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Abstract Book

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About ILCM

Indian Conference on Life Cycle Management (ILCM) is a flagship event instituted by FICCI to promote Life Cycle Thinking among various stakeholder groups in India - government, industry, academia as well as non-voluntary sector. It is the only forum in India that focuses exclusively on Life Cycle Management and related topics. The conference brings the latest knowledge and understanding about emerging concepts in Sustainable Consumption and Production to Indian industry. The platform is all the more significant as technical issues relevant to the host country drive the ILCM agenda.

ILCM 2016 was organized in partnership with Bureau of Indian Standards (BIS) and UNEP SETAC Life Cycle Initiative. In line with the Sustainable Development Goals (SDGs) releases last year, the cornerstone of this year's theme is the applicability of Life Cycle based tools and approaches in enabling shift towards Responsible Consumption and Production.

Theme and Focus Areas

Contributions for ILCM 2016 were invited under the following focus areas:

1. Application of LCT in Industry
2. Eco-innovation and Sustainable Products
3. Life Cycle Inventory data as fundamental necessity for Sustainable Production and Consumption

Program

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	Inaugural Address *Shri Anurag Goel, Former Secretary, Ministry of Corporate Affairs, Government of India*
	Theme Address *Dr. Feng Wang, Programme Officer – United Nations Environment Programme (UNEP)*
	Theme Address *Dr. Rajnish Karki, CEO – Karki Associates*
	Closing Remarks *Dr Sanjeevan Bajaj, Adviser – Quality Forum, FICCI*
	Vote of Thanks *Shri M A Patil, Director – Quality Forum, FICCI*
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	Tailoring LCA Practices to Achieve Business Imperatives *Ananda Sekar, SABIC Research & Technology Pvt. Ltd. (India)*
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	Opportunities and Challenges of Bioplastics as a Business Case for Eco-Innovation - Present and Future *Venkateshwaran Venkatachalam, Institute for Bioplastics and Biocomposites (Germany)*
	Constructed Wetland as a Natural Treatment System for Wastewater Management: An Eco-Sustainable Product *Dinesh Kumar, National Institute of Hydrology (India)*
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	Sustainable Production and Consumption Models and Certification Tools in Chinese Food Supply Chains "Capacity4food" *Itziar Vidorreta Herrán, GAIA (Spain)*
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	Sustainable Recycling Industries Project; Providing the Seed for LCI Data in India *Amir Safaei, ecoinvent (Switzerland)*
	Towards a Global Network of Interoperable LCA Databases *Feng Wang, UNEP (France)*
	Criteria for reviewing LCA data sets *Andreas Ciroth, GreenDelta (Germany)*
	Constructing a New Waste Input-Output Database and its Application in Life Cycle Analysis *Yasushi Kondo, Waseda University (Japan)*
	Developing Readiness for Creation of Indian LCA Database/Datasets *Sanjeevan Bajaj, FICCI (India)*
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	Product Stewardship through Life Cycle Assessment *Sandeep Shrivastava, Ambuja Cement (India)*
	ISO 14001:2015 - How Companies can address the new requirement of "Taking a Life Cycle Perspective" when identifying and assessing Environmental Aspects and Impacts *Martina Prox, ifu Hamburg (Germany)*
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	Avoided CO2 Emissions from Petrochemical Products - Methodology and Case Studies *Rajesh Mehta, SABIC Research & Technology Pvt. Ltd. (India)*
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Opportunities and Challenges of Bioplastics as a Business Case for Eco-Innovation - Present and Future	IfBB – Institute for Bioplastics and Biocomposites (Germany)
Constructed Wetland as a Natural Treatment System for Wastewater Management: An Eco-Sustainable Product	National Institute of Hydrology (India)
Session 3: LCT in enabling shift towards Sustainable Consumption Production	
Urban mining for a circular economy – A life cycle perspective	World Resource Forum (Switzerland)
Resource efficiency and Secondary Resource Management as a Foundation for Developmental Policy in India	GIZ (India)
Sustainable Production and Consumption Models and Certification Tools in Chinese Food Supply Chains "Capacity4food"	GAIA (Spain)
Circular Economy: Application of LCA and the Role of Steel Industry	TATA Steel (India)

Session 4: Life Cycle Inventory data as fundamental necessity for sustainable production and consumption	
Sustainable Recycling Industries Project; Providing the Seed for LCI Data in India	ecoinvent (Switzerland)
Towards a Global Network of Interoperable LCA Databases	UNEP (France)
Criteria for reviewing LCA data sets	GreenDelta (Germany)
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A Programmatic Approach to Mainstreaming Life Cycle Innovation	Forum for Sustainability through Life Cycle Innovation (Germany)
Session 6: Application of LCT in industry	
Low Environmental Impact Printing with HP Indigo Digital Press for Production of Flexible Packaging	HP (Spain)
Social Life Cycle Impact Assessment in Value Chain – A Pilot Study in Steel Industry	Mahindra Sanyo Special Steel Pvt. Ltd. (India)
Avoided CO2 Emissions from Petrochemical Products - Methodology and Case Studies	SABIC Research & Technology Pvt. Ltd. (India)
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Life Cycle Thinking and how optimisation of LCT of Scrap Apps Model would result in promoting resource efficiency	VB Scrapapp Management Services Pvt. Ltd. (India)
Life Cycle Assessment of Defluoridation of Ground Water using Laterite Soil based Adsorbents	Indian Institute of Technology, Roorkee (India)
Sustainable Smart Home Technologies in India: A Plausible Model for its Design, Development and Dissemination in Indian Cities	M.S Ramaiah Institute of Technology (India)
Guided Case Study as an approach to allow companies mastering LCA	GreenDelta (Germany)

Abstracts

I. The Role of Science in Shaping Sustainable Business: Unilever Case Study

Author: Edward Price
Organization: Unilever (UK)

Abstract

Unilever is a leading example of a multinational company in the Fast-Moving Consumer Goods (FMCG) sector. Unilever has long been an advocate of sustainable business, using scientific assessment as the basis for its strategy and initiatives. Given its business, Life Cycle Assessment (LCA) is established within the company and there is a current focus on improving the methodology and scope of LCA. Recent developments include new approaches to fill data gaps for agricultural ingredients and new impact assessment methods for assessing land use change. We have also adapted LCA approaches to inform corporate strategy and to engage a broad range of stakeholders both within the company and outside. The most recent and significant example of this has been the use of product foot printing as an integral element of Unilever's Sustainable Living Plan (USLP); currently over 2000 products are foot printed annually across 14 countries.

LCA approaches will continue to play an important role in Unilever's strategy. However, there is an urgent need to develop more predictive, regional/global level approaches that take into account the limited availability of many earth resources, the non-linearity of certain impacts and the absolute limits of sustainability. Several conceptual systems-level frameworks and theories already exist, but the Planetary Boundary (PB) approach has been selected as the most promising for developments in data, modeling and contextualization of environmental assessment. We have identified the need for developments in informatics to exploit new data gathering approaches as well as new modelling initiatives utilizing Geographical Information Systems (GIS) mapping and 'big data' approaches. In particular, we see real value in developing a distinct and novel, 'PB-enabled' normative LCA approach to support product/service/sectorial decision making.

Reference

Clift, R; Druckmann, A; Taking Stock of Industrial Ecology; Chapter 15, pp 291-302; Open Access, DOI 10.1007/978-3-319-20571-7

II. Tailoring LCA Practices to Achieve Business Imperatives

Authors: Dr. Ashok Menon[1], Dr. Avantika Shastri[1], Mr. Ananda Sekar[1], Ms. Neena C[1], Mr. Rajesh Mehta[1], Mr. RaviTeja Pabbisetty[1], Ms. Suchira Sen[1]
Organization: [1]SABIC Research & Technology Pvt. Ltd. (India)

Abstract

For a large diversified petrochemicals major such as SABIC, the uses of LCA spans across products ranging from high-end engineering thermoplastics, base petrochemicals to metals and fertilizers, and several functions such as technology, marketing, manufacturing, supply chain etc. Over a period of 8 years, we have successfully used life cycle thinking and information from life cycle assessment for several different purposes, such as marketing of sustainable products, product risk assessment, technology benchmarking, evolving long term strategy, sustainability impact analysis of large investment projects, technology portfolio management, regulatory advocacy and many others. We are constantly expanding the scope of LCA by leveraging our know-how into areas such as CDP reporting, organizational LCA, scope 3 GHG assessment and avoided emissions portfolio.

A complete LCA is often viewed as a time and resource intensive activity. In practice, however, depending on parameters such as the intended audience and intended use of the information, an LCA can be tailored to

balance time, resources, rigour, completeness and data quality to achieve each desired business imperative. We will share an overview of the various processes, tools and LCA framework utilized at SABIC that demonstrates how to effectively apply different LCA levels to maximize impact to the business.
Several LCA case studies will be showcased to demonstrate this ability for structured flexibility in life cycle assessment. The concepts discussed can be applied by any company desirous of institutionalizing life cycle thinking into core business practice.

III. LCA: A Holistic Approach for driving sustainability

Author: Abhay Pathak
Organization: TATA Motors Ltd. (India)

Abstract

Objective: In order to design and develop sustainable automobile products, Tata Motors Ltd. (TML) has taken up Life Cycle Assessment (LCA) initiative. LCA is being used at Tata Motors to identify environmental and social hotspots, so as to improve enviro-social performance of the organization on lifecycle basis.

The LCA of an automobile is a complex process involving data collection of numerous parts, assemblies and sub-assemblies of an automobile product, which are 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 various challenges in conducting LCA of a complete car.

The LCA study was performed using a software tool – GaBi, supplied by PE International. TML is the 1st Indian automobile company to conduct such LCA studies using GaBi.

Description: Tata Motors began its LCA journey way back in 2009 and started with performing LCAs of auto components to support design changes from environmental perspective. Later on, Tata Motors conducted LCA of a complete car on “Cradle to Grave” basis. TML is the first Indian automobile manufacturer conducting LCA of a car, benchmarking with global auto majors like VW, BMW and Mercedes Benz.

Additionally, TML has also performed LCA of automotive fuels in Indian context using “Well to Wheel” analysis. The study includes various automotive fuels being used in India and combination of engine technologies, which were evaluated for energy efficiency and associated GHG emissions in “Well to Tank” and “Tank to Wheel” stages of automotive fuels. This is also the first of such study conducted in Indian context. It has provided immense inputs for development of low carbon automobile products.

Conclusion: TML has been regularly conducting the LCAs of its products and comparing the carbon footprint of different products. The study has also offered other opportunities to improve environmental performance in supply chain. It was also observed that data collection is the key challenge in performing LCA of an automobile.

Going forward, LCAs would be used for identifying social impacts and implementing measures to improve social performance across lifecycle. This will enable TML to drive sustainability in holistic manner and improve all round sustainability performance.

IV. Sustainability as a source of innovation: Results of UNEP Eco-innovation project

Author: Liazzat Rabbiosi
Organization: UNEP (France)

Abstract
Now more than ever, environmental change is limiting businesses' capacity to create value. This has been amplified by the costs of pressures exerted by rapidly globalizing supply chains, intensified consumption of scarce natural resources, and externalities brought about by environmental degradation. These trends have in turn spurred more intense action by governments and civil society to curb the negative effects of production and consumption patterns, placing further operational constraints on businesses. Businesses can no longer afford to ignore sustainability as a central factor for their companies' long-term competitiveness. Most companies now understand the critical need to include sustainability in their business practices to ensure their market viability. Many however do not know what this entails, where to start, and how to go about achieving the systemic change that is needed.

Eco-innovation is an approach for companies to lead their way in sustainability. It is a continuous process of change that requires companies to think strategically and systematically through life cycle thinking about sustainability issues. The approach requires re-thinking a company's business strategy and business model to address key sustainability hotspots through innovative solutions developed in collaboration with value chain partners. Sustainability becomes part of the company DNA and a source of innovation, in turn fuelling engines of inclusive and sustainable growth.

UNEP has implemented a project in 8 countries in which this approach has been tested with small and medium enterprises (SMEs). It yielded interesting results demonstrating the feasibility of applying life cycle thinking at SME level and eco-innovation approach and its contribution to more sustainable value chains and circular economy. The results will be presented by the implementing partners from Sri Lanka and Vietnam.

V. Implementation of the D4r Laptop Pilot Case in the Basque Country

Authors: Mrs. Itziar Vidorreta Herrán, Mrs. Idoia Muñoz
Organization: GAIA (Spain)

Abstract
Introduction: The D4R (Design for recycling, repair, refurbishment and reuse) laptop was developed in conjunction with MicroPro Computers (MPC), a Dublin-based computer manufacturer. The objective is for the manufacturer to form an industrial network in different regions. In this case we are presenting the industrial network established in the Basque Country, Spain.

