Life Cycle Initiative

FICCI

India LCA Directory

September 2014

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Photographs have been submitted by the case study contributors

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Abbreviations

AIGMF	All India Glass Manufacturers' Federation
CPSE	Central Public Sector Enterprises
CSR	Corporate Social Responsibility
DAP	Di ammonium phosphate
DEG	Di-Ethylene Glycol
DPE	Department of Public Enterprises
EO	Ethylene Oxide
EOD	Ethylene Oxide Derivative
FICCI	Federation of Indian Chambers of Commerce and Industry
GHG	Greenhouse Gas
GRIHA	Green Rating for Integrated Habitat Assessment
HDPE	High-density polyethylene
HVAC	Heating, Ventilation, and Air conditioning
IICA	Indian Institute of Corporate Affairs
ILCD	International Reference Life Cycle Data System
ILCM	Indian Conference on Life Cycle Management
ISLCA	Indian Society for Life Cycle Assessment
LCA/M	Life Cycle Assessment & Management
LCI	Life Cycle Inventory

Abbreviations

LCIA	Life Cycle Impact Assessment
LD	Low Density
LDPE	Low-density polyethylene
LEED	Leadership in Energy and Environmental Design
LLDPE	Linear low-density polyethylene
MEG	Mono Ethylene Glycol
MoEF&CC	Ministry of Environment, Forests and Climate Change
NPK	Nitrogen Phosphate Potassium
NVG	National Voluntary Guidelines
PEG	Polyethylene Glycol
SEBI	Securities and Exchange Board of India
SFI	Sustainable Forestry Initiative
TC	Tissue Culture
TEG	Triethylene Glycol

Foreword

Life Cycle Management (LCM) is among the new business approaches that organizations can use to counter the adverse impacts along with, and not at the cost of, business growth and performance.

India LCA Directory is a first-of-its-kind initiative in India to compile the Life Cycle Assessment/Management (LCA/M) work being done by academia, researchers and companies in the country. The overall objective of the Directory is to provide a general idea on the work being done in India on LCA/M and how the companies are striving to create a sustainable value chain. It will act as a reference book demonstrating the experience gained from the application of Life Cycle based tools and approaches for sustainability. The examples have been submitted by the organizations and individuals working in this domain. The referenced tools in these case studies may relate to environmental 'footprint' assessments, such as Carbon, Water Footprints as well as Life Cycle oriented tools for assessing and managing other dimensions of sustainability.

Dr. Sanjeevan Bajaj
CEO-FICCI Quality Forum

Need for India LCA Directory

I

Need for India LCA Directory

Who should read it?

LCA Directory will become useful resource for environmentally progressive manufacturers and suppliers, product and process designers, executives and managers, and government officials who want to learn about the application of life cycle based approaches. This will serve as an easy reference for anyone who is interested in getting first-hand information on the work that has been done so far in India. This book will appeal to practitioners from a wide range of disciplines working on Life Cycle based tools/approaches in industry, government, consultants, who are interested in learning more about LCA.

What does it cover?

This document provides an overview of LCA studies and LCM practices in various organizations. It covers a crude overview of real time examples submitted by various companies who have adopted life cycle thinking in their operations. This Directory is an attempt to showcase the work being done in India and corroborate that LCA is not just a scientific concept or research subject but also used and implemented in businesses. The reference studies for this Directory have been sourced in following manner:

1. Case studies submitted by companies
2. Abstracts received for Indian Conference on Life Cycle Management (ILCM)
3. Studies/research work available in public domain/knowledge
4. Policies and guidelines recommending use of Life Cycle Approaches
5. List of organisations following/interested in Life Cycle Thinking in India

Editor's Note II

Editor's Note

A call for case studies was launched widely for inviting various organizations to submit their work on LCA/M. While inviting case studies, contributors were requested to submit their work reflecting a true and fair view of the project. The contributors were also asked for a formal consent stating no objection to the case studies being published in the public domain on print and electronic media by FICCI. Six case studies were received through the open call which may not be fully representative of all the LCA related work.

In addition to the above, the abstracts received for Indian Conference on Life Cycle Management (ILCM 2012 & 2013) were also included in this Directory.

Introduction to the Concept

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Introduction to the Concept

Accelerating growth and sustainable development, along with food and energy security are amongst the most crucial challenges in the world today. While addressing sustainability issues, industry can also identify opportunities to strengthen their decisions, reduce risks and expand profitability. The impact of products' environmental footprints and the need to lower the environmental risks are critical issues for businesses today.

More and more institutional and individual consumers want to understand cosmos of the products they buy. They demand answers to their questions on products, covering the 3Ps of sustainability: People, Planet and Profit. Ongoing discussions at international level unanimously agree that systematic management of product and material life cycles can accelerate the shift towards more sustainable patterns of consumption and production.

Applying Life Cycle Thinking to the pillars of sustainability offers a way of incorporating sustainable development in decision-making processes. Life Cycle Thinking also means taking account of environmental, social and economic impacts of a product over its entire life cycle (from raw material extraction through materials processing, manufacturing, distribution, use, repair and maintenance, and disposal or recycling) and value chain. Life Cycle Management (LCM) is among the new business approaches that organizations can use to counter the adverse impacts along with, and not at the cost of, business growth and performance. Life Cycle Assessment (LCA) and its use in product design and supply chain management is becoming a matter of prime concern for organizations' business strategies. Organizations can apply LCA results to product development, strategic planning, marketing and influencing public policy. LCA can help in deployment of funds allocated towards sustainable development measures. Organizations who succeed in integrating LCA with existing decision-making frameworks can achieve smarter sustainability.

Case Studies IV

Case Studies

The following case studies are included in this Directory:

Table 1: Case Studies authenticated by implementing organizations

S.No.	Case Study	Organization	Source
1.	Sustainability in 3M	3M India	Response to open call for case studies
2.	Sustainability in Infosys	Infosys	Response to open call for case studies
3.	Emission hotspot identification in coke ovens using life cycle assessment	TATA Steel	Response to open call for case studies
4.	Life Cycle Management in India Glycols	India Glycols Limited	Response to open call for case studies
5.	Life Cycle Approach in Jain Irrigation Systems Limited	Jain Irrigation Systems Limited	Response to open call for case studies
6.	A Comparative LCA on Multilayer PE Packaging Films	SABIC	Abstract

Table 2: Case Studies presented at ILCM, organized by FICCI

S.No.	Case Study	Organization	Source
7.	LCA of an Automobile Component by Tata Motors Limited	TATA Motors Limited	Abstract
8.	LCA of biotechnological solution to improve productivity in shrimp farming	Novozymes South Asia Pvt Limited	Abstract
9.	Life Cycle Assessment – A Case Study of Fertilizer Manufacturing	Tata Chemicals Limited	Abstract
10.	Sustainable management of water resources through effective water monitoring and impact analysis of community water in Bundelkhand	Rio Tinto	Abstract
11.	LCA and Sustainable Construction Industry	National Council for Cement and Building Materials	Abstract
12.	Comparative LCA of Road Paving Technologies in India: A Case study of NH-4	Central Road Research Institute	Abstract
13.	Indian container glass industry - Life Cycle Analysis	All India Glass Manufacture's Federation	Abstract
14.	Sustainability assessment of tannery waste management using Life Cycle Assessment	Central Leather Research Institute & PERI Institute of Technology	Abstract

S.No.	Case Study	Organization	Source
15.	Ronozyme® Phytase – an environmentally friendly alternative to inorganic phosphorous in pig and poultry feed	Novozymes South Asia Private Limited, India & Novozymes A/S, Denmark	Abstract

Table 3: Case Studies submitted by Authors

S.No.	Case Study	Organization	Source
1.	Restricted Life Cycle Assessment for the Use of Liquefied Petroleum Gas and Kerosene as Cooking Fuels in India	Technical University Berlin	Scientific paper received in response to open call for case studies

1. Sustainability in 3M

Organization: 3M India

Environmental sustainability is included in 3M's strategies. There are business processes for life cycle management of products and to identify new products and market opportunities, as well as ways to reduce the impacts of their products. LCM is an integral part of 3M's product introduction process worldwide.

