar panels of sufficient supply.

4) Except transportation and electricity, all other activities show less contribution for total CFP of the industry.

5) Since scope 3 (indirect emissions) showed the highest CFP, knowledge of this carbon footprints may assist industries to pursue emissions mitigation projects not just within the organization but also across indirect emission activities

6) The industry management and employees should be provided proper energy management training for sustainable development to implement a better Environmental Management System.

7) By implementing better Environmental Management System in industry and training to employees, industry can achieve goal of carbon neutrality.

Remedial measures for CFP reduction:

There are certain ways to reduce greenhouse gas emissions from the industrial sector, including energy efficiency, fuel switching, combined heat and power, use of renewable energy, and the more efficient use and recycling of materials. Once you know where you are using or possibly wasting energy, you can tighten up and become more efficient. Reducing unnecessary energy inefficiencies is a vital step to minimizing industrial carbon footprint. Small changes such as switching lights off, turning off computers when they're not required and figuring out which machines need to be on standby and which can be switched off, can all contribute to the cause.

By studying the emission sources and carbon footprint data of Baldev Textile Mills Pvt. Limited, following remedial measures are suggested.

1. To reduce carbon footprint generated by electricity consumption in industry, solar energy as renewable source can be used. Solar PV installations can be combined to provide electricity on a commercial scale, or arranged in smaller configurations for mini-grids or personal use. Using solar PV to power mini-grids is an excellent way to bring electricity access to people who do not live near power transmission lines, particularly in developing countries with excellent solar energy resources.

2. To reduce carbon footprint generated by petrol consumption for commuting, the industry can provide its own transportation facility like office bus, share cars, etc. to their employees. Public transportation should be promoted. A cycle-to-work scheme could be a great incentive for someone to jump on their bike instead of getting in the car. This could have a positive impact on both the environment and their well-being. Another idea can be introducing a carpooling scheme, which is often welcomed by employees too.

3. To reduce carbon footprint by LPG consumption, biogas plant can be installed within the industry premises. Food waste generated from canteen and other organic biodegradable waste can be used as raw material for biogas generation.

4. The high heating values of prepared bio-coals from the representative biomass are within 25.4 to 28.2 MJ kg^{-1}, which are comparable to that of the commercial coals. Life cycle assessment further shows that the bio-coal production process could achieve net positive energy, financial, and environmental benefits.

5. Also industry can implement a better waste management plan for solid waste management. The most effective methods of industrial waste management are ones that aim to reduce, reuse, and recycle when possible, and that are guaranteed to cause no harm to the environment. Recycling and waste-to-energy options should also be practiced. It should be ensured to have a proper recycling system in place, and that people use it. Have it in all aspects of the business, so the huge packaging from the large-scale machinery and the paper from the office have somewhere to be recycled. The first step is always to try and minimize waste, but when that's not possible, think to recycle or reuse.

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