In addition, we will pilot a lease based business model, where partner companies in different regions provide a localized repair, upgrading and take-back service to customers, ensuring positive economic feedback for network partners.

Materials and Methods: This has been made possible through: D4R product design features that facilitate integration of by-product materials and components into the manufacturing process; the creation of an industrial network of suppliers and local assembly agencies permitting; and the creation of a resource exchange platform that increases the visibility of by-products

Results: Putting together the requirements under the characteristics of the economic situation of the Basque Country and the geographical situation, Eskilara has identified the most suitable companies following three novel concepts in industrial networks; it is being conducted on an international basis; it is being conducted by SME's; it demonstrates manufacturing with low entropy waste materials.

Discussion: Eskilara has set up an industrial network composed by wooden companies, IT refurbishes and marketing specialists. Egurlandua and Budland working to design a wooden shell. PC Lagun aimed to collect; repair and shell electronic products. Prosumerlab, will design the most suitable marketing strategy, and Eskilara will be leading the network and the exploitation of the product and the service structure.

Conclusion: The result of the pilot implementation of the D4R laptop, is to test and validate if a future franchise industrial network could be implemented in which the manufacturing of the D4R could be done in its European region for sale in their catchment areas.

VI. Opportunities and Challenges of Bioplastics as a Business Case for Eco-Innovation - Present and Future

Authors: Mr. Sebastian Spierling[1], Mr. Venkateshwaran Venkatachalam[1], Ms. Eva Knüpffer[2], Prof. Dr.-Ing. Hans-Josef Endres[3]
Organization: IfBB - Institute for Bioplastics and Biocomposites[1], Fraunhofer Institute for Building Physics IBP[2], IfBB - Institute for Bioplastics and Biocomposites[3]

Abstract
Introduction: In the ever increasing quest for a sustainable development, eco-innovation provides a win-win solution to create business opportunities and benefit the environment by reducing their impacts, enhancing resilience to environmental pressures and achieve a more efficient and responsible use of natural resources1. The global over-dependence of fossil based plastics and their negative impacts on the environment have paved way to the emergence of bioplastics in the past few years. The growing bioplastics market (current share of 6-7% of the global plastics market and expected to be 10% within next 5 years2), regulatory pressures in response to rising resource scarcity and environmental degradation using conventional plastics reinforce bioplastics market as a business case for eco-innovation.

Materials and Methods: A plastic material is defined as a bioplastic, if it is either biobased, biodegradable or features both properties3. Bioplastics, over the years have proved to have multiple benefits on different levels with respect to reduced use of fossil resources, reduced dependency on oil imports, End-of-Life options and contribution to the society. The business case for eco-innovation for bioplastics along the value chain will provide an overview of market trends, relevant indicators (environmental, economic and social), business drivers and present examples that aims for not only a holistic and sustainable transformation of environment, economy and society but also demonstrate compelling reasons to embark on an eco-innovation process.

Conclusion and Discussion: The presentation will discuss the opportunities and challenges associated with the development of bioplastics market for eco-innovation, in order to substitute the conventional fossil based plastics in the near future. Finally, the presentation will highlight the results of current research projects and developments in this regard.

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VII. Constructed Wetland as a Natural Treatment System for Wastewater Management: An Eco-Sustainable Product

Authors: Dinesh Kumar[1], Dr. V. C. Goyal[2]*
Organization: [1&2]National Institute of Hydrology

Abstract

In India, wastewater generation is increasing with improvement of water supply in urban areas with multi-fold growth in effluents [1]. The availability of water for drinking and sanitation, industrial applications, commercial purposes, including construction as well for irrigation is in short supply [2, 4]. On the one hand, there is an escalating demand of water for domestic, agriculture, as well as industrial purposes and on the other hand, the available water is being deteriorated as a result of a disposal of domestic and industrial effluents [3, 5].

Wastewater treatment is one of the major issues faced by Indian communities in last several decades because the installed conventional mechanized systems turn out to be rather expensive in terms of both the installation as well as operation and maintenance (O&M) costs [6, 7]. It has been estimated that the energy used in the conventional wastewater treatment systems is around one fifth of a municipality's total energy requirement, and it may continue to rise exponentially in the coming years on account of increasing water consumption and implementation of further stringent regulations [8, 9]. Therefore, it is imperative to select appropriate wastewater treatment facilities that can treat sewages and wastewaters at phenomenally low O&M costs and yet render higher degree of treatment as compared with conventional mechanized treatment systems. Such alternative facilities are known as Natural Treatment Systems (NTS).

Among the various variants of NTS, Constructed Wetland (CW) based facilities have attracted attention of wastewater practitioners across the world, including India, due to of its several innate benefits [5]. To evaluate the state-of-art of this technology, a Life Cycle Assessment (LCA) based study was undertaken for comparison of the most practiced wastewater treatment technology (i.e., Activated Sludge Process; ASP) with the CW. To carry out this study, few representative study sites based on these technologies were selected in the city of Jaipur, the State of Rajasthan, India and primary data collected for detailed estimation on consumption of resources to run the facilities. The parameters selected during assessment include coal required for generation of electrical energy, global warming potential, acidification potential, and abiotic resources depletion potential. CW was found to be highly energy efficient as compared to ASP. Hence, CW offers an attractive as well as eco-sustainable alternative for wastewater treatment due to its potential for resource conservation and higher efficiency of treatment at lower costs.

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VIII. Urban mining for a circular economy – A life cycle perspective

Author: Mrs. Sonia Valdivia[1]

Organization: World Resource Forum (Switzerland)

Abstract

Aim: The aim of this abstract is to discuss the potential of developing countries to mainstream urban mining and to which extent this can contribute to a circular economy. Key aspects of the recovery of metals will be used to exemplify and articulate the discussion.

Scope

Growing stakeholders' concerns on sustainability issues and increasing prices and depletion of natural resources are drivers in the search for alternative business models.

The application of the circular economy requires decision-makers and consumers to a) rethink about our lifestyles and the way we consume, preferring access over ownership; b) reuse materials through exchanging, cascading and recovering raw materials throughout their lifecycle also called urban mining; and c) redesign waste out of the industrial economy – designing goods and services that can be easily broken down and transformed, or designing business models which minimize the need of physical demand for goods in the first place.

Circular economy requires a change from the linear industrial model of 'take-make-waste-dispose' towards life cycle based models such as urban mining which is the process of recovering materials from any kind of anthropogenic stocks including products, building and waste.

Urban mining and the recovery of metals such as aluminium, copper, and gold found in waste from computers and electrical equipment to cars and ships is a rapidly growing economic activity worldwide which offers opportunities for circular economies. Concrete examples have been identified in the cases of steel and aluminium recycling in Chile and other emerging economies.

Conclusion

Many developing economies, which have grown up with the reality of resource scarcity, have the highest reuse and recycling rates and have developed a number of innovative approaches in line with the circular economy approach.

IX. Resource Efficiency and Secondary Resource Management as a Foundation for Developmental Policy in India

Authors: Dr. Ashish Chaturvedi[1], Jai Kumar Gaurav[1], Dr. K. Vijayalakshmi[2], Pratibha Ruth Caleb[2], Vaibhav Rathi[2], Dr. Abhijit Banerjee[3], Katharina Paterok[3], Manjeet Singh Saluja[3], Dr. Rachna Arora[3], Titiksha Fernandes[3], Uwe Becker[3], Bhawna Tyagi[4], Nitish Arora[4], Dr. Shilpi Kapur[4], Sonakshi Saluja[4], Souvik Bhattacharjya[4]

Organizations: [1]adelphi research, [2]Development Alternatives (DA), [3]GIZ-India, [4]The Energy and Resources Institute (TERI)

Abstract

Introduction: With a growing population, high economic growth rates, rapid industrialisation and urbanisation, India faces significant resource constraints and negative externalities which are expected to worsen in future. To achieve sustainable economic growth, India has to embark on the pathway of enhanced resource efficiency (RE) and make better use of secondary raw materials (SRM). To address these challenges, the Ministry of Environment, Forest and Climate Change (MoEFCC) has constituted the Indian Resource Panel (InRP) comprised of diverse experts with support from the Indo-German bilateral cooperation project being implemented by GIZ. The first task of the InRP was to map the existing Indian policy landscape from a RE perspective.

Methodology: A comprehensive analysis of the Government of India's policies and programmes related to the different stages of the product life cycle including mining, product design, production, consumption and waste generation was performed with the goal of identifying gaps with respect to RE and SRM.

Key findings: Limited Attention to Lifecycle Thinking in Policy Making: The analysis clearly shows that life cycle thinking for managing environmental/resource issues is not widespread in India. Most policies are focused on particular stages of the lifecycle. This might be a result of the mandates of different Ministries but clearly hampers the development of environmentally and economically effective policies.

Limited Attention to Mainstreaming RE and SRM: The analysis also shows that there is limited attention to mainstreaming RE and SRM at the policy level in India. Although certain exceptions exist, a majority of the policies do not create an enabling environment for businesses to enhance resource productivity or use secondary resources in their production processes. The reasons for such limited attention to RE and SRM are further analysed.

Recommendations: Based on the findings, the recommendations are to develop an overarching framework for RE and SRM in India. Development of Standards and pilot examples across various sectors need to be undertaken. The focus on Green Public Procurement will also create a push for achieving RE.

X. Sustainable Production and Consumption Models and Certification Tools in Chinese Food Supply Chains "Capacity4food"

Authors: Mr. Jokin Garatea, Mrs. Begoña Benito
Organization: GAIA

Abstract

Introduction: Food industry represents nowadays a crucial motor for economic development. However, it has serious impacts on environment due to water and energy consumption, and pollution of high organic strength liquids. China is one of world's leading food producers, with the Provinces of Qinghai, Henan and Sichuan ranking first

Materials and Methods: During Capacity4Food project implementation http://www.capacity4food.eu/en/ in China, we have developed a software tool following the "Sustainability Conformity Model" and various manuals to enable companies, mainly SMEs, from the food industry to implement best practice, improvements and innovations throughout the production and handling process, with an overall positive impact on the sustainability of their processes and in view of obtaining specific certifications. A complete training toolkit for Sustainable Food Advisers has also been developed.

Results: Since the project started, it assessed 613 (out of 1196 collaborating in the project) Chinese companies based on this Sustainability Conformity Model and 1196 Chinese SMEs have collaborated in voluntary auditing programs.

The Sustainable Food Adviser training is also being a complete success as its main innovative advantages are the European Certifications (EQF and e-CF) and its methodology based on learning by working on real life case studies already implemented in SMEs

Discussion: The Sustainability Conformity Model offers a framework to evaluate the sustainability of the food companies from an environmental, social and economic point of view, and to identify a set of recommendations to improve their behavior towards sustainability.

Conclusion: Sustainable food advisers promoted and contribute to implement new sustainable production and consumption models and certification tools (SFC Certification) in the Chinese food. Training is based on the Capacity4Food software tool which helps SMEs in the food sector to improve the efficiency, environmental performance and CSR of their processes and enhance the visibility, exportability and market penetration of their products domestically and abroad.

XI. Circular Economy: Application of LCA and the Role of Steel Industry

Authors: Mr. Kumaraguru R, Mr. Aniket Bodewar, Ms. Sonali Kamble
Organization: TATA Steel (India)

Abstract

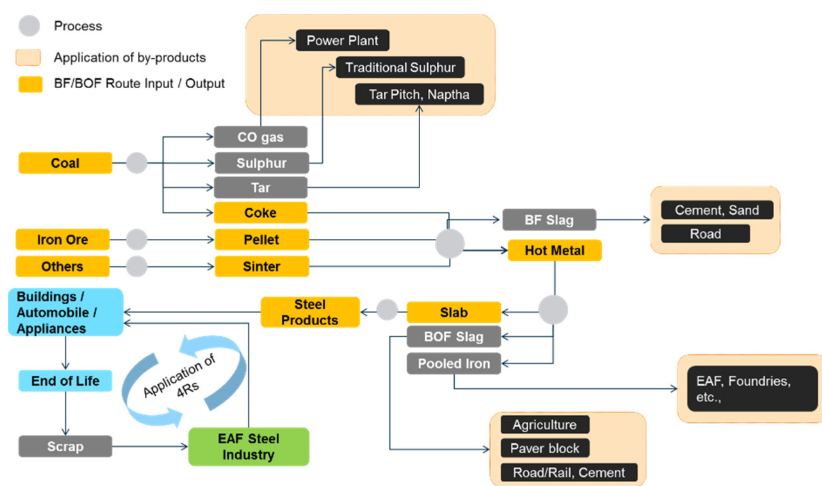
Introduction: A Circular Economy based business model makes a compelling case for sustainable development. It promotes a business model with zero waste which is in total contrast from a linear model which is based on take, make, use, and dispose principle. The concept of 4Rs – Reduce, Re-use, Re-manufacture and Recycle enable existing businesses to move towards Circular Economy. Quantification of these concepts is imperative to measure and achieve sustainability. Life Cycle Assessment is the technique that defines, measures, analyses and identifies improvements (using the 4Rs concept) in product's value chain. LCA takes the holistic approach in estimating the product's environmental footprint and help avoid shifting of impacts to other life cycle stages. Steel is THE material that fully aligns with the concept of Circular Economy and can drive businesses to achieve the circular model. This analysis shows how LCA helps in establishing Steel as a permanent material in the Circular Economy.