3M's Life Cycle Approach

At 3M, LCM is a process for identifying and managing the environmental, health, safety, and regulatory (EHS&R) impacts and efficient use of resources in 3M products throughout their life cycle to guide responsible design, development, manufacturing, use and disposal. 3M's LCM Policy requires all new products to undergo LCM review prior to introduction and that existing products must receive LCM reviews on a prioritized basis. LCM is globally integrated in 3M's New Product Introduction System. LCM process includes expert evaluations and studies, wherever appropriate. It considers all potential impacts, risks, advantages and opportunities including: 3M lab, manufacturing, logistics, customer use, regulatory compliance including intended markets and geographies, end of life, and EHS&R claims.

Life Cycle Management Examples in 3M

Below are the recent innovative environmental, health, and safety product solutions that exemplify sustainability attributes, including:

- The launch of the Post-it® Greener Notes. These notes are made from 100 percent recycled paper (30 percent post consumer content) and are manufactured with a plant-based adhesive, which is made from plants that are replenished after harvesting. And like all Post-it® Notes, they are

SFI Chain of Custody Certified where the paper used comes from forests that are well-managed where trees are replanted and they are recyclable.

- A line of automotive aftermarket products, including 3M™ Engine Oil Flush, formulated with fewer volatile organic compounds.

Figure 1: Post-it Greener Notes: a 3M Product

Figure 2: 3M™ Engine Oil Flush

- 3M™ Synthetic Resin Adhesive: a wood adhesive that is free of phthalates (chemicals used as “plasticizers”).

Figure 3: 3M™ Synthetic Resin Adhesive

2. Emission hotspot identification in coke ovens using Life Cycle Assessment

Organization: TATA Steel

Responsible practices and procedures ensure that all aspects of Tata Steel's business is conducted with the utmost respect for the environment. Tata Steel is committed to playing an active and constructive role in addressing climate change – both by reducing its own Carbon Footprint and by creating high-performance steels that will make it possible to produce lighter, more fuel-efficient vehicles and energy-efficient buildings. Having already halved the amount of energy needed to make a tonne of steel over the last 40 years, Tata Steel has set itself a target of reducing CO_2 emissions by a further 20% within the next decade.

Sustainability in TATA Steel

A process LCA (gate-to-gate approach) can be dynamically used to evaluate the environmental performance of a process chain. In the present study, a process LCA has been applied to identify the emission hotspots in the coke ovens at Tata Steel's Jamshedpur works. The coke ovens has been divided into a process chain comprising of coal handling unit, battery, coke handling unit and by-products plant. LCA model with these processes was built in GaBi and life cycle balances were performed. Emission hotspots were identified and specific recommendations were suggested.

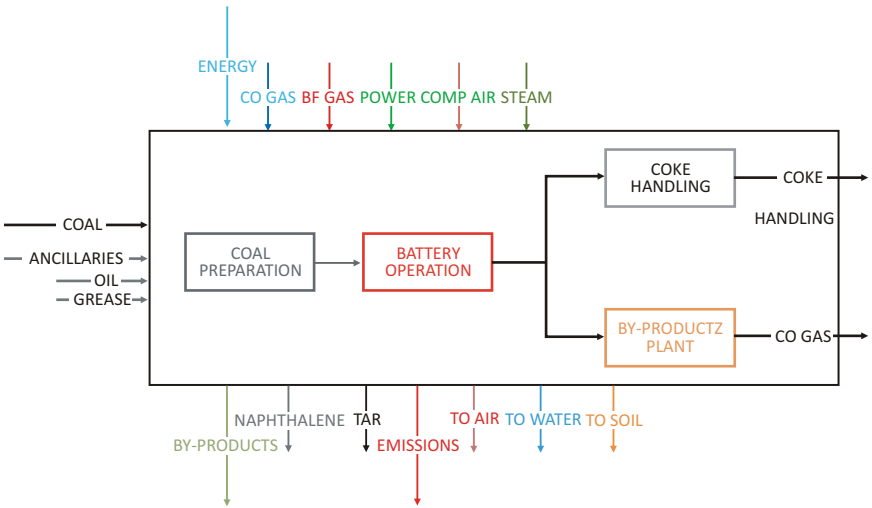
Work & Methodology

The objective of the study is to identify emission hotspots in the coke ovens at Tata Steel, Jamshedpur. A gate to gate LCA was applied to achieve this objective. The entire coke plant was divided into 4 process categories; coal handling,

battery operations, by-products plant and coke handling. Further, the battery operations process comprised of 3 batteries; battery B1, B2 & B3.

These batteries were associated with one coal and coke handling unit each. However, there is only 1 by-products plant for all the batteries. A Life Cycle Assessment model with these 4 processes was developed in GaBi 4. It calculates different types of balances and helps in analyzing and interpreting the results. Impact categories, which are used to classify and characterize the environment, are selected based on the goal and scope of the study.

Figure 4: Flow diagram show the system boundary for a coke plant



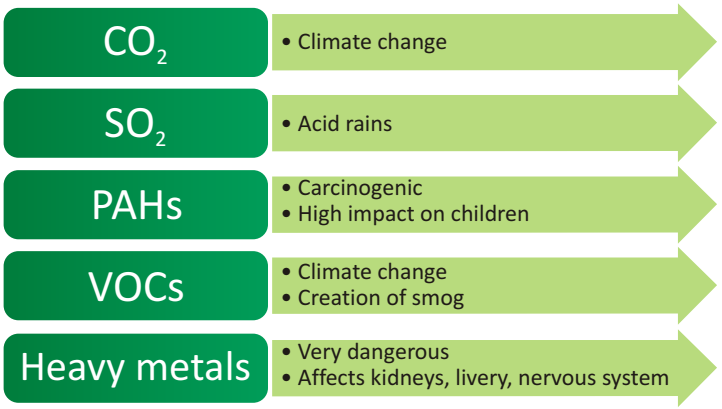
Result

The battery operations process was found to be the one with higher environmental impact as compared to the other 3 processes. Among the

batteries, battery B1 has the highest total acidification potential and also the highest acidification potential per ton of coke produced followed by batteries B2 and B3. Battery B3 has the highest total global warming potential.

However, Battery B1 has a higher global warming potential per ton of coke produced as compared to batteries B2 & B3. Battery B2 has the highest human toxicity potential among all the batteries.

Figure 5: Environmental impact categories considered for the study



The study measures the environmental impacts, does internal benchmarking and identifies the enablers which will help reduce the emissions. Based on these results an internal benchmarking exercise was carried out to improve the coke plant performance.

Figure 6: Acidification potential in the coke plant processes

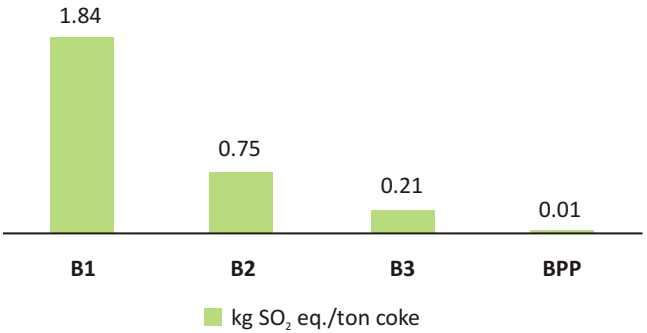


Figure 7: Global warming potential in the coke plant processes

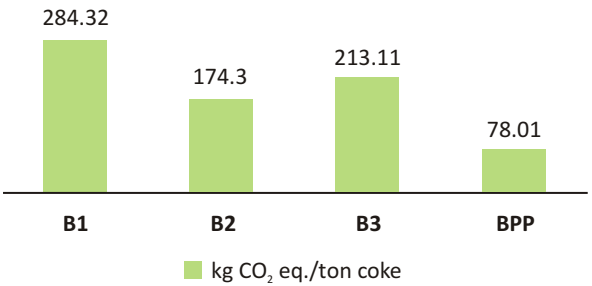


Figure 8: Human toxicity potential in the coke plant processes

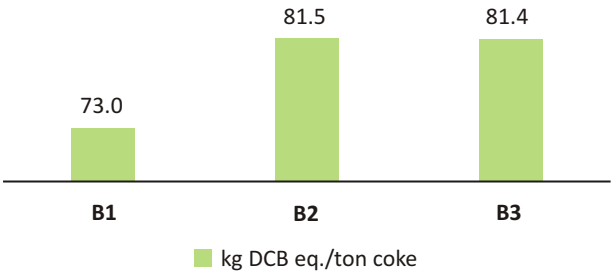
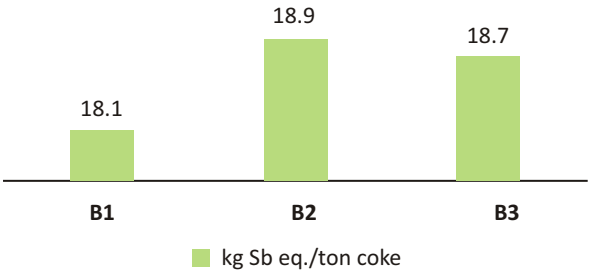


Figure 9: Abiotic depletion potential in the coke plant processes



Conclusion

Higher acidification potential per ton of coke produced is an indication of comparatively higher sulphur and nitrogen oxides emission. The coke ovens at Jamshedpur uses 3 different gases for under-firing namely; coke oven gas, blast furnace gas and LD gas. The coke oven gas used for under-firing in the batteries was found to be the source of sulphur oxides whereas the nitrogen oxides emission could be from numerous sources which need to be ascertained. The higher total global warming potential in battery B3 is due to the use of blast furnace and LD gas in under-firing. The global warming potential per ton of coke produced is highest for battery B1 though. The cross leakages from the battery walls are responsible for this. These conclusions can be used to prioritize the abatement strategy for the diverse range of pollutants. An environmental appraisal based on these findings can be carried out to identify causes for the emission hotspots. Also, Life Cycle Inventory developed in this study can be used in future LCAs.

3. Life Cycle Management in India Glycols Limited

Organization: India Glycols Limited

India Glycols Limited (IGL) holds the distinction of being the only green petrochemical company of its kind. It is the first and only company in the world to have commercialised the production of ethylene oxide, its derivatives and glycols from renewable agricultural resources, namely molasses. India Glycols has set up its ethylene glycol plant in technical collaboration with Scientific Design Inc, USA. The plant produces three derivatives of Ethylene Glycols — Monoethylene Glycol (MEG), Diethylene Glycol (DEG) and Triethylene Glycol (TEG).

- **Life Cycle Assessment:**

  i. LCA study is carried out for MEG and Ethylene Oxide (EO) of India Glycols Limited. LCA studies for Glycol Ethers, Glycol Ether Acetates, and PEGs and other products are in process

  ii. IGL focuses on improving sustainability, by looking at energy usage, Carbon Footprints and LCA of products

  iii. The methodology of the study is based on ISO 14044: 2006 standard

  iv. Presently 'Life Cycle Assessment' & 'GHG Accounting' of Ethylene oxide derivative (EOD) and downstream products of IGL is in progress

  v. LCA study analysis includes the activities from cradle to gate

  vi. The study addresses the following environmental impact categories:

    - GHG Impacts, Carcinogens, Respirable organics, Respirable Inorganics, Climate Change, Radiation, Ozone Layer, Eco-toxicity, Eutrophication/Acidification, Land Use, Minerals, Fossil Fuels ; and accounting is carried out as per Eco-indicator 99 (H) / Europe

- In this study, we have used hierarchist (h/h) perspective of Eco Indicator-99 as the weights given to human health and ecosystem quality; resources are in line with the importance given to them in India
- IPCC 2007 GWP100a are applied for Global Warming Potential and GHG accounting. The system modelling is performed in SimaPro 7.3.3

- **Life Cycle Management:**

  United Nation Environment Programme selected IGL's LCM project as 1 of the 8 projects selected out of 22 proposals submitted worldwide for 'Life Cycle Management Capability Maturity Model Pilot Project'. The project has been successfully implemented by IGL.

Figure 10: Bio-Ethylene Oxide Derivative Plant, India Glycols

Figure 11: Bio-MEG/Bio-Ethylene Oxide Plant, India Glycols

4. Life Cycle Approach in Jain Irrigation Systems Limited

Organization: Jain Irrigation Systems Limited

The integrated model successfully implemented by Jain Irrigation is an excellent example for mitigating and adapting to the climate change. This model needed a proper understanding with energy and water perspective and thus Life Cycle Approach was adopted. The energy and water consumption in producing banana was monitored and calculated. Each step was important hence, during micro propagation and then on the farm the water and energy were monitored. The comparison with the traditional method of planting and irrigation was also done.

Work & Methodology

The Life Cycle Approach was applied to calculate the impact on environment for producing the banana fruit. For micro propagation (Tissue Culture) of banana plantlet, the water and Carbon Footprint was calculated, considering water and energy required in each stage of the banana sapling. Other than carbon dioxide (energy), rest of the GHG emissions were insignificant. Carbon sequestered by the trees planted in the premises of Tissue Culture Park was also significant in reducing the Carbon Footprint. The water recycled also improved the efficiency and hence over all Water Footprint was minimized.

Figure 12: Banana Plantlet at the stage of dispatches

During the field study at the farmers plot and research plot, comparison was made between drip irrigated banana and conventional banana.

It was found that the water savings is in the tune of 6000 cubic meter per hectare in cropping cycle and energy savings is in the tune of 2.08 MWh per hectare in a cropping cycle. Considering this impact for 5000 ha area, if brought under drip irrigation, micro propagated banana sapling will ensure that savings can be in the tune of 30 million cubic meters and energy savings in the tune of 10,800 MWh and hence the carbon dioxide that can be saved will be in the tune of 8200 tCO_2e. Second part of the LCA study is to understand the environmental effect at initial stage of micro propagation at Jain Irrigation Tissue culture facility.

Figure 13: Fully grown TC Banana ready for harvest

Figure 14: Water Footprint of plantlet

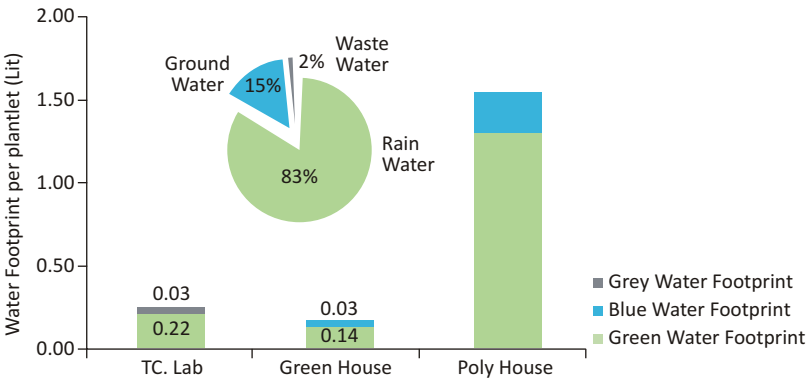


Figure 15: Net GHG emission per banana plantlet

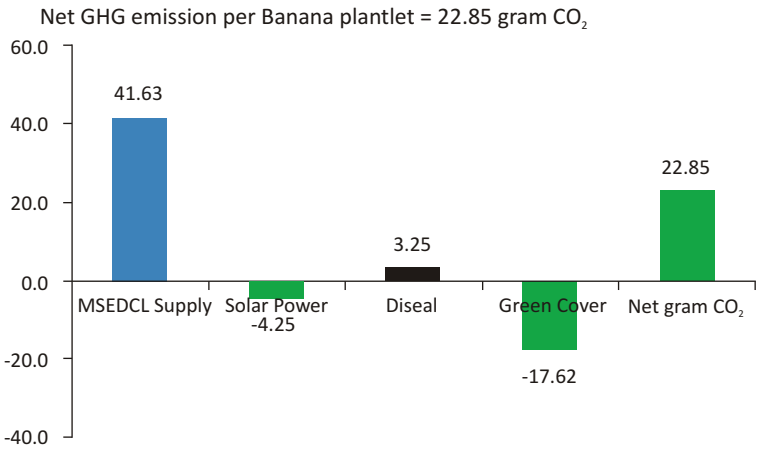


Figure 16: Comparison of Water footprint of banana for drip irrigation and flood irrigation

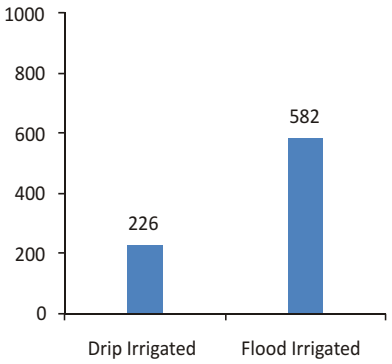
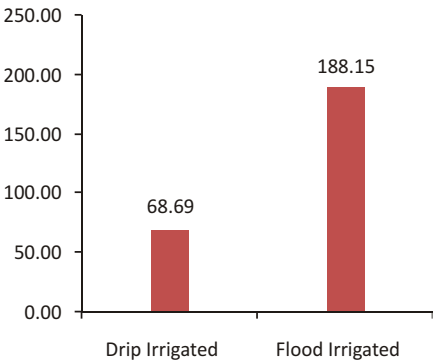


Figure 17: Comparison of Carbon footprint of banana for drip irrigation and flood irrigation



Conclusion

It was found that water used by banana saplings is 1.99 litres in it life cycle up to dispatch of the plantlet to farmers field while in traditional method of planting, farmer has to irrigate the farm and water consumed per sapling is 122 litres which is 60 times more. More area should be brought under drip irrigation and micro-propagated banana plantation in developing and under developed area. This will ensure disease free saplings and uniform growth with assured yield. The drip irrigation will also assure savings in water and energy. This is one of the sustainable agriculture models which can solve a number of problems at the same time.