Materials and Methods

- ISO 14040, ISO 14044, worldsteel LCA Methodology
- LCA software, Research publications

Results and Discussion

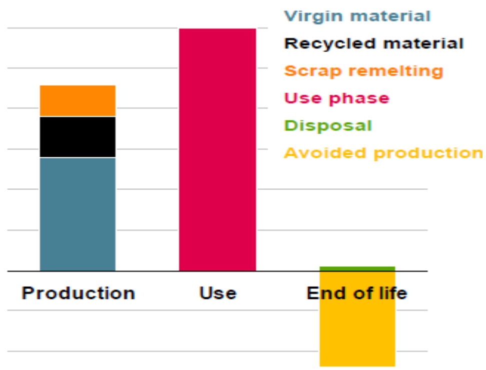
- Fig 1: Life Cycle of Steel and its Applications



- Unlike other materials, steel is completely recyclable and LCA helps in quantifying the positive impact associated with scrap recycling at the end of life
- BF/BOF based steel making generates about 10 different by-products. LCA helps in identifying the environmentally best application of those by-products

Fig 2: Environmental Impact of Steel Product (Eg. Kg CO2e/t product)

Fig 3: Potential replacements by LD Slag (kg CO2e avoided/t slag)



Source: WorldSteel

Conclusion

- LCA will continue to play a crucial role in the steel industry. Technological advances will identify new applications for by-products which will replace the conventional input materials. LCA will help in understanding the environmental impact in replacing those conventional input materials. LCA effectively proves the circularity of steel at its end of life and the related impact from scrap usage.

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XII. Sustainable Recycling Industries Project; Providing the Seed for LCI Data in India

Author: Dr. Amir Safaei
Organization: ecoinvent

Abstract

Sustainable Recycling Industries (SRI) is a project funded by the Swiss State Secretariat of Economic Affairs (SECO) and is jointly implemented by the Institute for Materials Science & Technology (Empa), the World Resources Forum (WRF) and ecoinvent Centre, through three linked components:

Life Cycle Inventories (SRI-LCI): SRI develops the local capacity for conducing LCA and generating LCI, and collects and provides regional LCI data used in life cycle studies of environmental and economic performance of industrial activities;

Recycling Initiatives: SRI improves the local capacity for sustainable recycling, and

SRI Roundtable: SRI organizes a stakeholder consultation for the development of sustainability criteria for secondary materials.

Ecoinvent centre is the implementer of the SRI-LCI in India, Latin America (Brazil, Colombia, Peru) and South Africa. SRI-LCI has commenced in 2015 and will be concluded by the end of 2017. As a part of the LCA/LCI expertise development, capacity building workshops, with tailored aims and formats to suit a wide range of audience, has been carried out in India. The data collection projects for the provision of LCI data of back ground processes (electricity, transportation, and construction) and important sectors have also started and preliminary results are available.

The purpose of this paper to describe the SRI-LCI project, its goals, status and hitherto progress in different sub-tasks across India. A summary of capacity building workshops conducted in India is presented by analyzing the post-workshop survey. The LCI data collection and provision projects in India, including the preliminary constructed datasets for India, are also discussed and presented. Future activities in capacity building and data collection, and the synergies for collaboration close the discussions.

XIII. Towards a Global Network of Interoperable LCA Databases

Authors: Llorenç Milà i Canals[1], Hugo Schally[2], Wesley Ingwersen[3], Cecilia Leite[4], Tiago Braga[4], Andreas Ciroth[5], Simone Fazio[6], Mark Goedkoop[7], Christoffer Krewer[8], Sangwon Suh[9], Kiyotaka Tahara[10], Johan Tivander[11], Elisa Tonda[1], Bruce Vigon[12], Gregor Wernet[13], Fayçal Boureima[1], Feng Wang[1]

Organization: [1]United Nations Environment Programme, Division of Technology, Industry and Economics, [2]EC DG ENV, [3]U.S. Environmental Protection Agency, [4]IBICT (Brazil), [5]GreenDelta (Germany), [6]EC DG JRC, [7]PRé-Sustainability (The Netherlands), [8]ST (Sweden), [9]University of California (USA), [10]AIST (Japan), [11]Chalmers (Sweden), [12]SETAC (Global), [13]Ecoinvent (Switzerland)

Abstract

Introduction: In March 2016, 13 governments launched the "Global LCA Data Access" network (GLAD), with the vision to establish "a global network comprised of independently-operated and interoperable LCA databases that connects multiple data sources to support life cycle assessment in a way that facilitates sustainability-related decisions". The GLAD network aims at delivering an electronic system and protocol to enable access by users to the majority of the LCA databases and other relevant sustainability data. It allows using data seamlessly in LCA software, with sufficient documentation of metadata that allows for defining "fitness for purpose" by any end user.

Materials and methods: Three working groups (WG) have been launched by the Steering Committee of GLAD network: i) "Network Architecture and Technology" ii) "Nomenclature and iii) "Metadata descriptors". Working groups are co-chairs by experts and gather more than 50 experts worldwide. Each working group has defined a workplan, timeline and corresponding budget for the duration of the project.

Results: As of now, the following deliverables are planned to be completed: Network Architecture and Technology: Review of existing examples and technologies for interoperable databases, and development of a central and multi-lingual user interface, enabling access to "nodes" (database owners providing LCA data fulfilling technical specifications of GLAD) worldwide, ensuring interoperability through agreed nomenclature and metadata descriptors; Nomenclature: Agreed elementary flows mapping file ready for critical review of existing nomenclature mapping systems; Metadata descriptors: Identification of data quality assessment needs, with a focus on meta-information.

Conclusion: In conclusion, enhanced data accessibility and interoperability will benefit the whole community and the mainstream applicability of LCA, and is the foundation for key sustainability initiatives. Policy makers are relying on it for e.g. developing sound SCP policies. Industries will be able to base their innovation and strategic sustainability decisions on more robust information.

XIV. Criteria for reviewing LCA data sets

Authors: Andreas Ciroth[1], Alessandra Zamagni[2], Chris Foster[3], Jutta Hildenbrand[4], Bruce Vigon[5], Guido Sonnemann[6]**

*Organizations: [1]GreenDelta, [2]EcoInnovazione and ENEA, [3]EuGeos, [4]Swerea, [5]SETAC, [6]Bordeaux University, *authorship pending*

Abstract

Introduction: Quality assurance for LCA data sets is an essential aspect when building credible LCA databases and when using generic LCA data sets from such databases. Since ISO 14040 and 14044 and also the "review ISO" 14071 address quality indicators and review aspects for entire LCA case studies only where datasets are applied in a defined context, a broadly accepted, internationally agreed criteria set and approach for reviewing LCA data sets outside of a specific study context is lacking so far.

Methodology: In order to close this gap, a project was launched within the UNEP/SETAC life cycle initiative to develop and coordinate review criteria specifically for LCA data sets. This new set of criteria builds on, and combines, existing solutions for individual databases quality systems, and extends them. One newly included aspect is for example materiality, which is used for assessing completeness of the data set.
Meanwhile, a set of criteria with scores and assessment rules has been developed, presented and discussed in an international stakeholder workshop, in Nantes in France in May 2016; afterwards, the criteria development has been finalized.

Results and Conclusion: We will explain the rationale for developing the set of review criteria, present and discuss the developed criteria, and show an application on two different data sets, from two different existing database systems.

XV. Constructing a New Waste Input-Output Database and its Application in Life Cycle Analysis

Author: Yasushi Kondo

Organization: Waseda University (Japan)

Abstract

Introduction: A decreasing rate of material stock accumulation in developed economies will lead to a sizable decrease in the demand for materials recovered from waste products. Thus, an LCA incorporating a constant, predetermined recycling rate of recovered materials, could potentially yield misleading conclusions. With this background, we have developed a new waste input-output (WIO) database for Japan, in which data on disaggregated waste flow like animal and food waste, paper waste, iron and steel scrap, non-ferrous metal scrap, slag and sludge are compiled.1 In this study, we share our experience in developing database and introduce its application.

Method: The WIO analysis1 is a unique framework of hybrid input-output analysis (IOA), consisting of an accounting system and analytical models. Using WIO, hybrid LCA studies2 can be conducted with a proper consideration of waste/by-product flow. In developing our database, we have used data on large business establishments' plans and results of industrial waste management. Although one can obtain PDF files of the latest plans and results from the local government through the Internet, those files do not provide computer-readable numerical data. Therefore, we downloaded all those PDF files through the Internet and then developed a large database of industrial waste generation by large establishments. The database provides establishment-level information on industrial waste generation by waste types and by industries.

Discussion: Having developed a new method to identify inter-industry waste flow based on publicly available data sources, we have constructed a more reliable database. Because establishment-level information is available, in addition, the developed database could contribute to an uncertainty analysis for LCA and MFA.

Acknowledgements

This study is a part of a research project for the development of methods and databases for environmental hotspot analysis, which is a three-year project for 2014 to 2017 funded by Japan Science and Technology Agency

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XVI. Developing Readiness for Creation of Indian LCA Database/Datasets

Authors: Sanjeevan Bajaj, Archana Datta, Sakshi Bhargava
Organization: Federation of Indian Chambers of Commerce and Industry (FICCI)

Abstract

Life Cycle Assessment (LCA) can be an important tool to reduce environmental impacts from growing industrialization. Identifying the most significant causes of environmental impacts along supply chains can be invaluable in improving the sustainability of a product and/or production process. However, the data requirements for LCA studies are quite high - detailed production inventories of all processes along the life cycle need to be evaluated. Such activities can be undertaken only if locally relevant Life Cycle Inventory (LCI) datasets are available.

The development of reliable LCI data typically requires considerable expert time inputs and expense, requirements that have generally impeded the application of LCA in India. The lack of widely available, critically reviewed, comprehensive LCI databases is the main reason why LCAs in India are frequently dismissed as expensive and time consuming.

Federation of Indian Chambers of Commerce & Industry (FICCI) with support from UNEP-SETAC Life Cycle Initiative recently concluded a project on 'Developing readiness for creation of Indian LCA database/datasets' to raise awareness on the need for LCA Data in the context of Sustainable Consumption and Production, as well as enhanced engagement among a range of Indian stakeholders.

Following activities were completed under this project:

- Consultations with key stakeholders to identify key issues and opportunities to facilitate exchange of views on how readiness for creating national LCA database/datasets may be developed
- Preparation of roadmap for Indian LCA Database development

The paper focuses on findings of project including key drivers and issues for developing Indian LCA database. It will also showcase the way forward for any future activity taken up in on developing databases in India.

***Keywords**: Life Cycle Assessment, Life Cycle Inventory, Database, Datasets*

XVII. Product Stewardship through Life Cycle Assessment

Author: Sandeep Shrivastava
Organization: Ambuja Cement (India)

Abstract

Introduction: Ambuja Cements Ltd (ACL), a part of the global conglomerate LafargeHolcim, is one of the leading Indian cement companies. Cement is the most important raw material for any construction activity, and its production includes intensive use of natural resources. Being an environmentally responsible company, ACL makes constant effort for resourceful material management by using alternative fuel (AFR), and wastes like fly ash to reduce clinker factor and improved Thermal Substitution Rate (TSR). With such innovative strategies, Portland Pozzolana Cement (PPC) amounts to over 92% of our cement production.

ACL constantly strives to set the benchmark for its product quality by focusing on responsible product design, raw material consumption, sustainable fuel mix and innovative product development. For this purpose, ACL has developed Environmental Product Declaration (EPD) after a Life Cycle Assessment (LCA) of PPC product was conducted at one of our plants in Himachal Pradesh.

Methodology: The study was conducted in accordance to ISO 14040 & ISO 14044 requirements as well as Cement Product Category Rules (PCR) UN CPC 3744 for the assessment of the environmental performance of cement product.