5. Sustainability in Infosys

Organization: Infosys

In the last five years, Infosys has reduced its per capita energy consumption by 40% and its per capita water consumption by 34%. This has been possible because of the steps that it has taken. Infosys has changed the way buildings are designed and operated. It has built new buildings which consume 66% less energy and 40% less water compared to the older buildings, at no extra capital cost. If not for these initiatives, Infosys would have spent an additional 450 million units of electricity or translating an additional $55 million over last 5 years.

About Green Initiatives

Infosys has taken great strides during the past five years to become sustainable in its operations. The company is working to reduce its per capita electricity consumption by 50 percent from 2007-2008 levels and to source all its electricity needs from renewable resources by the end of 2017. Between 2007 and 2013, Infosys reduced its per capita electricity consumption by 40 percent. The company's per capita water consumption declined by 34 percent and GHG emissions dropped by 15.3 percent during the same period. The company encourages employees to endorse sustainable practices that reduce their daily consumption of resources. Infosys Eco Clubs (employee driven initiative to endorse green practices) are passionate partners in these efforts.

The company is currently applying for more than 4 million square feet of LEED/GRIHA certifications. Our buildings are 50% more efficient than 5 years ago. Data shows that going green makes great economic sense and all it takes to achieve benefits is for businesses to show leadership and to put in the right strategy and efforts. By designing the buildings with day lighting, motion sensor lightings, and by using the most efficient equipment, Infosys has been able to

reduce electricity consumption. Infosys has the first commercially radiant cooled building in India. Various other new innovations such as radiant panels and chilled beams have been utilized. All these technologies have further reduced our energy consumption. HVAC retrofits have resulted in 7.7 MW energy savings.

At Infosys, the focus is on ensuring to sequester more fresh water into the ground than consumption. Water requirement is met from rain water and recycled water. Infosys has setup an extensive network of lakes for rain water harvesting across many campuses. State of the art sewage treatment plants has been set up to recycle and use 100% of this water for flushing, cooling towers, and landscaping, in all the campuses. In the last five years, Infosys has managed to reduce per capita water consumption to 72 L per day from baseline number of 108 L, from 2008 levels.

Infosys is working towards ensuring 100% segregation of waste at source in all the campuses. Organic waste that is generated onsite is treated by composting or biogas plants.

Figure 18: India's first commercially radiant cooled building, Software Development Block-1 in Hyderabad. Infosys has 7 LEED Platinum rated buildings and 2 GRIHA Five Star rated buildings.

6. A Comparative LCA on Multilayer PE Packaging Films

Organization: SABIC

Contribution of packaging to the overall lifecycle impact of a product can be reduced by improving material effectiveness, bringing in operational and supply chain efficiencies, and better end of life management. Therefore, effort needs to be directed towards development and selection of sustainable packaging solution for a particular application.

Work &Methodology

In this work, SABIC conducted lifecycle analysis of polyethylene (PE) multilayer packaging film used for packaging of a set of 6 bottle beverage pack. Key product properties considered for this application are puncture and tear propagation resistance, optical properties and shrink force. Conventional 3 layer packaging film was compared with 5 layer packaging film having better material properties. SABIC has developed a recipe for multilayer PE packaging film which enhances material properties of the film and improves its material effectiveness allowing 22% reduction in film thickness.

7 impact categories were considered for comparison-climate change, ozone depletion, particulate matter/respiratory inorganics, eutrophication-terrestrial, eutrophication-aquatic, photochemical ozone formation, cumulative energy demand. International Reference Life Cycle Data System recommended characterization models were used for these impact categories except cumulative energy demand. The selected models and their characterization factors for the studied impact categories are classified as level I or II by ILCD and recommended for all types of lifecycle based decision support. Plastics Europe Ecoprofiles on LDPE, HDPE, LLDPE resins were used along with reported industry average data on blown film extrusion to build LCA model. European Union 2010 end of life statistics

was used to represent end of life scenario. Both types of multilayer films have similar end of life fate as recyclability of the PE multilayer film is not impacted with increase in number of layers.

SimaPro 7.3.3 was used for building LCA model and conducting impact analysis.

Results

Results from the study show that 22% down gauging of the packaging film results in close to 22% reduction in environmental footprint for all studied impact categories. Sensitivity studies were performed to measure effect of higher recycling rates; increase in 10% recycling rate reduced the lifecycle GHG emissions by 8.9% only. 4 different allocation approaches to recycling were applied to study the effect of allocation approach on packaging film's first life absolute footprint. Cradle to grave lifecycle impacts were smallest when avoided burden allocation approach was applied, followed by 50/50 and open loop. Cut off approach showed highest environmental footprint for PE packaging film.

Conclusion

It was concluded that increase in material effectiveness through product innovations has the maximum impact in reduction of environmental footprint of packaging film.

7. LCA of an Automobile Component by Tata Motors Limited

Organization: TATA Motors Limited

In order to design and develop sustainable automobile products, Tata Motors Limited (TML) has taken up LCA initiative at Engineering Research Centre, Pune. LCA of an automobile is a complex process involving data collection for more than 1000 parts of a car; manufactured in-house and by vendors. Hence, to begin with, TML has carried out LCA of selected automotive components mainly to evaluate major environmental impacts, compare Carbon Footprint with respect to change in material of automotive components and understand challenges in conducting LCA of a complete car. TML is the 1st Indian automobile company to conduct such LCA studies using GaBi-software by PE International.

Work & Methodology

LCA study of an "Air Intake Manifold", a component of a small car was carried out. During its development, it was decided to change the material of component from conventional non-ferrous material to a polymer material. The component is manufactured by a Pune based vendor and supplied to TML manufacturing plant located in Gujarat. It was decided to compare the Carbon Footprint of air intake manifold made in polymer vis-à-vis conventional material, on cradle-to-gate basis. The study has covered data collection related to sourcing of material and associated bought out parts, manufacturing process, testing, packaging and logistics of finished component up to TML manufacturing plant in Gujarat. This data was then processed through LCA software tool and environmental impacts including Carbon Footprint were evaluated and compared.

Conclusion

It was found that overall Carbon Footprint of the component is reduced by 40 % after changing air intake manifold material from non-ferrous to polymer; and offered other opportunities to improve environmental performance in supply chain. It was also observed that data collection is the key challenge in performing car LCA.

8. LCA of biotechnological solution to improve productivity in shrimp farming

Organization: Novozymes South Asia Private Limited

It has been estimated that aquaculture will be the source of 50% food by 2012 (FAO 2010). Therefore, intensive farming has led to another area where attention is required, i.e. the pond conditions and hygiene. The development of new microbial products has opened the door to new possibilities for clean shrimp farming, where microorganisms are used as a supplement to tackle the development of unhygienic conditions in the pond.

Work & Methodology

In this study, 2 different technologies for shrimp production have been compared: conventional efficient shrimp farming & efficient shrimp farming using PondDtox. PondDtox is a newly developed biotechnological product controlling hydrogen sulfide concentration in the pond. This reduces stress on shrimp and leads to higher yield in shrimp production. The purpose of the study was to investigate the environmental implications of applying PondDtox in Asian shrimp farming.

The study was conducted as a LCA following the ISO guidelines 14040 and 14044 where all significant processes from “cradle to grave” are included. The study addresses the following environmental impact categories: Global warming, acidification, eutrophication. Furthermore, fossil energy and agricultural land use are considered as indicators of the most important scarce resources which are affected by a change to PondDtox.

Result

As PondDtox is able to maintain the water quality in the aquaculture ponds, it is observed that the shrimps are healthier which is reflected in their higher yields of 5%-35%. When benefits are calculated per ton of shrimp, the savings are seen in the amount of feed 5%-20% and electricity 5%-25% saved.

9. Life Cycle Assessment – A Case Study of Fertilizer Manufacturing

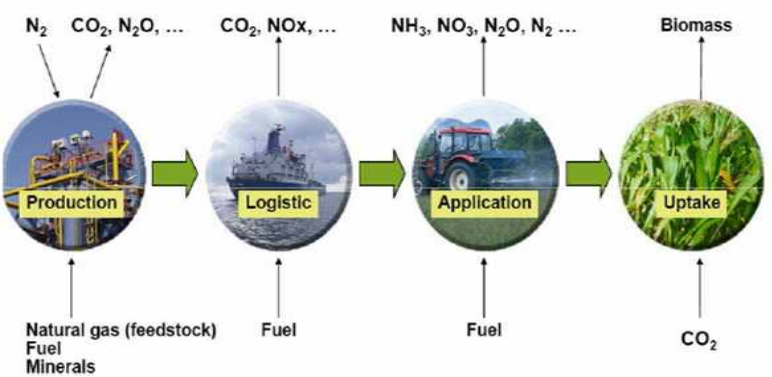
Organization: Tata Chemicals Limited

Fertilizer production, distribution and use embark a large environmental foot print directly or indirectly till end of its useful life. At the same time fertilizers enhance agriculture production to support food security and achieving Millennium Development goal. LCA is an important tool for developing a self environmental portrait of business and evaluating its environmental burdens throughout its value chain. The initial phase of LCA is the collection and calculation of LCI data which quantify the material, energy and emission data associated with a functional system. This stage precedes the LCIA stage which involves classifying, characterization and evaluating these data in relation to ecological impacts. A further possible stage is the interpretation of data and potential for improvement through modification of the functional systems.

Fertilizer business at Tata Chemicals Limited initiated various initiatives to address all possible environmental challenges and risk. These initiatives include implementation of global environmental standards, Carbon Footprint, Water Footprint, Life Cycle Assessment etc.

Life Cycle of Fertilizer Cradle-to-Gate LCA for urea manufacturing and DAP/NPK manufacturing using GaBi software has been completed for various environmental impacts under sustainable manufacturing and agriculture.

Figure 19: Preliminary result of LCA of three kinds of fertilizers



10. Sustainable management of water resources through effective water monitoring and impact analysis of community water in Bundelkhand

Organization: Rio Tinto

Bundelkhand is considered one of the water stressed and drought prone area in central India. From centuries effective water conservation practices have been implemented in this region to meet water demand of communities in the form of ponds and open dug-wells but these water conservation practices are not sufficient to meet community and business demand. Bundelkhand used to receive about 1000 to 1200 mm average rainfall every year which is considered good rain in comparison to Western Australia and Israel. There is a great potential to make area water positive but unavailability of baseline data put forth challenges before water experts and planners to design and harvest the rain water for development of the area.

Work & Methodology

In 2008, the Bunder Project (Rio Tinto) environment team began a series of water monitoring studies to better understand the availability of water in district Chhatarpur, Madhya Pradesh, which was thought to be water deficient. In consultation with local communities studies were conducted to determine water levels and water quality at 250 sites in 15 villages. The environmental team visited each of these sites every month to collect information.

Result

The results of the studies indicated that sufficient water was available for the communities if appropriate water management and water conservation practices were adopted. This information has led to investment in a water drilling campaign supported by the Bunder Project for sustainable development of water supply to local community. Bunder Community team negotiated with community representatives and formed Village Water and Sanitation Committees (VWSC) in villages to manage and maintain developed water resources sustainably.

Conclusion

The results of drilling at different sites have confirmed the availability of sufficient water to meet the demands of community.

11. LCA and Sustainable Construction Industry

Organization: National Council for Cement and Building Materials

The construction industry in India is one of the fastest growing sectors due to the economic development of the nation. Indian construction industry is adopting newer technologies and environmental friendly methods and materials for sustainable construction in the country. LCA is rapidly emerging as a useful environmental management tool worldwide for selection of environmental friendly methodologies and to drive towards sustainability. Also, Green Building movement in India is slowly gaining popularity in Indian construction industry. However, LCA tool in integration with the existing Green Building systems will prove to be much more useful to all the stakeholders.

As LCA study has been carried out first time for Construction industry in India, we do hope that findings in this paper will be useful for various stakeholders of construction industry, who are looking for an environmental solution. A sincere effort has been made to evaluate inputs in terms of building materials, thermal energy, electrical energy & outputs commercial buildings. It is imperative for construction industry to make use of LCA tool in adopting sustainable materials having green supply chain to achieve environmental excellence in a competitive global environment.

12. Comparative LCA of Road Paving Technologies in India: A Case study of NH-4

Organization: Central Road Research Institute

Roads form an integral part of transport and economic infrastructure of a country. In India, the current predominant types of roads are conventional bituminous hot mix while more environment friendly and cost effective technologies have been introduced.

Work & Methodology

This work compares the environmental impacts of Hot Mix, Warm Mix and Concrete Mix technologies by conducting a comparative LCA using Simapro 7.3. A section of NH-4 between Belgaon and Maharashtra border is taken as a case study to conduct a comparative LCA study for each pavement type in Indian conditions. For impact assessment, the tool Eco-indicator 99 is used, which involves categories effect on human health, ecological damage, and bulk resource usage.

Result

It is observed that the Warm mix had a slightly higher impact in the long term, which may be due to the manufacture of synthetic zeolites. Considering all additional categories, it is observed that hot mix and warm mix pavement technologies have more impacts.

Conclusion

Concrete pavements are potentially the better choice as they had lesser overall impact score. However, synthetic zeolites in warm mix can be replaced with natural zeolites for large scale constructions to reduce its effects.

13. Indian container glass industry - Life Cycle Analysis

Organization: All India Glass Manufacturer's Federation (AIGMF)

Glass industries in India are focusing towards sustainability through creating value for all its stakeholders with improved eco-efficiency, environmental efficiency, resource efficiency and social development in an increased manner. Glass industries have given prime importance and advantages to their direct customers and end users by not only creating value through their products and services but also mitigating the environmental impacts of the material during its manufacturing, use as well as disposal phase.

Work & Methodology

Glass is by far the most recycled packaging material and it can be recycled indefinitely without loss of quality or performance. This study deals with the cradle to grave Life Cycle Assessment of container glass in India wherein site-specific data representative of current technology used in India (72% of production volume) were collected for container glass. The total production volume of container glass in India was 2.8 million tonnes. As per the requirement of comparative LCA, study was reviewed and passed through the critical review panel in line with ISO 14040 and ISO 14044 requirements.

Glass recycling is a closed loop system, creating no additional waste or by-products. Recycling glass reduces consumption of raw materials, extends the life of plant equipment, such as furnaces, and saves energy. Returning glass to the glassmaking process makes a great deal of sense in environmental terms, since it saves energy and primary mineral resources, as well as reducing waste and pollution emissions.Reduction of CO_2 emissions in relation to the (reduced)

consumption of raw materials and reduction of NOx, dust and SO_2 emissions in proportional relation to the (reduced) energy input.

Conclusion

The work explains comprehensively the advantages to AIGMF as a result of understanding and assessing the environmental impact of container glass as a product during its life cycle (raw material extraction to recycling). It also evaluated the environmental value creation during the use stage by customers and end-users and its various disposal mechanisms i.e. recycling and landfill.

14. Sustainability assessment of tannery waste management using Life Cycle Assessment

Organization: Central Leather Research Institute
PERI Institute of Technology

In developing countries for control of water pollution from tanneries, the conventional wastewater treatment using primary treatment followed by activated sludge process or open anaerobic or aerobic lagoons are being adopted. These treatment units are energy intensive or generate odorous and green house gases.