The study was conducted for the period of “Jan 2015 to Dec 2015”. A cradle to grave approach was followed for the study and relevant primary and published data were used to draw the conclusions and comparisons with other international cement manufacturers.

Results: The significant comparisons on the basis of published EPDs are:

1) The primary energy demand at ACL is fairly lower than many other players;
2) Global Warming Potential (excl. biogenic carbon) and Ozone layer depletion potential of ACL product is comparatively lower than many other int’l players;

Conclusion: The study highlighted further improvement opportunities for ACL and also displayed the company’s leadership in the Indian cement industry in the field of product stewardship and sustainable business practices.

This initiative added another feather to our cap by making Ambuja Cements Limited the first Indian cement company with Environmental Product Declaration in place.

XVIII. ISO 14001:2015 - How Companies can address the new requirement of "Taking a Life Cycle Perspective" when identifying and assessing Environmental Aspects and Impacts

Author: Martina Prox
Organization: ifu Hamburg (Germany)

Abstract

Introduction: In 2015 the revision of the Environmental Management standard ISO 14001 was published. Companies with a certified Environmental Management System (EMS) will have to follow the new version of the standard latest from 2018. All companies getting a newly certified EMS need to apply the new version directly. The contribution will give insights on the possibilities that companies have to comply with in the requirement of taking a life cycle perspective and which opportunities for Life Cycle Management is bringing this development to the companies.

What's new in ISO 14001: 2015
The standard ISO 14001 for Environmental Management Systems has been revised and the new requirement to take a life cycle perspective when assessing the environmental relevance of the company's activities has been added. Environmental Management Systems have been undergoing a development not only reflected in a revised management standard, but also in corporate practice.

Environmental performance assessment according to ISO 14001 used to take into account the system boundaries of one organization. Product environmental performance has been measured considering a life cycle perspective applying LCA according to ISO 14040 and ISO 14044. Both types of approaches have co-existed in corporate practice but were hardly linked. However, this is changing right now. Organizational and product related approaches require interrelated, quantified physical data with a life cycle perspective.

Conclusions: Developed originally as a product- or process-oriented approach (ISO 14040 and ISO 14044) corporations start to apply LCA to assess organization's environmental impacts, which now is also possible according to the new guidance document ISO/TS 14072:2014 on LCA of Organizations (ISO 2014). Thus the somehow artificial separation between a product's perspective and an organizational perspective that can be observed in business practice for is no longer useful or at least limiting synergies and life cycle innovation.

XIX. A Programmatic Approach to Mainstreaming Life Cycle Innovation

Authors: Philip Strothmann[1], Guido Sonnemann[2] And Jim Fava[1]*
Organizations: [1]Forum for Sustainability through Life Cycle Innovation, Berlin, Germany
[2]University of Bordeaux, Bordeaux, France

Abstract

Over the past two decades, we have made significant progress in achieving methodological improvements and building capacity to conduct life cycle assessment studies and generating national data sets. Life Cycle Management (LCM) has been also been growing to focus on policy and use of life cycle information. However, LCM is still not applied on a large enough scale to affect significant change. One challenge that will need to be overcome is the lack of visibility and reach of the Life Cycle Community.

To achieve this objective, two major issues for mainstreaming LCM need to be addressed that are intrinsically linked: collaboration and communication. In order to radically increase the take up of Life Cycle based approaches in business and government, the Life Cycle Community, including life cycle professionals and users of life cycle information, should enhance global collaboration among itself, as well as with others and communicate to a wider set of stakeholders.

To facilitate this global coordination and communication effort, the Forum for Sustainability through Life Cycle Innovation has been established in 2015. It provides a home for the life cycle community, acts as a central information and networking hub and is currently developing a shared set of ideas and principles to ensure coherent advocacy efforts throughout the world. The FSLCI's overall objective is to broaden the understanding and application of life cycle innovation to enhance sustainability on a global scale.

The presentation will provide an overview of the achievements of the FSLCI during its first year of existence and outline its programmatic approach for the next two years to further global coordination, collaboration and communication to advance life cycle innovation.

XX. Low Environmental Impact Printing with HP Indigo Digital Press for Production of Flexible Packaging

Authors: Ms. Upasana Choudhary, Mr.Hajime Machikawa, Ms. Noa Falk-Yogev
Organization: HP India

Abstract

Aim and Scope: In 2014, HP had introduced HP indigo 20000 digital press which has been revolutionizing flexible packaging market ever since. Unlike conventional printing technology, digital printing requires neither plates nor cylinders and enables new markets such short run, versioning, and variable data printing for the flexible packaging market. The aim of this study is to assess the environmental impacts of coffee pouches made using flexible packaging and printed on all exterior surfaces using each of three alternative printing technologies; Gravure, Flexo and Digital. In particular, the study explores the environmental impacts of printing and how it might change with different printing techniques and different print volumes. This study is based on the attributional LCA approach. The LCA model and report follows ISO 14040 (ISO, 2006a) and 14044 (ISO, 2006b) requirements for comparative LCA studies intended to be disclosed publically.

Conclusion: Printing can contribute up to 30% of the cradle-to-gate life cycle impacts. In the printing stage, the energy consumption during printing is shown to be the largest environmental hotspot. Many of the printing impacts considered in this LCA are significantly affected by the source of electricity generation followed by material waste. Printing with the HP Indigo 20000 digital press demonstrates low environmental impacts across all environmental impact areas at their associated economical job sizes across all 13 environmental impact categories considered. At a ≈3,000 m^2 print job size, the HP Indigo 20000 has lower impacts than the CI flexo print system across all impact categories considered, generally by a margin of 40-65%. At a ≈5,000 m^2 print job, the HP Indigo 20000 has lower impacts than printing with rotogravure across all categories considered, generally by a margin of 60-80%.

The HP Indigo 20000 digital printing advantage of lower environmental impact carries through up to print job sizes of 10,000 m^2.

Reference: Nathan Ayer, Lise Laurin. Life Cycle Assessment Comparison of Flexible Packaging Printed Using Three Different Methods for Short-Run Jobs. By EarthShift Global, LLC

XXI. Social Life Cycle Impact Assessment in Value Chain – A Pilot Study in Steel Industry

Authors: Ambalika Gupta, Ramachandra Rane
Organization: Mahindra Sanyo Special Steel Pvt. Ltd. (India)

Abstract

Steel has always played an indispensable role in the history of any country on the road to growth and development. The Social, Economic and Environmental impacts of the industry have also been acknowledged. Efforts are made to monitor, reduce, check and mitigate the environmental impacts like depletion of the non-renewable resources, acidification, eutrophication, emissions and other related threats. The social impacts, any industry that matter can cause across its value chain should be accepted. It is interesting to undertake a study where the value chain is spread across the geographies from developed to the developing country like that India.

In an attempt to study the social impact of its product Mahindra Sanyo Special Steel Pvt Ltd (MSSSPL) undertook the pilot case study with one of our customer by using the matrix developed as a part of the social roundtable. Ten companies from various industries have come together under the guidance from PRe to devise and validate the methodology to conduct Social Life Cycle Assessment. The product considered is a tapered roller bearing produced by MSSSPL.

Conclusion

Scale-based and the quantitative approaches have been tested to prove their feasibility and of the relative indicators. As the product life cycle covers an emerging country India, it was meaningful to test all the indicators and their feasibility, by considering the different local contexts. India is considered a country with perceived high social hotspots, but these risks can be seen as an opportunity for all the companies that have a good level of commitment towards their social responsibility.

XXII. Avoided CO_2 Emissions from Petrochemical Products - Methodology and Case Studies

Authors: Mr. Rajesh Mehta[1], Ms. Gretchen Govoni[2], Mr. Sachin Nande[1], Mr. Raviteja Pabbisetty[1], Ms. Neena C.[1], Mr. Abhijeet Parvatker[1], Ms. Suchira Sen[1], Mr. Ananda K. Sekar[1], Dr. Ashok Menon[1], Dr. Avantika Shastri[1], Mr. Harald Pilz[3], Ms. Evelin Kletzer[3], Mr. Bernt Brandt[3]
Organization: [1]SABIC Research & Technology Pvt. Ltd., [2]SABIC Corporate Sustainability, [3]Denkstatt GmbH

Abstract

Recent developments in climate science warn of a dire need for steep reductions in global GHG1 emissions. According to IPCC2, manufacturing industry accounts for 30% of global CO2 emissions and the chemical industry accounts for 17%3 of this share. This indicates fair potential for the industry towards CO2 emission reductions. However, this only accounts for direct industry emissions, while the actual potential for chemical industry is significantly higher enabled by introduction of products and technologies that can avoid significant emissions during use and disposal.

The Avoided Emissions concept developed by ICCA4 along with WBCSD5 is a measure of reductions in GHG1 emissions enabled over life of a product, when compared to the market incumbent product servicing the same application. While ICCA (2009) is based on a market sector approach, subsequent work by ICCA and WBCSD (2013) recommends a product-based approach to avoided emissions. Wider application of such methodologies by companies for various purposes from corporate reporting to portfolio assessment and technology development present a need for adoption of a hybrid approach. This presentation will cover overview of learnings from developing unique avoided emission methods for several value chains such as fertilizers, polymers and base chemicals. The improvements provide sound basis for reporting avoided emission benefits and setting improvement targets at a corporate level, potentially for industry advocacy and as the basis for determining relative GHG benefits for commercial product portfolio assessments.

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XXIII. Sustainability assessment of product with the application of life cycle assessment and foot printing tools

Authors: Dr. R. K. Sharma, Sarang Khati
Organization: India Glycols Limited

Abstract

Industries can focus sustainable development, by looking at its Energy Usage, Carbon Footprints (CFP) and Life Cycle Assessment (LCA) of products by integrating all as Life Cycle Management System.

In the business community sustainability is coined “the triple bottom line”, expressing that industry has to expand the traditional economic aspects to include environmental and social dimensions - to create a more “sustainable business”. Based on this management system, IGL is continuously working for sustainable development.

Life cycle thinking expands the traditional focus on manufacturing processes to incorporate various aspects associated with a product over its entire life cycle. The producers become responsible for the products from cradle to grave and has, for instance, to develop products with improved performance in all phases of the product life cycle.

The main goal of life cycle thinking is to reduce resource use and emissions from/to the environment as well as to improve the social performance in various stages of a product’s life. LCM is a dynamic process; organizations begin with small goals and objectives with the resources and becoming more ambitious over time.

In this way, companies can achieve cleaner products and processes, a competitive advantage in the marketplace, and an improved platform to meet the needs of a changing business climate.

Corporate sustainability initiatives have grown in number, scope and size in recent years. Consumption of manufactured products may have effect on resources and the environment. These effects occur at every stage in a product's life cycle-from the extraction of the raw materials from the ground through the processing, manufacturing, and transportation phases, ending with use and disposal or recycling. The effects can either be direct (such as air emissions produced from automobile usage) or indirect (such as the pollution and impact on waterways from the production of electricity used in the manufacturing process). Life Cycle Assessment (LCA) can be best suitable methodology in this case as it quantifies these direct and indirect effects of products and processes.

The present LCM system is integrated with following ISO 14044:2006 and ISO 14040:2006 standards. India Glycols Limited (IGL) is the first organization worldwide generates products as Ethylene Oxide (EO) and its Derivatives through bio route and carried out LCA study of Ethylene Oxide, EO downstream products and its Derivatives. The input material for Bio-EO is Ethanol obtained from sugarcane molasses and input material for conventional EO is Ethylene obtained from crude oil. Result as per LCA methodology like IPCC 2013 GWP 100a shows that Life cycle impact of Bio-EO is lowest, compare to EO through petro route.

Life Cycle Assessment aims at specifying the environmental consequences of products or services from cradle to grave/gate. In ISO 14040, LCA is defined as the "compilation and evaluation of the inputs, outputs, and potential environmental impacts of a product system throughout its life cycle". The core application of LCA concerns product related decisions support. It can be hotspot identification in product systems, product development, product comparison, green procurement and market claims. However, LCA is also, next to other tools, important for technology choices, setting technologies into a product related chain perspective.

LCA is increasingly used at a strategic level for business development, policy development, and education.

XXIV. Technological and Life Cycle Assessment of Organics Processing Odour Control Technologies

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Abstract

As more municipalities and communities across the world look towards implementing organic waste management programs or upgrading existing ones, composting facilities are emerging as a popular choice. However, odour from these facilities continues to be one of the most important concerns in terms of cost & effective mitigation. This paper provides a technological and life cycle assessment of some of the different odour control technologies and treatment methods that can be implemented in organics processing facilities. The technological assessment compared biofilters, packed tower wet scrubbers, fine mist wet scrubbers, activated carbon adsorption, thermal oxidization, oxidization chemicals and masking agents. The technologies/treatment methods were evaluated and compared based on a variety of operational, usage and cost parameters. Based on the technological assessment it was found that, biofilters and packed bed wet scrubbers are the most applicable odour control technologies for use in organics processing faculties. A Life

Cycle Assessment was then done to compare the environmental impacts of the packed-bed wet scrubber system, organic (wood-chip media) bio-filter and inorganic (synthetic media) bio-filter system. Twelve impact categories were assessed; cumulative energy demand (CED), climate change, human toxicity, photochemical oxidant formation, metal depletion, fossil depletion, terrestrial acidification, freshwater eutrophication, marine eutrophication, terrestrial eco-toxicity, freshwater eco-toxicity and marine eco-toxicity. The results showed that for all impact categories the synthetic media biofilter had the highest environmental impact, followed by the wood chip media bio-filter system. The packed-bed system had the lowest environmental impact for all categories.

XXV. Approaches for a Regionalized Environmental Policy Based Distance-to-Target Weighting in LCAs

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Abstract

Introduction: Recent methodological developments1, 2 have given new momentum to weighting as an optional element in Life Cycle Assessment (LCA). Distance-to-Target (DtT) weighting is based on the distance of policy (desired) targets to current environmental situations. So far, it includes policy targets for a few regions or countries only (e.g. Swiss targets in the “Ecological Scarcity Method”3 (ESM)). However, as product supply chains are spread over many countries, their specific environmental situations and targets should be incorporated in overarching approaches on a global scale.

Materials & Methods: The current study is carried out, in order to understand the influence and the effect of different countries and regions with their specific environmental policy targets. Considering different perspectives (consumer-, producer-, worst-case-regions) on a global scale, two new DtT weighting approaches are developed in addition to the existing ESM. Their applicability is examined by comparing steel and aluminum automobile components in a case study.

Results & Discussion: In comparison to existing DtT weighting methods, this work provides country-specific results based on different weighting perspectives in national, regional and global contexts considering three environmental parameters (CO2eq., SO2, Water). The analysis reveals significant differences in the obtained weighting results depending on the examined perspectives and considered regions with their respective target values. Normalization flows are also identified to have significant influence on the respective eco-factors.

Conclusion: The analysis shows that the introduced DtT weighting approaches are applicable for LCA practitioners. Furthermore, the possibilities of an advanced weighting on a global scale with different perspectives is believed to lead to a better understanding of regionalized weighting results of global products’ life cycles. However, for a complete implementation of the presented approaches, further data gathering is needed on environmental situations, as well as on policy targets from global down to national levels for all relevant environmental parameters.

Keywords: *Distance-to-Target, Weighting, Normalization, Ecological Scarcity Method*

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XXVI. Regionalized Life Cycle Inventory of Power Producing Technologies and Power Grids in India

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Organizations: Chalmers University of Technology, Sweden[1], Paul Scherrer Institute, Switzerland[2], ecoinvent Centre, Switzerland[3]

Abstract

Introduction: Indian electricity production mix, technological level, and local conditions vary considerably across the states and union territories. Hence, national-level life-cycle inventory of Indian power systems as presented in ecoinvent v3.2 may not represent well this high variability. This study aims to prepare a consistent regionalised model of the same system with local data to evaluate necessity of such regionalised inventories for a large country - India.

Materials and Methods: Data collection covers domestic power production, inter-exchanges among the regional grids, and import from Bhutan in 2012-2013. Region-specific key plant parameter data (e.g. efficiency, fuel quality) are mostly unavailable on plant level: if at all, relevant data are available on a statelevel.

Further, transmission and transformation (T&T) losses have been inventoried. Local emission data are also mostly unavailable except emissions of CO_2. Emission values for other important emissions (NO_x, SO_x, CH_4, CO, PM) are therefore calculated based on expert-opinions and literature information.

Results and Discussion: The impact assessment results show high variations among the power grids due to variation in grid mixes, key parameter values and T&T losses. For example, Global Warming Potential (GWP 100a in kg CO_2eq/kWh, IPCC 2013) score of power from the Eastern-grid (1.6) is nearly four times higher than the North-eastern-grid (0.4) and also considerably higher than the other grids. To compare, the GWP score of the national average of Indian electricity supplied at high voltage (1.3), in ecoinvent v3.2, is off the both lowest and highest regional scores. In general, grids with higher contribution from hard coal score higher in GWP. Moreover, relatively high

T&T losses corresponds to gradual increase in emission down the chain from gross production.

Conclusion: This confirms the validity of regionalised inventories for countries with large mix and key parameter variations to provide higher quality information and accuracy in life-cycle studies.

Keywords: *India, Life Cycle Inventory Data, Regionalisation, Uncertainty*

XXVII. Application of Life Cycle Assessment to Concrete Production using Alternative Materials

Authors: Sandeep Shrivastava[1], Sunil Jatoliya[2]
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Abstract

The life cycle assessment (LCA) is used for analyzing and comparing the environmental impacts associated with the product or product system throughout its life cycle. In last decade, a number of LCA studies have been published to evaluate the environmental burdens of the PV systems. LCA results for the PV systems are significantly vary with the LCI data and location. The purpose of this study is to collect new LCI data for the PV production and calculating the energy payback time, greenhouse payback time and carbon footprint of the silicon-based PV system i.e. mono-crystalline, multi-crystalline and ribbon-silicon. The SimaPro 8.1 and PVsyst 5.74 are used for the study. SimaPro 8.1 software has accepted worldwide for evaluating the environmental impacts of product and product system. To calculate EPBT, GPBT and carbon footprint, cumulative energy demand and GHG emissions are required to calculate first, therefore, this study uses Single-issue method in SimaPro 8.1 software to estimate the CED and GHG emissions for various production processes of PV system. The life cycle inventory data used for this study are based on the Chinese production, and collected for the years 2011-2013. A 100 kWp building-integrated systems installed at Jaipur, (Rajasthan), India has considered for the study with local tilt angle of 27 degrees. The PVsyst 5.74 Software has been used to calculate the annual electricity generation. The EPBTs and GPBTs values evaluated by the study are ranging from 1.42-1.98 years and 0.86-1.22 years for all silicon based PV technologies.

***Key words**: LCA, PV system, BIPV, cumulative energy demand*

XXVIII. Life Cycle Assessment of Products from agro Based Companies in Uganda

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Abstract

Introduction: Despite the fact that Life Cycle Assessment (LCA) is a very vital tool, it has not been used in Uganda most likely because very little is known about it. In an attempt to initiate and promote LCA in Uganda, a partnership among Makerere University, selected agro based companies and Uganda National Bureau of Standards (UNBS) was initiated with the broad aim of promoting life cycle thinking for improved agricultural products competitiveness on regional and international market.

Materials and Methods: System boundary was based on cradle-to-gate. Functional units were; 1kg of fruit (Pineapples, Mangoes, Bananas) leaving the farm gate, 1kg of dried fruits and1litre of fruit juice produced at the factory per year. Net emission from land cover changes were estimated using; $\Delta C = \Sigma$ (Activity data * Emission factor). Calculations of N_2O from manure management were obtained using; $N_2O = N_{ex} * FRAC_{GASM} * EFA$. CML 2002 together with CML-IA characterization factors were used to get impact category indicator results.

Results, discussion, conclusion & recommendations: Results show that carbon dioxide emissions were from areas where land cover/use change was from tree cover to crop fields leading to global warming potential

impact. This impact was also brought about by the use of fuel. The other impact categories (ecological toxicity, human toxicity, photochemical oxidation and abiotic depletion) were brought about by the packaging material used. Results also showed that energy consumption was highest at the processing stage of product life cycle. There was also a problem of lack of records.

Results suggested that there is need to avoid and/or minimize conversion of tree/forest covered land to agricultural land use because of the high carbon emissions associated with the process, a need to resorting to renewable energy sources of which are potentially available in Uganda and development of a national database to support LCA efforts.

XXIX. Life Cycle Inventory Data for Carbon Footprint – A Case of Cut Flower Production in Kenya

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Abstract

Aim: Conventional approaches including linear thinking rely on the availability of plentiful and inexpensive natural resources to satisfy demand. With increasing population and declining resources, systems that can support current and future generations are crucial. The linear 'take, make, and waste' approach is becoming less viable and Life Cycle Assessments (LCAs) thinking becoming much popular in making environmental decisions of all production systems including cut flowers.

Introduction: Successful and sustainable Kenyan cut flower industry development depends on a shared understanding of the social and environmental impacts of its products and services. Quantifying environmental footprints of a unit of flowers requires reliable local databases benchmarked with other databases.

Scope: Data for computation of Carbon dioxide equivalent (CO_2e) emissions in a unit of cut flower from gate to gate was sought from random unidentified Kenyan farms.

Materials and Methods: Selected CO_2e computational tools and Intergovernmental Panel on Climate Change Guidelines were used to define the data. Structured questionnaires and interviews were used to collect the data which were processed for the emissions.

Results: Lack of a national database meant reliance on individual company data kept which was varied depending on the cropping cycle, management style, rose flower species, locality, among other factors. Regional averages were used.

Discussions: Quality database development for LCAs is an expensive and time consuming worthy venture. Reliable, quality and all product-phase inventories are vital. Proper inventories can lead to sharing of best practices and mitigate environmental burden and manage brand risks. Local databases are crucial for carrying out LCAs and hence need to allocate resources for developing databases.

Conclusions: Life cycle inventory data will help with better decision making and drive the desired environmental results locally and internationally.

XXX. Benefits of Local Life Cycle Inventory for Sustainable production and Consumption

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Abstract

LCA helps us make informed choices along the entire chain of a product's life cycle, from cradle to grave, taking into account all the relevant impacts on the economy, the environment and the society.
The impacts of all life cycle stages need to be considered comprehensively by all the stakeholders of the society like the citizens, the companies and the governments, when they make decisions on sustainable consumption and production patterns, policies and management strategies.

Key to accurate calculation of various impacts is locally available life cycle data. Local data helps in more nearly accurate calculation of results and thus better decision on sustainable production and consumption. Impediments to creation of local data can be

1. Absence of or apathy to life cycle culture
2. Lack of local regulation and implementation
3. LCA research not being part of higher studies
4. Lack of grants to promote research in LCA domain

Local data can bring benefits for all the stakeholders of the society.

Industries, for instance, may integrate the life cycle concept with their strategy to guide product and process development in a more sustainable direction. Incorporating life cycle and sustainability management will improve image and brand value for both world market players as well as smaller suppliers and producers.

Government can share global responsibility towards sustainable production and consumption and ensure sustainability benefits to its citizens. Such initiatives by Governments strengthen the industry in regional and global markets.

Global citizen is the ultimate beneficiary of this initiative as this helps consumption through better information for purchasing, transport systems, energy sources etc.

XXXI. Life Cycle Impact of Carry Bags in India: A Cradle to Gate perspective

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Organization: University of Delhi[1,3,4], Indian Institute of Technology[2]

Abstract

Introduction: In the last decade, due to rising incomes in India, there is an increase in consumption of clothing and therefore the use of carry bags. LDPE, Polypropylene and Paper bag are the three most popular carry bags handed out by retailers when people purchase clothes. Plastic seems to be a natural target in the pursuit to eliminate all that is not green. Several local government bodies and town-planning bodies have banned usage of plastic bags. In India, Non-woven Polypropylene bags and paper bags are used as an alternative carry bag.

Aim: This study aims to analyse the life cycle impact of three types of carry bags and identify the most sustainable carry bag among the available alternatives using Life Cycle Assessment methodology.

A single use, single trip scenario has been established as the functional unit. **S**ince data for Indian context are still to be included in LCI databases and it compelled the data collection to be done from various sources. Effort has been made to collect data in Indian context, through plant visits and interviews, journal articles, and industrial survey reports. This data has been combined with some data from LCA reports and datasets of other countries to complete the data for various life cycle phases.

Scope: The study generates the life cycle inventory for the considered carry bags and report indicators such as energy use, GHG emissions and water use of the considered carry bags.

The boundary considered is from "Cradle to Gate", involving raw material acquisition, intermediate transport, energy within feedstock production processes including conversion of intermediate material to bag and packaging involved. The information gathered has been utilised to evaluate the hotspots in the life cycle stages which has been utilised to provide recommendations for the industry as well as consumers.

Conclusion: The results would reveal the environmental sustainability of carry bags and help the retailers and policy makers identify the most sustainable carry bag and choose the most environment friendly alternative.