Work & Methodology

The main objective of performing this environmental assessment, by means of LCA technique, of different wastewater treatment alternatives is to establish sustainable and energy efficient treatment technologies by lowering global environmental load.

Conclusion

From the LCA studies on environmental impact factor of different wastewater schemes, it is concluded that Upflow Anaerobic Sludge Blanket (UASB) followed by activated sludge process is the best scheme to meet the standards. This LCA based approach must be encouraged for decision makers for selection of appropriate treatment scheme for tannery waste management. In addition, financial aspect has also been considered including the capital and operational cost for different wastewater treatment schemes for selecting sustainable option.

15. Ronozyme® Phytase – an environmentally friendly alternative to inorganic phosphorous in pig and poultry feed

Organization: Novozymes South Asia Private Limited, India
Novozymes A/S, Denmark

RONOZYME® phytases are a series of industrial enzyme products produced by Novozymes A/S and marketed by DSM Nutrional Products Limited. The phytases are capable of degrading naturally occurring phytate in pig and poultry feed and release phytases content of phosphorous essential for animal's growth. RONOZYME® phytases can be used as a substitution to inorganic phosphorous like MCP (Mono Calcium Phosphate) to animal feed.

Work & Methodology

This study addresses the environmental implications of substituting inorganic phosphorus with RONOZYME® phytases. LCA is used as an analytical tool, and modeling of the two considered product systems across the product chains is facilitated by Simapro 7.2 software. The study addresses changes induced by switching from one alternative to the other, and all significant processes influenced by the change are included in the study. Using RONOZYME® phytases in pig's and poultry's feed is justified by major advantages in terms of saved contributions to global warming potential, nutrient enrichment (algae bloom), acidification and particularly energy savings from inorganic phosphorous production.

Conclusion

RONOZYME® phytases are enzymes that can play a pivotal role in a transition to more sustainable bio based economy and focus should be addressed to the evolving enzyme technology in environmental research.

16. Restricted Life Cycle Assessment for the use of Liquefied Petroleum Gas and Kerosene as cooking fuels in India

Organization: Technical University of Berlin

The use of energy for cooking is one of the most important sectors for the energy consumptionin India. This was one of the first LCA study carried out in India in 1990s in the Indian energy sector.

Work & Methodology

The goal of the study was to compare different types of cooking and their ecological advantages and disadvantages over the whole life cycle. The life cycle of the two fuels (Liquefied Petroleum Gas and Kerosene) is identical in many points. This study investigates the situation in India in life cycle inventories for the following stages: Extraction of the resources crude oil and natural gas; processing of crude oil in refineries to LPG, kerosene and other products; extraction of LPG from natural gas in fractionating plants; bottling of LPG in bottling plants; distribution and transport of the fuels; cooking with LPG and kerosene. Environmental impacts caused by the necessary imports of products are considered in the inventory using literature data. The study presented a Life Cycle Assessment for the use of kerosene and liquefied petroleum gas as cooking fuels.

Conclusion

The study makes a reflection on the economic conditions and the social consequences of both life cycles. The environmental impacts are summarised with final calculated ecological profiles for the two fuels. A direct comparison of cooking with the two fuels shows in the majority of the investigated indicators an ecological advantage in the use of LPG over kerosene. The study shows also the necessity to consider the whole life cycle for a proper comparison of the investigated cooking possibilities. The results can be compared with a life cycle assessment of biomass fuels being undertaken with the same goal definition.

List of Organizations working in LCA/M

V

List of Organizations working in LCA/M

S.No	Organization	Reference link
1	3M India Ltd.	http://solutions.3mindia.co.in/wps/portal/3M/en_IN/about-3M/information/corporate/responsibility/
2	All India Glass Manufacturer's Federation	http://aigmf.com/past-events.php#9
3	Annamalai University	www.indialca.com/pdf/ILCM-2012-Agenda.pdf
4	Bhoruka Park Pvt Ltd.	http://www.bhorukapark.com/index.htm
5	Bureau of Indian Standards	https://archive.org/details/gov.in.is.iso.14044.2006
6	Central Road Research Institute	www.indialca.com/pdf/ILCM-2012-Agenda.pdf
7	Coca Cola India	http://www.coca-colaindia.com/sustainability/sustainability.html
8	Confederation of Indian Industry	http://www.greenbusinesscentre.com/lcanetwork
9	Environmental Resources Management	http://www.indialca.com/pdf/ILCM-2012-Agenda.pdf
10	Federation of Indian Chambers of Commerce & Industry	http://www.indialca.com/
11	GE India Technology Centre	http://papers.sae.org/2012-01-0650/
12	Hemchandracharya North Gujarat University	www.jerad.org/ppapers/dnload.php?vl=2&is=4b&st=773
13	Herman Miller	http://www.greenbusinesscentre.com/lcapresentations
14	Hewlett-Packard India	www.indialca.com/pdf/ILCM-2013-agenda.pdf?

S.No	Organization	Reference link
15	Hindusthan National Glass & Industries Ltd	http://www.packagingconnections.com/downloads/GlassLCA_AbridgedReport_AIGMF_02May 2012%20_3_.pdf
16	India Glycols Ltd.	http://www.indiaglycols.com/aboutus/note_from_the_chairman.htm
17	Indian Institute of Petroleum	http://www.iip.res.in/divisions.php?pgID=div_31 &type=34
18	Indian Institute of Science	http://www.cpdm.iisc.ernet.in/ideaslab/sustainability.php
19	Indian Institute of Technology	http://link.springer.com/chapter/10.1007%2F978-94-007-1899-9_26
20	Indian Oil Corporation	http://www.energypublishing.org/publication/conference-proceedings/wpc-proceedings/20th-wpc-proceedings/block-4/forum-21/posters/life-cycle-assessment-on-use-of-jatropha-biodiesel-in-indian-transportation-sector
21	Indian Plywood Industries Research & Training Institute	http://www.ipirti.gov.in/lifecycle.html
22	Indira Gandhi Institute of Development Research	http://link.springer.com/article/10.1007/BF02994058
23	Infosys	http://www.infosys.com/sustainability/Pages/index.aspx
24	InterfaceFLOR	http://mgsarchitecture.in/products/floorings/61 interfaceflor-launches-convert
25	Jain Irrigation Systems Ltd.	http://www.waterfootprint.org/?page=files/Publications
26	Ministry of Environment & Forests, India	http://envfor.nic.in/division/items-work-handled-4
27	Motilal Nehru National Institute of Technology	http://www.tandfonline.com/doi/abs/10.1080/15435075.2010.493803#.U1eBEFWSyWp
28	National Council for Cement and Building Materials	http://commerce.nic.in/pressrelease/pressrelease_detail.asp?id=1482

S.No	Organization	Reference link
29	National Environmental Engineering Research Institute	www.jerad.org/ppapers/dnload.php?vl=2&is=4b&st=773
30	National Institute of Industrial Engineering	www.lcacenter.org/lca-lcm/pdf/LCA-EMS.pdf
31	National Institute of Technology	http://www.tandfonline.com/doi/abs/10.1080/15435075.2010.493803#.U1eBEFWSyWp
32	Novozymes South Asia (P) Ltd.	http://www.novozymes.com/en/sustainability/Published-LCA-studies/Documents/Environmental%20advantages%20of%20phytase%20over%20inorganic%20phosphate%20in%20poultry%20feed.pdf
33	PE International	http://www.pe-international.com/india/index/
34	Polygenta Technologies	www.polygenta.com/news/PressReleaseLCM-CMMPilotProject.pdf
35	Simapro Software Development India Pvt. Ltd	http://www.simaproindia.com/
36	Resource Optimization Initiative	http://www.roionline.org/activities-of-roi.htm
37	Rio Tinto	http://www.riotinto.com/sustainabledevelopment2012/governance/product_stewardship.html
38	SABIC Research & Technology Pvt. Ltd.	http://conferences.chalmers.se/index.php/LCM/LCM2013/paper/download/544/145
39	SGS India	http://www.sgsgroup.in/en-gb/Industrial-Manufacturing/Services-Related-to-Production-and Products/Consultancy/Life-Cycle-Assessment.aspx
40	TATA Chemicals Ltd.	http://www.tatachemicals.com/sustainability/downloads/2008-10/sustainability_report2008-10.pdf
41	TATA Motors Ltd.	http://www.tatamotors.com/sustainability/pdf/GRI-10-11.pdf
42	Tata Steel Ltd.	http://www.tatasteelconstruction.com/en/sustainability/the_whole_story/

S.No	Organization	Reference link
43	TERI University	http://www.ijest.org/?_action=articleInfo&article=982
44	Unilever India	http://www.unilever.com/sustainable-living/ourapproach/eco-efficiencyinmanufacturing/managementsystem/lifecycle/
45	Vasantdada Sugar Institute	http://www.vsisugar.com/india/environmentalsciences/research-environmental-sciences.htm

LCA Networks in India

VI

LCA Networks in India

There are numerous international, national and regional networks whose major activities relate to knowledge sharing and communication, showcasing case studies, development of life cycle inventories and impact assessment methods and capacity building. An effort has been made to consolidate the forums/communities existing in this sector in India.