XIII. Life Cycle Thinking and How Optimisation of LCT of Scrap Apps Model Would Result in Promoting Resource Efficiency

Author: Raghav Shunglu
Organization: Scrapapp

Abstract

When discussing 'resource efficiency', how important is it to consider Life Cycle Management Processes (LCMPs) in recycling – particularly, as the ultimate step in consumption, the efficiencies it represents to LCMPs at the production end of the spectrum? Secondly, how does one understand, in a complete vacuum of data and formalised knowledge, the Life Cycle Thinking (LCT) of a heavily informal scrap management system? Is there a way through which this resource efficiency can be quantified, modeled and assessed from an econometric perspective, as well as firsthand experience? Lastly, would it be possible to compute the viability and policy legislative intervention that aim at improvements in LCT? These are some of the questions this paper would like to present from authors who have learnt from trial and error, the tribulations (and successes) of that graveyard of LCT-- the waste and scrap management and recycling sector.

An inquiry into the above necessitates a study of the ScrapApp model (a startup engaged in the waste and scrap management sector) and the efforts it is making to streamline and structure the informal waste management industry in India. At the heart of the scene, lies the Kabadiwala who bridges the gap between the waste generators and the recycling/processing entities. They maximise the resource extraction value compared to any other entity in the formal space due to a few simple practices-- using child labour, not paying minimum wages, dumping of solid waste in open fields while taking only the precious metals, dismantling electronic waste without minimum safety wear etc. From an economic perspective, this is resource maximisation at a must lesser cost as implementation is not stringent and the industry provides employment to a lot of uneducated people who would not get employed elsewhere.

ScrapApp seeks to forge an alternative model of development that is sustainable in the truest sense of the word- trash to trees model that converts the waste and scrap of various malls, residential welfare associations, educational institutions, factories etc. into trees thereby completing a closed loop of collecting, sorting,

transporting and recycling different materials of waste and scrap value. From the proceeds, the planting of trees in bio reserves across the country leads to a reduction in carbon footprint and a balanced ecosystem. However, its forays into the currently informal sector caused ScrapApp to revamp its LCMPs, to enable a symbiotic relationship between the Kabadiwala and the formal sector.

This ScrapApp sought to do by educating the potential supply chains about organized waste management and implementing segregation so as to reduce additional manual labour the garbage room. This paper seeks to analyse the experiences of SrapApp, from its study of the status quo and its observations on inefficiencies from field work. It will also attempt to econometrically quantify, by way of case study the refinement of its models to address such inefficiencies and dwell on the policy and legislative amendments, and the impact it will have on the revamped efficient model.

XXXII. Life Cycle Assessment of Defluoridation of Ground Water using Laterite Soil Based Adsorbents

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**Corresponding author: Dr. Prasenjit Mondal, Department of Chemical Engineering, Indian Institute of Technology Roorkee*

Abstract

Groundwater contamination due to fluoride has become an alarming issue in many countries in the world including India[1]. A large number of common people are suffering from fluoride related diseases due to prolonged consumption of contaminated groundwater water[2]. The present work, deals with the LCA of the defluoridation process using low cost laterite soil based adsorbents. These adsorbents were used to remove fluoride from ground water containing 10 mg/l fluoride to meet the WHO recommendation of 1.5 mg/L. The three adsorbents (viz. thermally treated laterite, acid treated laterite and acid-base treated laterite) were made from same raw material by different techniques. The scope of LCA study consists of acquisition of raw materials, transportation, process and final disposal of spent adsorbents by immobilization in the form of clay bricks. The amount of adsorbents is decided on the basis of adsorbent required to treating 600 L of water. Environmental impacts were interpreted with the help of CML 2001 and TRACI. The results from life cycle impact assessment reveals that thermal treated laterite shows maximum impacts followed by acid-base treated laterite. Further sensitivity analysis shows that transportation of raw material from mining site to processing site and production of electricity required to manufacture bricks for disposal of spent adsorbent create maximum impacts.

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XXXIII. Sustainable Smart Home Technologies in India: A Plausible Model for its Design, Development and Dissemination in Indian Cities

Authors: Meenakshi Piplani, Kriti Bhalla
Organization: M. S. Ramaiah Institute of Technology

Abstract

Introduction: The aim of this paper is to evaluate the impact and acceptability of Innovative Smart Home technologies in India and to provide a plausible model for its design, development and dissemination. India is moving rapidly towards becoming a country with 40% of its population (590 Million), which would live in cities by 2030. Consequently, the necessity of Urban Housing will increase rapidly across the country. Furthermore, most of the Indian cities are becoming over-crowded and polluted which demands the development of new, affordable cities that can sustain itself. In order to achieve the aim of sustainable smart cities in the afore-mentioned context, smart home technologies can prove to be a game-changer.

Materials and Methods: This paper explores the features of Smart home Technology that is relevant and desired in the Urban Indian scenario by studying the needs of users across various demographic regions in India. Moreover, the paper also probes into the supporting infrastructures needed for proper installation and use of such technologies. A market survey of existing Smart home technologies was done along with a critical analysis of prevalent research literature. In addition to this, an online survey was conducted to ascertain the usability and need of such technologies in India. A Life cycle analysis (LCA) was conducted for Smart home technologies to better understand the systems and its inherent problems. Moreover, statistical inferences were drawn from the resulting data to derive the socio-economic factors that determine the Smart Home technology that will be suitable in the Indian Context.

Results: Currently, without Government subsidies these technologies are far too expensive. The affordability of Smart Home technologies is a major hindrance in the dissemination of these technologies. The results showed that the Indian people are apprehensive of the new technology in terms of security concerns, complexity and lack of understanding.

Discussion: Many of these technologies are not fool-proof and still in research and development (R&D) phase, so standardisation and reliability are major concerns. Operation and maintenance (O&M) of these technologies need skilled personnel which was found to be inadequate. Sustainable technologies pertaining to Climate control, A/V control, automated control of electronic appliances and high-tech security solutions exist currently in the Indian Market. However, the supporting infrastructure was found missing in most Indian cities.

Conclusion: Smart home technologies can help us build energy efficient and less polluting cities. The Industry must be standardised by the Government for quality control of products. Affordable, smart sustainable homes will become a reality for the common people only via mass scale production and consumption. The rebound effect and backfire also needs to be considered while widespread dissemination of these technologies. This paper will help the Government in terms of its projected 100 Smart cities plan; and various private stakeholders to understand the current perception of prospective Smart technologies, impact and challenges for better planning and sustainable management in this field.

XXXIV. Guided Case Study as an approach to allow companies mastering LCA

Authors: Franziska Moller, Andreas Ciroth
Organization: GreenDelta GmbH, Berlin

Abstract

Introduction: The need for Life Cycle Assessment (LCA) information within companies is increasing world-wide. Be it due to laws (e.g. in Europe: directive 2014/95/EU1), in the course of bidding procedures as competitive advantage, on request by clients, or simply for own interest. This leads to a whole new group of LCA practitioners, who do not yet mainly work in the field of LCA and maybe never will, but need to deliver LCA results. For those having to do their first LCA study, maybe even compliant to ISO 14040/14044, this can be quite challenging. What other options are there instead of commissioning the work or hiring an LCA expert?

Methodology: The concept of a "Guided Case Study" is introduced. The general procedure of this service is as follows: A consultant guides the client through the creation of his/her LCA study or through the creation of a baseline model, giving feedback, support and recommendations at all important stages. For the client, it is often the first LCA application. It is shown how this approach helps users understand LCA methodology and create LCA studies often with less effort, but more importantly, increase LCA knowledge so that it is easier for clients to adapt, change and expand their models in the future independent from a consultant. Second, it is shown how this approach helps to understand how LCA should best be implemented in an organisation. The concept will be explained using a real-life case that was conducted with a client, an international packaging label producer.

Results and Conclusion: The case will show how the client was able to conduct LCA studies internally for one example product and several subsequent products explaining the effort, as well as the expertise and benefits gained throughout the process of the Guided Case Study.

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XXXV. Utilization of CETP Sludge for Manufacturing Building Material

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Abstract

Utilization of CETP Sludge for manufacturing building material
The state of Gujarat houses number of industries generating variety of hazardous waste of several million tons per annum, which is required to be safely disposed of. Landfill disposal is becoming more and more complicated because of scarcity of disposal sites and cost of disposal. CEE aims to solve this issue in a sustainable manner by utilizing solid/hazardous wastes from industries for making building materials, which is widely being practiced in developed countries. Hazardous waste generated from a CETP to the tune of 20 tons per day is required to be disposed of in a landfill site the cost of which is more than Rs. 1.2 Cr per annum. By manufacturing blocks/bricks from CETP sludge will lead to reduce to GHG emission, increase life span of land fill site as well as a very cost effective (less than 40% manufacturing cost of conventional method) and environmentally safe product. The bricks will be used for compound walls, paving, flooring, benches for garden and others except residential purposes.

After extensive literature review and consultation with experts and bricks makers, the methodology was developed. In a Lab scale experiment, CETP sludge (up to 15%) was mixed with fly ash, cement, coarse aggregate, lime, gypsum, lime and geo-polymer in suitable proportions and the mixtures were properly blended and bricks were prepared by application of hydraulic pressure through automatic brick manufacturing machine. These bricks were cured by water spraying.

The physical as well as chemical analysis indicated that the product has very good compressive strength of 75 kg/sq. cm and meets the criteria as regards moisture content and water absorption ratio. The curing water meets TCLP test indicating no evidence of any toxic material.

This product utilizes hazardous waste, increases the life of the SLF, reduces the air pollution and GHG emission and limits the usage of land, a very costly natural resource which can be used for other important purpose.

Acronyms
CETP: Common Effluent Treatment Plant; GHG: Green House Gas
SLF: Secured Landfill; TCLP: Toxic Characteristics Leaching Procedure

XXXVI. Evaluating Architectural Concerns in Reducing Carbon Footprint of Dairy Industry

Author: Ar. Nidhi Dixit Laturkar

Abstract

Introduction: Globally major contributors of carbon footprints have been the heavy industries, service sector and urban societies. The paper looks at existing methodology by international Dairy Federation (IDF) and then evaluates how it needs to be altered to suit the institutional frameworks in India. Hence, in the background of these frameworks, a cradle to table approach method of carbon foot printing is established and an attempt is being made to go beyond the existing methods to understand carbon footprint as a tool for architects. The output is in form of comparative analysis of existing layout of chosen case and selected redesign option for it overall carbon footprint. The established methods of certifications are limited to products and materials and buildings in isolation.

Aim: Studying carbon Footprint through different tools and evaluate architectural interventions in reducing carbon footprint of dairy industry.

Scope and limitations

- The study is limited to the western zone of India as it’s the highest producer of milk. (Banerjee, 2007).
- Co-operative model is chosen as project case, as it has been a successful model in India.
- In all the case studies, drawings have not been provided. Hence there is a limitation of study, restricting it to only site layout.
- Software’s used have limitations, as GEMIS does not have base data files for India.
- Currently the existing rating system in India, doesn’t consider dairy sector for certifications.

Methodology

- Literature review method is adopted to study the available carbon foot printing method.
- Case studies were done to understand working of dairies in India.
- Software tools are used to calculate carbon footprint.

Conclusion: The findings were compiled to establish a "cradle to table" approach. A brief comparative analysis is done to understand the difference between the existing designs carbon footprint and the proposed design footprint.

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XXXVII. Life Cycle Assessment of Greenhouse Gases Emissions from Biomass Power: A Study from India

Authors: Dr. Moonmoon Hiloidhari[1, 2*], Ms. Sampriti Kataki[2], Prof. Indu Shekhar Thakur[2], Dr. T V Ramachandra[3], Dr. Anoop Singh[4], Prof. D C Baruah[2]

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Abstract

The environmental footprints of biomass power can be evaluated and compared with conventional power generation systems using Life Cycle Assessment (LCA). Rice straw residue is abundantly available in rural India and it is a potential biomass power feedstock. However, rice production processes, rice straw harvest, collection, transportation and other associated logistics releases greenhouse gases (GHGs). Furthermore, combustion of rice straw for power generation also releases significant amounts of GHGs. The present case study is conducted in Sonitpur district of Assam, India to assess life cycle GHGs emissions from rice straw based biomass power generation. Four different rice production scenarios (traditional and mechanized) are investigated and compared with coal-fired power plant to assess GHGs emissions (CO_2, N_2O and CH_4) footprint. It is observed that the rice production practices and the degree of mechanization influence the GHGs emissions while considering rice straw as feedstock. About 6% increase in CO_2e GHGs emissions has been observed from rice straw based power generation under mechanized methods (1.52 kg CO_2e kWh^{-1}) compared with traditional methods (bullock and animal powered) of rice production (1.44 kg CO_2e kWh^{-1}). Analyzing the rice straw *vs*. coal-fired power plant, it is observed that a substantial amount of emission reduction (47%) is possible in rice straw based power generation compared with coal based power generation (2.12 kg CO_2e kWh^{-1}). The findings of the present study further strengthen the earlier claims of the scientific community that biomass power has less GHGs emissions impacts than coal-fired power plant. However, issues such as the bioenergy impact on land use change, biodiversity needs further investigation.