1. India LCA Alliance:

Website: www.indialca.com
In operation: 2012

Freely accessible, comprehensive, information and knowledge sharing platform to create awareness and increase understanding on Life Cycle Thinking in India. Facilitated by Federation of Indian Chambers of Commerce and Industry, it aims to build capacity among industries, government, civil society and NGOs in India on Life Cycle concepts and tools. The primary objectives are:

- To create large scale awareness and build national capacity on LCA/M through conferences, training programmes and pilot projects
- To share International and National best practices on LCA/M implementations
- To develop Indian LCA databases across range of industries
- To increase membership spanning industries, governments and NGOs

2. Indian Society for Life Cycle Assessment (ISLCA):

Website:http://www.neef.in/islca.html
In operation: 1997

Promoted by National Ecology and Environment Foundation, the objectives of ISLCA are as follows:

- Capacity building for development of LCA in India through its courses, training programmes, conferences, seminars, research projects etc
- Integrating socio-economic concepts in LCA
- Representing India in national and international forums
- Networking with leading professionals in LCA and related fields
- Promoting publications of the ISLCA

3. LCI India Network:

Website:http://www.greenbusinesscentre.com/lcanetwork
In operation: Not known

The objective of this network is to develop Life Cycle inventory data for India and share information amongst members. This forum is being facilitated by Confederation of Indian Industry - Sohrabji Godrej Green Business Centre (CII GBC) and Ecoinvent.

4. South and South-East Asia (SEASIA) Network on Life Cycle Initiative of UNEP:

Website:http://www.estis.net/sites/seasia/
In operation: Not known

SEASIA Network represents UNEP-SETAC's Life Cycle Initiative (LCI) programme in South and South-East Asian Countries. SEASIA member countries include all developing countries in South, South-East and East Asia regions.

LCA Events in India

VII

LCA Events in India

Following table provides the list of e Indian LCA/M events that have been organized to date:

S.No	Event Name	Organizer	Date
1	Indian Conference on Life Cycle Management (ILCM 2014)	FICCI Quality Forum	29-30 September 2014
2	Indian Conference on Life Cycle Assessment & Management (ILCM 2013)	FICCI Quality Forum	24-27 September 2013
3	Indian Conference on Life Cycle Assessment & Management (ILCM 2012)	FICCI Quality Forum	21-23 August 2012
4	International Conference on EcoBalance & Life Cycle Assessment in India	Indira Gandhi Institute of Development Research	13-15 February 2002
5	Workshop on Life Cycle Assessment	CII GBC	8 July, 2011

Policy initiatives related to LCA/M VIII

Policy initiatives related to LCA/M

Discussed below are the policy initiatives put forth by different Ministries and Government bodies which includes a consideration of life cycle based approach for achieving sustainable development:

I. National Voluntary Guidelines on Social, Environmental & Economic Responsibilities of Business[1]

Issued by: Indian Institute of Corporate Affairs (IICA)

Ministry: Ministry of Corporate Affairs

The guidelines emphasize the role of business sector in helping India achieve the goal of sustainable development and economic growth.

Of the nine principles of NVG, Principles 2 states that "Businesses should provide goods and services that are safe and contribute to sustainability throughout their life cycle. Responsible businesses, therefore, should engineer value in their goods and services by keeping in mind these impacts". The principle emphasizes that in order to function effectively and profitably, businesses should work to improve the quality of life of people. It recognizes that all stages of the product life cycle, right from design to final disposal of the goods and services after use, have an impact on society and the environment. The principle, while appreciating that businesses are increasingly aware of the need to be internally efficient and responsible, exhorts them to extend their processes to cover the entire value chain – from sourcing of raw materials or process inputs to distribution and disposal.

1 http://www.mca.gov.in/Ministry/latestnews/National_Voluntary_Guidelines_2011_12jul2011.pdf

Principle 2: Businesses should provide goods and services that are safe and contribute to sustainability throughout their life cycle

Core Elements

- Businesses should assure safety and optimal resource use over the life cycle of the product – from design to disposal and ensure that everyone connected with it-designers, producers, value chain members, customers and recyclers are aware of their responsibilities.
- Businesses should raise the consumer's awareness of their rights through education, product labelling, appropriate and helpful marketing communication, full details of contents and composition and promotion of safe usage and disposal of their products and services.
- In designing the product, businesses should ensure that the manufacturing processes and technologies required to produce it are resource efficient and sustainable.
- Businesses should regularly review and improve upon the process of new technology development, deployment and commercialization, incorporating social, ethical and environmental considerations.
- Businesses should recognize and respect the rights of people who may be owners of traditional knowledge and other forms of intellectual property
- Businesses should recognize that overconsumption results in unsustainable exploitation of our planet's resources and should therefore promote sustainable consumption, including recycling of resources.

II. SEBI Guidelines on Business Responsibility Report[2]

Issued by: Securities and Exchange Board of India (SEBI)
Ministry: Independent regulator

SEBI is the regulator for the securities market in India. SEBI has asked listed companies to mandatorily submit an annual business responsibility report wherein they have to disclose compliance to various environmental, social and governance aspects. The Business Responsibility Reports (BRRs) would be mandatory for top 100-listed entities based on market capitalisation at BSE and NSE. The norms have been issued in line with 'National Voluntary Guidelines on Social, Environmental and Economic Responsibilities of Business' published by Ministry of Corporate Affairs.

III. Guidelines on Corporate Social Responsibility and Sustainability for Central Public Sector Enterprises[3]

Issued by: Department of Public Enterprises
Ministry: Ministry of Heavy Industries and Public Enterprises

The Department of Public Enterprises being the nodal department for all Central Public Sector Enterprises (CPSEs) formulates policy pertaining to the role of CPSEs in the economy. It lays down policy guidelines for performance improvement and evaluation, autonomy and financial delegation, personnel management and other related areas in respect of CPSEs. The Department of Public Enterprises has issued on April 2010, “Guidelines on Corporate Social Responsibility for Central Public Sector Enterprises”. The guidelines lay stress on the link of Corporate Social Responsibility with sustainable development and define Corporate Social Responsibility (CSR) as a philosophy wherein organizations serve the interest of society by taking responsibility for the impact of their activities on customers, employees, shareholders,

2 http://www.sebi.gov.in/cms/sebi_data/attachdocs/1344915990072.pdf
3 http://www.sebi.gov.in/cms/sebi_data/attachdocs/1344915990072.pdf

communities and the environment in all aspects of their operations. Under these guidelines, CPSEs have to create mandatorily, through a Board Resolution, a CSR and sustainability budget as a specified percentage of net profit of the previous year.

As per these guidelines in their concern for social and environment sustainability, corporate enterprises are expected to produce goods and services which are resource efficient, consumer friendly and environmentally sustainable throughout their life cycles. Educating the consumers and spreading awareness about the handling, usage and advantages of the eco-friendly products and influencing consumer preference for such products is what is expected of responsible business.

Public sector enterprises are exhorted in the guidelines to join hands with other public sector companies for planning, implementing and monitoring mega projects for optimal use of resources and synergy of expertise and capabilities for maximum socio-economic or environmental impacts.

The India LCA Roadmap: Vision for the Future

IX

The India LCA roadmap: Vision for the future

While a number of LCA studies have already been completed in India, a broad outreach across the country and into different regions is needed to enhance the understanding of LCM by public policy and business decision-makers. The deliberations were initiated with the launch of ILCM 2012 which was organized to discuss about LCA/M and promote usage of LCA tools in India. The need for greater awareness, capacity building and technical assistance on LCA are clearly identified as key components for LCA development in future. In order to address these issues, multiple stakeholders were to be engaged to develop business case and build capability on LCA. To facilitate such engagement, a National Roundtable 'Towards an Indian Roadmap on Life Cycle Assessment and Management was organized following ILCM 2012 to initiate discussion and serve as an input for development of an Indian Roadmap on Life Cycle Assessment and Management. Following the roundtable, a brainstorming session was also conducted in March 2013 for expanding network and cooperation on LCA in India. The conclusions from the above mentioned discussions served as the knowledge foundation for developing LCA/M Roadmap for India.

The roadmap is expected to show the business and policy case for Life Cycle Management in India, to cover the demand side for knowledge with regard to Life Cycle Approaches. It will further lay down concrete steps for capacity building and technical assistance in various areas of LCA, such as Life Cycle Inventory data and

related databases, LCA methodologies and adaptive approaches. The following elements form a part of the national roadmap for LCA in India:

a. Capacity Building with training programmes (for public & private sector)

b. Uptake of LCA in educational institute

c. Technical Assistance to public, private sector and research institutes taking up LCA projects/activities

d. Involvement of Indian Government to provide a framework (especially on data/databases) without insistence on introducing any mandatory activities or regulations

e. Organization of regional programmes with regional stakeholders

In line with the above objective that the roadmap is expected to meet, a session on "Mainstreaming Life Cycle Thinking in Sustainable Consumption and Production policy making" is scheduled on September 30, 2014 following ILCM 2014. Co-hosted by MoEF&CC, Government of India and FICCI, supported by UNEP, the aim of this session is to invite and reflect on the view points of relevant stakeholders. It will also provide pointers for updating the national roadmap on mainstreaming Life Cycle Approaches in India.

Credits

Editor - FICCI Quality Forum

A thought leader in its area of influence, Federation of Indian Chambers of Commerce & Industry (FICCI) carries forward initiatives in support of rapid, inclusive and sustainable growth encompassing health, education, environment, livelihood, and skill development. Currently FICCI represents 70 sectors of the economy and is engaged in Policy Advocacy, International Outreach, B2B Matchmaking, Capacity Building, Training and Consultancy across sectors.

FICCI Quality Forum (FQF) is a specialized division of FICCI working in the areas of Quality and Environment Management, Climate Change and Sustainable Production/Consumption. FQF is already conducting several accredited training courses in collaboration with leading training organizations in the areas of quality and environment management. To facilitate Indian industry keep abreast of latest developments in its domain, FQF constantly strives to organize Scientific Symposiums and Business Seminars on topics of contemporary relevance. FQF has taken the initiative to create a platform for national and international experts, practitioners, researchers, and academicians working on Life Cycle Management topics and build a focal point for LCA/M knowledge and expertise in the country.

Annex I: Terms & Definition[4]

Carbon Footprint	A total product Carbon Footprint is a measure of the direct and indirect greenhouse gas (GHG) emissions associated with all activities in the product's life cycle. Products are both goods and services. Such a Carbon Footprint can be calculated by performing (according to international standards) an LCA that concentrates on GHG emissions that have an effect on climate change
Cradle-to-gate	An assessment that includes part of the product's life cycle, including material acquisition through the production of the studied product and excluding the use or end-of-life stages. (WRI and WBCSD 2010)
Cradle-to-grave	A cradle-to-grave assessment considers impacts at each stage of a product's life cycle, from the time natural resources are extracted from ground and processed through each subsequent stage of manufacturing, transportation, product use, recycling, and ultimately, disposal. (Athena Institute & National Renewable Energy Laboratory draft 2010)
Eco efficiency	Concept of creating more goods and services while using fewer resources ,creating less waste and pollution
Ecodesign	Approach to design a product with special consideration for environmental impacts of the product during its life cycle
Eco-innovation[5]	Eco innovation is the development and application of a business model ,shaped by a new business strategy that incorporates sustainability throughout all business operations based on Life Cycle Thinking and in cooperation with partners across the value chain .It entails a coordinated set of modifications or novel solutions to products (goods/services) processes , market approach and organizational structure which leads to a company's enhanced performance and competitiveness
Impact category	Impact Categories are logical groupings of Life Cycle Assessment results of interest to stakeholders and decision makers . (UNEP /SETAC 2009)

4 UNEP SETAC Life Cycle Initiative at http://www.lifecycleinitiative.org/resources/life-cycle-terminology-2/

5 http://www.unep.org/ecoinnovationproject/

Life Cycle	Consecutive and interlinked stages of a product system from raw material acquisition or generation from natural resources to final disposal .(ISO 2006)
Life Cycle Approaches	Techniques and tools to inventory and assess the impacts along the life cycle of products .
Life Cycle Assessment	Compilation and evaluation of the inputs , outputs and the potential environmental impacts of a product system throughout its life cycle .
Life Cycle Costing (LCC)	Life Cycle Costing ,or LCC ,is a compilation and assessment of all costs related to a product , over its entire life cycle , from production to use ,maintenance and disposal .
Life Cycle Inventory (LCI)	The phase of Life Cycle Assessment where data are collected ,the systems are modeled , and the LCI results are obtained . (UNEP /SETAC ,2009)
Life Cycle Inventory Analysis	Phase of Life Cycle Assessment involving the compilation and quantification of inputs and outputs for a product throughout its life cycle .(ISO 2006)
Life Cycle Inventory Database	A system intended to organize ,store ,and retrieve large amounts of digital LCI datasets easily .It consists of an organized collection of LCI datasets that completely or partially conforms to a common set of criteria , including methodology , format , review , and nomenclature ,and that allows for interconnection of individual datasets that can be specified for use with identified impact assessment methods in application of life cycle assessments and life cycle impact assessments .
Life Cycle Management (LCM)	Life Cycle Management is a product management system aiming to minimize environmental and socio - economic burdens associated with an organization's product or product portfolio during its entire life cycle and across its value chain .LCM is not a single tool or methodology ,but a management system collecting , structuring and disseminating product -related information from various programs ,concepts ,and tools .
Life Cycle Sustainability Assessment (LCSA)	Life Cycle Sustainability Assessment (LCSA) refers to the evaluation of all environmental ,social and economic negative impacts and benefits in decision making processes towards more sustainable products throughout their life cycle . (UNEP /SETAC , 2011)

Life Cycle Thinking	Life Cycle Thinking is a mostly qualitative discussion to identify stages of the life cycle and /or the potential environmental impacts of greatest significance e g .for use in a design brief or in an introductory discussion of policy measures . The greatest benefit is that it helps focus consideration of the full life cycle of the product or system .data are typically qualitative (statements) or very general and available by heart quantitative data . (Christiansen et al .1997)
Product Life Cycle	Product life cycle has different meanings for different functional groups .It can refer to purchase ,use and disposal of the product from the owner /user perspective .The environmental product life cycle consists of all the direct and supporting processes required to build ,distribute ,use ,maintain ,and retire a product ,from extraction of raw materials to their final disposal or recycle ,i e . cradle to grave .
Product system	ISO defines product system as a collection of materially and energetically connected unit processes ,which perform one or more defined functions . The term "product " used alone includes not only product systems but can also include service systems .
Social Life Cycle Assessment (S ŁCA)	S ŁCA is a social impact (eal and potential impacts)assessment technique that aims to assess the social and socio economic aspects of products and their positive and negative impacts along their life cycle encompassing extraction and processing of raw materials ;manufacturing ;distribution ;use ;reuse ;maintenance ; recycling ,and final disposal .(UNEP /SETAC ,2009)
Supply chain	System of organizations , people , technology , activities , information and resources involved in moving a product or service from supplier to customer . Supply chain activities transform natural resources ,raw materials and components into a finished product that is delivered to end customer .
Sustainable consumption and production	The UN Commission on Sustainable Development (UNCSD) defined sustainable consumption and production as use of goods and services that respond to basic needs and bring a better quality of life , while minimizing the use of natural resources , toxic materials and emissions of waste

Sustainable development	Brundtland Commission (Our Common Future, 1987) defined sustainable development as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. The concept was a compromise between rich economies pushing for stronger environmental protection and developing economies focused on poverty alleviation
Value chain	Model describing activities that a firm operating in a specific industry conducts to receive raw materials as input, add value to the raw materials through various processes and deliver finished products to customers (set of input activities that a company carries out in order to create value for its valued customers)

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