***Keywords**: Rice straw biomass; Biomass power; Life Cycle Assessment; Greenhouse gas footprint*

XXXVIII. Assessment of Carbon Footprint from Electricity Sector in Nigeria

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Abstract

Global warming have been linked to increasing CO_2 emissions from anthropogenic activities across the globe thereby making greenhouse gas accounting, monitoring and reporting mandatory for nations. We examined consumption trend from the period of 2002 to 2013 in Nigeria's electricity sector using life cycle assessment (LCA). Data was obtained using the online calculator developed for Nigeria by the International Energy Agency (IEA). Data inventory was computed using Formatted Microsoft Excel emission calculator (FMEEC). Result indicated that industrial, commercial and public places and residential accounted for 16, 27, and 57 % CO_2 emissions releases. The carbon footprints increased with increased electricity generation and supply for all the sectors during the period under review. We suggest the accelerated supply of prepaid meter to the residential sector by the Distribution Companies (DISCOs) to facilitate energy efficiency and conservation to reduce carbon footprints vis-à-vis global warming. Nigeria Electricity Regulatory Authority (NERC) should remove all bottlenecks to prepaid meter supply, encourage private sector financing and promote the use of energy efficiency gadgets in homes to curb global warming.

Introduction: Climate change concerns have brought a renewed interest in greenhouse gas accounting and monitoring around the globe. The introduction of efficient metering regime is considered crucial for meeting CO_2 emission reduction targets especially with rising electricity demand [1, 2]. This paper assesses CO_2 emissions from electricity consumption in Nigeria.

Materials and Methods

Goal and Scope

The goal of the study is identifying hotspots of emission discharge in electricity consumption from grid supply using LCA methodology [3, 4]. The scope of this study is only limited to final electricity consumption excluding generation and transmission units. The functional unit is the consumption of 1 Mwh per year from 2002 - 2013.

Data Inventory

Electricity consumption inventory data was collated using online electricity calculator developed for Nigeria by [5] for the period 2002 - 2013. The emission factors used for obtaining carbon footprints are listed in [6]. Inventory was processed with the aid of a FMEEC adapted for Nigeria to obtain carbon footprint (CP) in terms of CO_2 equivalent for CO_2, CH_4 and N_2O per functional unit. The carbon footprint for each year was calculated by multiplying the emissions per electricity consumed by their corresponding global warming potential factors of the gases and adding them up to obtain the CO_2 equivalents (CO_2-e) expressed in tonnes.

Results and Discussion: The results show that there was increasing trend in carbon footprint from the residential sector (figure 1). This could be attributed to the slow pace of industrialization in the country as a result of power outages leading to capital flights. The capital flight also accounted for increases in power consumption from the commercial and public places whereby job losses from the industrial sectors encouraged setting up of small retail businesses in the country (figure 2).

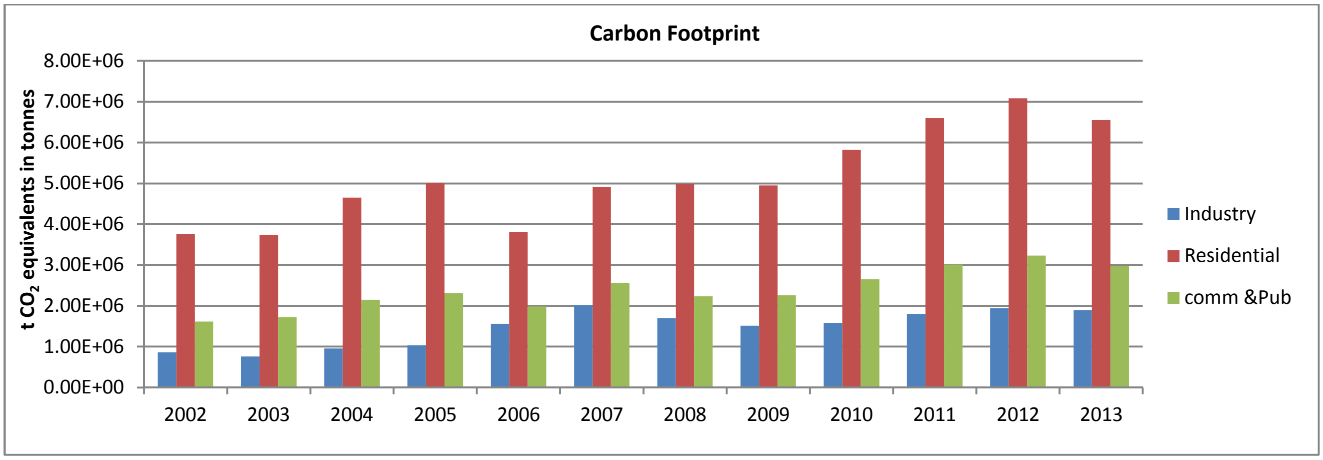

Figure 1. Showing carbon footprint from electricity consumption.

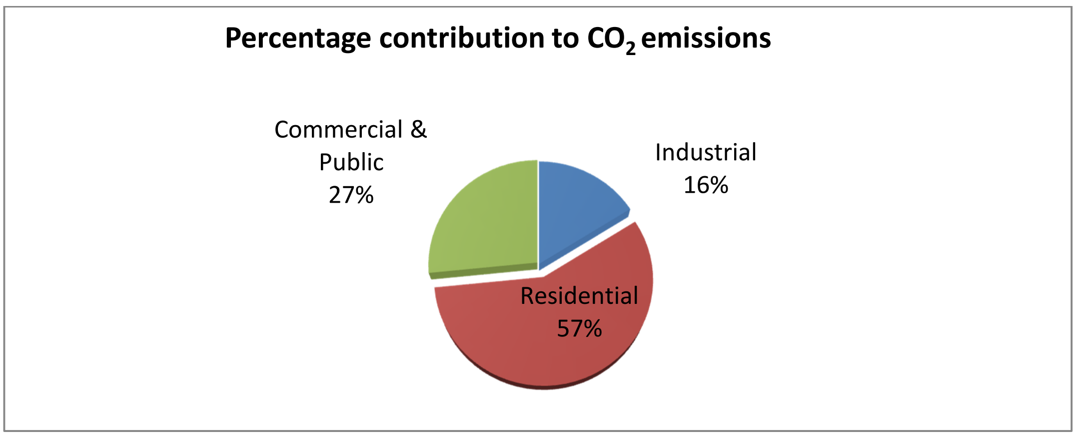

Figure 2: Showing the percentages contribution to carbon footprint

Conclusion: With the residential sector accounting for the highest amount of CO_2 emission releases, there is need for the NERC to mandate the DISCOs to supply prepaid meters to consumers. A flexible loan repayment plans driven by banks is required to fast track the process.

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XXXIX. Use of HPLC in Lambda-Cyhalothrin Analysis in Kales, Tomatoes and Cabbages from a Rural Setting in Kenya

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Abstract

A vegetable is any part of a plant that is consumed by humans as food as part of a savoury course or meal. They are highly nutritious and form as key food commodity in the human consumption. They are also highly perishable due to their low shelf life. A diet rich in vegetables and fruits can lower blood pressure, reduce risk of heart disease and stroke, prevent some types of cancer, lower risk of eye and digestive problems. When researchers combined findings from the Harvard studies with several other long-term studies in the U.S. and Europe, and looked at coronary heart disease and stroke separately, they found a similar protective effect: Individuals who ate more than 5 servings of fruits and vegetables per day had roughly a 20 percent lower risk of coronary heart disease and stroke, compared with individuals who ate less than 3 servings per day. Pesticide residues are the major contaminants found in vegetables. Pesticides are used in management of pests and diseases in Agricultural and Horticultural crops. They can leave adverse effects on the nervous system. Some harmful pesticides can cause several hazardous diseases like cancer, liver, kidney, and lung damage. Certain pesticides can also cause loss of weight and appetite, irritability, insomnia, behavioural disorder and dermatological problems. There are many pesticides in use today including; insecticides, acaricides, nematocides, herbicides, and avicides. Pyrethroids are the most commonly used insecticides. The pyrethroids in use include; deltamethrin, lambda-cyhalothrin and chismethrin. Lambda-cyhalothrin was analysed in selected vegetables (kales, cabbages and tomatoes) in this study. The samples were obtained from different sellers in some rural setting in Kenya known as Makuyu, during the dry and wet seasons. They were extracted for the lambda-cyhalothrin using organic solvents. The residues were then determined using high performance liquid chromatography (HPLC**)**. The analysis of the data was done using t-test, regression analysis and ANOVA. In this case, lambda-cyhalothrin was analysed in vegetable samples obtained from the urban area (Nairobi Markets) during the dry and wet seasons. It was observed that the samples analysed during the dry season had higher residue levels of lambda-cyhalothrin (ranging from 0.0300 mg/kg to 0.3400 mg/kg), than those analysed during the wet season which, ranged between 0.0001 and 0.0040 mg/kg . The difference between the two seasons was significant at 95 % confidence level, ($t_{(8,\ 0.05)} = 2.31$ and $t_{calculated} = 4.30$). Almost all the samples analysed during the wet season had undetectable levels of lambda-cyhalothrin. The residue levels observed during the dry season were higher than the FAO/WHO's ADI of 0.02 mg/kg, but less than the FAO/WHO's MRLs of 0.2 mg/kg (FAO/WHO, 1996), while the levels of lambda-cyhalothrin obtained during the wet seasons were all lower than the two bodies' set standards.

Keywords : *Vegetables, Rural setting, Pyrethroids, Lambda-cyhalothrin and HPLC*

XL. Life Cycle Assessment of Solar PV System for Sustainable Electric Power Generation

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[2]University College of Bahrain, Kingdom of Bahrain.

Abstract

Renewable source of energy in the form of Solar PV can be used as a supplement to our energy needs in spite of its low conversion efficiencies, high capital cost, large land usage and seasonal variation in solar insolation as techno – economic factors are expected to improve in future. In developing countries like India with scarce hydrocarbon and Uranium resources, one must rely on alternative sources to meet ever increasing energy demand in a sustainable manner. This paper covers the Life Cycle Assessment of a 100 kWp Solar PV based electric power generation system located in India, based on embodied energy data available from secondary sources and also by modeling & simulation on SimaPro 8.2 LCA software with ECOINVENT 3 as database. As part of this LCA study, an inventory analysis will be carried out for a multi-crystalline Silicon (mc-Si) Solar PV, roof top electric power generation system for the inputs used, raw material extracted, and the amount of residuals consequently released into the environment. The study results will be expressed in terms of pre-defined metrics such as Energy Payback Time (EPBT). Further, the environmental impact assessment will cover the important categories such as Global Warming Potential (GWP). The investigations help policy makers & energy planners to compare various power generating options and justify investments on alternative sources to meet the growing demand for electric power in a sustainable manner.

XLI. Use of Life Cycle Assessment for future electricity scenario for Mauritius

Authors: Ms. Ravina Brizmohun and Dr. Toolseeram Ramjeawon
Organization: University of Mauritius

Abstract

The global energy consumption is expected to increase steadily over the next twenty years and the largest increase is predicted to come from the developing world. The current trend in energy supply is bound to undergo major shifts given the challenges that the sector faces. The main challenges to sustainability due to the current trend of dependence on fossil fuels are increasing greenhouse gas emissions, which lead to climate change, decreasing energy security, air pollution leading to health problems and lack of universal access to energy services (GEA, 2012). Therefore, it is crucial that a holistic approach be taken to ensure efficient and sustainable energy demand, especially in the electricity sector. This is in fact one of the biggest challenges being faced in the world and one of the seventeen 'Sustainable Development Goals (SDGs)' of the 2030 Agenda for Sustainable Development of the United Nations is to 'ensure access to affordable, reliable, sustainable and modern energy for all' address the issue of increased energy demand. However, the determination of future scenarios for energy mix remains a major challenge for any nation. Life Cycle thinking is an effective approach for countries to assess the environmental impacts of electricity generation and can provide assistance in developing future scenarios for electricity mix. The presentation will highlight the results of LCA of current electricity generation in Mauritius and compare the impacts of future electricity scenarios, based on an increase in renewable sources. The results of the study can be used to assist policy makers make wise choices when considering different electricity options, when looking at environmental sustainability.

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XLII. Study for Intelligent Expertise through the Circular Economy: The Case of the Cortaderia Selloana in Urdaibai Estuary

Authors: Mrs. Agara Ruiz, Mrs. Itziar Vidorreta
Organization: GAIA

Abstract

Introduction: Invasive alien plants are a big environmental problem. In most cases these plants have come because of human activity, directly or indirectly, introduced accidentally or voluntarily.

The project aims to design and implement a closed ecosystem of circular economy (zero waste) following an intelligent specialization methodology in the environment of Urdaibai estuary; which is a natural area declared as a Biosphere Reserve by UNESCO in 1984, located in Vizcaya, Spain.

Materials and Methods: By circular economy, an economic growth will be developed reducing the consumption of resources, based on assimilating production processes, where every waste becomes a resource.

Circular economy methodology will be implemented by studying the different uses that Cortaderia selloana can bring to the environment. This plant comes from non-tropical regions of South America, and can be extended across various territories, becoming one of the most abundant species in Bascay, Spain.

Having this in mind, circular economy methodology has been implemented first by the analysis of the ancient wisdoms to find the different traditional uses of this invasive plant.

Results: By studying and analyzing the ancient wisdoms, the Cortaderia selloana can provide different uses such as tea (which will serve as a "home remedy" for reducing inflammation of the liver, kidney pains and stomach pain), vellum, essential oil and baskets. Through the different uses that this plant can bring us, a close circular economy methodology will be achieved.

Discussion: Apart from using the methodology of the circular economy, the problem that exists with invasive alien species will be reduced. Whereupon, you will ensure that a problem becomes virtue.

Conclusion: In conclusion, the project is viable socially, environmentally and economically. Socially, it creates jobs. Environmentally, greater naturalness is achieved in our environment giving prominence to indigenous species. And economically, it generates economic benefits in the area of influence.

XLIII. Decision Support Tool for Life Cycle Environmental Assessment of Suburban Railway Corridors

Authors: Shinde Amar Mohan[1], Anil Kumar Dikshit1 and Rajesh Kumar Singh[2]
Organization: Indian Institute of Technology Bombay[1], Thinkstep Sustainability Solutions Pvt. Ltd[2]

Abstract

Introduction: Suburban railways are crucial to reduce the environmental impact of urban passenger transport in developing countries1,2. Life cycle assessment based decision support tool (DST) has been developed with the objective to identify main drivers of environmental impact of existing as well as proposed suburban railway corridors. DST offers the opportunity to assess the influence of alternative electricity production, service life of railway infrastructure and varying level of train occupancy on environmental impact of railway corridors.

Materials and methods: This assessment includes life cycle environmental impacts of construction and maintenance of railway track, power supply installations, and passenger amenities like foot over bridges and platforms. It also includes the manufacturing and maintenance of electric multiple unit comprises trailer coach and motor coach, in addition to operation phase. GaBi software has been used to identify environmental impact in terms of global warming, ozone depletion, acidification, eutrophication and photochemical ozone creation potential3. The life cycle inventory data has been collected from several departments of zonal railway divisions4-6. Life cycle inventory results are normalized to per passenger kilometer travelled as a functional unit.

Result and discussion: The results show that use phase has the largest environmental impact for most of the selected impact categories due to non-renewable electricity production. The life cycle impact of railway corridors could be reduced by increasing the share of renewable electricity for operating train services, enhancing the reuse potential and service life of track bed components and increasing the train occupancy.

Conclusions: This case study shows that life cycle analysis based DST can be used for comprehensive life cycle environmental evaluation of existing as well as proposed suburban railway corridors.

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XIV. Characteristics of the Information Technology Firms and their Implications on Innovation: A Study of Indian IT Firms

*Authors: Mr. Snehal Raichur, Mr. Senthilkumar Thangavelu, Dr. Amalendu Jyotishi**

Abstract

Information Technology (IT) industry in India has been playing a vital role in the growth of the economy. However, over the years the sector itself has undergone transformation. From an "outsourced provider" where Software Application Development and Maintenance (ADM) and Business Process Outsourcing (BPO) played critical roles in the initial years of growth due to competitive cost advantage and availability of skilled labor to knowledge based business. In the current scenario, "Innovation" plays a critical role to maintain the competitive advantage. Innovation can happen in the product, process, market or organizational level. India is gaining its prominence in the Innovation space and many international companies are building their "Innovation Centers" in India.

In this context the main objective of this study is to find the key characteristics of the IT firms and how they are impacting the innovation and its Life Cycle Management (LCM). We do so by reviewing extant literature on IT and Innovation, followed by analyzing the available data collected from Center for Monitoring Indian Economy (CMIE) ProwessIQ source.

Our analysis is based on several characteristics of IT firms that may have influence on innovation. These characteristics include age, firm size, culture, ownership as well as spatial characteristic. Our analysis brings out the influence of these characteristics on innovation.

Keywords: *Innovation strategy, IT Firms, Firm Characteristics, Life Cycle Management, India*

XV. LCA of PV lanterns made with plastic casing and bamboo casing

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Organization: Indian Institute of Technology, Bombay

Abstract

The development, use and promotion of PV lanterns to address the challenges of electrification and growing threats of climate change have been on the rise. Around 44 million solar lanterns have been sold by mid-2015. Each of these lanterns on an average contain around 150 grams of plastic for the casing leading to the accumulation of 6.6 million kg of plastic resulting in the 66 million CO2 emission into atmosphere. Also, these lanterns generate huge amount of waste plastics which leads to the issue of disposal of waste. In this study, the environmental impact of PV lanterns made with plastic casing and PV lanterns of same technical specification but made with bamboo as casing were compared using life cycle assessment methodology under two scenarios: PV lanterns with luminous efficacy of 25 lumens (Sc-1) and PV lanterns with luminous efficacy of 120 lumens (Sc-2). One solar lantern with plastic casing and bamboo casing was selected as the functional unit. These scenarios are modelled through the CML 2000 method using the GaBi software. The comparison was carried out from the global warming point of view. The analysis revealed that in both the scenarios, PV

JEL Classifications: L10, L86, M15

lanterns made with bamboo casing had the lower environmental impact than the PV lanterns made with plastic casing and the average CO2 emission was reduced by 88%.

Keywords: *PV lanterns, Plastic casing, Bamboo casing, Life cycle assessment, Global warming*

XVI. Decision Makers Thinking Lines on 'Social Life Cycle Factors' – A Sri Lankan Case Study Based on Prospective Road-Sector Biofuels

Authors: Chalaka Fernand[1], AJITH de ALWIS[2]
Organization: LCADesNet, (Sri Lanka)

Abstract

Introduction: Consideration of 'social factors' during investment projects has increased in Sri Lanka. However, no product social life cycle assessment (SLCA) has locally published yet. This research (a component of a Life Cycle Sustainability Assessment study) aims to explore decision makers' know-how and thinking on 'social life cycle factors'. 'Prospective road-sector biofuels' was selected as the target product.

Materials & methods: Survey was conducted online. Two main decision making groups: professionals and engineers were accessed via emails through membership channels and professional networks. Mainly three questions on: most relevant stakeholder group, social impact category and specific social indicators were aimed on target product. Selections of choices were based on a UNEP Guidelines for SLCA for Products and global literature survey.

Analysis was made using linear weightage.

Results: There were 286 responders and 'local community' was identified as the most important stakeholder out of four choices. 'Workers' were identified as least by engineers while as the third important by professionals. 'Value chain actors' was equally marked.

'Cultural heritage' was identified as the most important social life cycle category by engineers (52%) while 'Governance' by professionals (36%). For 'Human Rights' engineers scored 44% while professionals 22% which is the highest deviation. Scores were within 5% deviations for 'Health & Safety' and "Working Conditions'.

Transfer of technology and knowledge, public commitments to sustainability, health and safety, transparency on social/environmental issues, contribution to local employment and community engagement were equally identified as top five specific social indicators (~75%). Child labour was the least scored (1%).

Discussion and Conclusion: Based on top five specific indicators; both decision making groups are equally concerned on SLCA factors. This will simplify prospective road-sector biofuel SLCA studies. For the target product, 'local community' as the stakeholder and 'cultural heritage' as the social impact can be identified as the highest social concerns.

XVII. Life Cycle Analysis of Existing Infrastructure to meet Ethanol Blending Mandate in India

Authors: Sujata Bhaker, Priyanka Kaushal
Organization: TERI University

Abstract

Introduction: India produces about 2.75 billion liters of ethanol annually. Ethanol can either be produced by direct fermentation of sugar cane juice or from molasses (by-product of the sugar industry). There are about 356 distilleries having installed capacity of 4.5 billion litres of alcohol production. Out of it, 2 billion litres of fuel ethanol capacity is produced from distillery integrated sugar plant[3].

Since sugarcane production in India is cyclical, ethanol production also varies accordingly and therefore it does not assure optimum supply level to meet the demands. Due to the cyclical nature of sugarcane production and consequent shortfalls in molasses availability, the government has so far been unable to meet its mandated blending target of even 5 percent[2, 4]. So the main objective of this study is to develop sustainable and cost competitive solution to meet the ethanol blend target.

Methodology: To accomplish the objective of study, below mention methodology followed:

1. All sugar industry with integrated and standalone distillery unit across India were mapped to check the ethanol potential, prevailing technology, and their effectiveness in existing market.
2. Scenarios were build up to identify the efficient route to meet the ethanol blend target including cost and environmental impact of the scenarios using Life cycle assessment (LCA) tool follow ISO 14040 guidelines[1].

Conclusion: LCA and life cycle costing analysis give an indication on fuel economy considering different percentage of ethanol blending with gasoline. The effect of reduced energy consumption in the sugarcane milling and ethanol conversion can be taken into account to improve efficiency along the production chain as per their market scenarios.

This study also observed that ethanol can be produced from both sugarcane and bagasse. Previously bagasse was used to generate heat and power generation but now it also uses to produce ethanol. But from LCA point of view, when GHG emissions are considered, the production of electricity from bagasse is better option than the production of ethanol from bagasse.

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XVIII. Life Cycle Assessment of Urban Water Cycle: A Case Study of Nagpur City

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Organizations: Chemical Engineering Department, VNIT

Abstract

Sustainable development is the need of current world for the saving our future. As a tool of sustainability analysis, life-cycle assessment (LCA) is of major interest and widely used in the field of sustainable engineering. Life-Cycle Assessment is a technical, data-based and holistic approach to define and subsequently reduce the environmental burdens associated with a product, process, or activity. The main goal of this study is to use the Life Cycle Assessment methodology to carry out an environmental analysis of every stage of the urban water cycle in Nagpur city. The stages include Abstraction of water, treatment to convert it into potable water, pumping and distribution through pipeline network, domestic usage, collection of sewage and waste water treatment. The urban water system was modeled using GaBi software, and the data for LCA was collected through field visits and surveys. Impacts were calculated using LCIA methods CML2001, ReCiPe. Results showed that main source of impacts is electricity production for operations. Present study also focuses on the energy and material requirement during all stages and highlights high energy consuming stages giving a complete analysis of process in terms of environmental and economic context. This study will also help decision takers for understanding the weak stages and improving them in future scenarios.

***Keywords**: Sustainability, Life-Cycle Assessment, Urban water cycle, Environment.*

XIX. Comparative Life Cycle Assessment of Convectional Mosquito Coil Vs Alternative Herbal Mosquito Coils

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Abstract

Life Cycle Assessment (LCA) is increasingly being used as a decision-support tool, and the application of the method has shifted from scenarios examination to finding the consequences of change. Consequential LCA, focuses on examining all known consequences of a change, in unit processes, irrespective of whether they are within or outside the life cycle. Present study deals with the effects of change of some ingredients and processes in mosquito coil manufacturing. Mosquitoes being the prime carriers of major diseases like dengue, malaria etc., mosquito coils tend to be the cheap means of prevention. It is generally considered that the commercially available mosquito coils contain chemicals which are quite injurious for human health. The threat being based on emissions on burning, one neglects to take into account the environmental impact from its manufacturing to disposal. On other hand Authors have developed herbal mosquito coils from cow urine could be more sustainable over conventional coils but the results must be tested to prove the claim. LCA is best suited tool to assess the problem. In this study, both processes were modeled using software GaBi and data was collected from field visits and surveys. Results showed that newly developed herbal coils have less environmental impacts over conventional coils. This study helps describing the use of LCA for assessing sustainability of new products over conventional products.

***Keywords:** LCA, Sustainability, Mosquito coil, Environment*

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