Life Cycle Initiative

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Table of Contents

Organizer 1
Partners 1
Sponsors 1
Venue 1
Disclaimer 1
ILCM 2017 Committees 2
Scientific Committee 2
Organizing Committee 2
About ILCM 6
Theme and Focus Areas 6
Program 7
Conference Agenda 8
Abstracts 12
I. Circular Economy – Opportunities for the Plastics Industry 13
II. Promoting Circular Economy Strategies of Regions through Hybrid Input-Output Analysis 13
III. How Life Cycle Thinking is Transforming the Apparel and Textile Industry Towards Circularity 14
IV. Well-To-Wheel Analysis of fuel Options for Automotive Vehicles; Case Study of India 15
V. Environmental Sustainability Analysis of Selected Textiles Using Life-Cycle Assessment. 16
VI. Environmental Risk and Opportunity considering Life Cycle Perspective 17
VII. Strategic analysis of microalgae based CO2 sequestration and concomitant production of biodiesel and biogas: a life cycle perspective 18
VIII. Using Life Cycle Thinking for Improving Circular Economy in Urban Water Systems 18
IX. Life Cycle Approach and Ash utilization at NTPC 19
X. Modeling Valorization of Water Hyacinth for Sustainable use as Engineering Materials and Weed Control 20
XI. Organizing LCA Practice – Creating a Centre of Excellence 21
XII. Joint National Effort – for Successful Integration of Life Cycle Knowledge in Business and Policy ... 21
XIII. Applying Life Cycle Thinking Towards a Sustainable Future 22
XIV. Sustainable Consumption through Life Cycle Information in the Consumer Perspective: Issues, Challenges and Change Management through the 3Rs (Re-cycle, Re-use and Re-charge) 23
XV. Eco-labels in Garments – Are Consumers Informed or Confused? 24

XVI. ESI – Single Indicator Solution for Life Cycle Assessment........24
XVII. Sustainability Marketing: A Way Towards Life Cycle Management........25
XVIII. Life Sustainable Recycling Industries Project; Regionalized Consistent LCI Data for India........26
XIX. Global Life Cycle Inventory Data for Steel Products........27
XX. Life^2 Cycle Assessment: Assessing the Environmental Impacts of a Human Being........28
XXI. Socio-Economic Life-Cycle Assessment (SLCA) of Street Children in India: A Framework analyzing Casual Factors and Plausible Solutions for their Dismal Living Conditions........29
XXII. Life Cycle Thinking to Achieve Resource Efficiency........29
XXIII. Extended Producers' Responsibility: Supporting LCT in India........30
XXIV. A Life-Cycle Based Comparative Study of Electrical vehicles (EVS) Versus Internal Combustion Engine Vehicles (ICVS) as a Sustainable means of Transportation in India........31
XXV. Environmental footprint of cooking fuels: a life cycle assessment of ten fuel sources used in Indian households........32
XXVI. Integration of Life Cycle Approach for Achieving Bioethanol Blending Target of Pan India........33
XXVII. Social hotspots analysis and environmental LCA of a boiler........34
XXVIII. Developing Baseline for Lifecycle Thinking in the Activities of Newly Established Resource Efficiency and Cleaner Production Centers in Nigeria........35
XXIX. Socio-Economic Life Cycle Assessment (SLCA) of Rural Khadi Handloom Industry (rKHI): A Model for empowerment of Rural Women........36
XXX. Approaches to Promoting Life Cycle Thinking in a Large Organization – A SABIC Case study........36
XXXI. Application of Life Cycle Knowledge to Integrate Sustainability in Business Strategy: A Case Study from Sri Lankan Dairy Sector........37
XXXII. A Sustainable Urban-Design Solution for the Indian Garment Industry Using Life-Cycle Assessment Approach........38
XXXIII. Design for Sustainability through Life Cycle Thinking........39
XXXIV. Design for Sustainability Through Life Cycle Thinking........40
XXXV. Life Cycle Assessment based sustainability context analysis of municipal solid waste management in Harare, Zimbabwe........40
XXXVI. Life Cycle Oriented Material Selection Process for the Design of Drinking Water Transmission Network........41
XXXVII. Influence diagrams and scoping for Life Cycle and Sustainability Assessment, an example from sustainable mining........41
XXXVIII. Life Cycle Analysis of Shrimp Aquaculture Production Systems: Challenges and Opportunities 42
XXXIX. Simulation Environment Life Cycle Assessment at Enterprise Level........43
XL. Sweet-spot: An Open visualization plug-in for supporting effective interpretation of LCA results..44

XLI. Life Cycle Analysis of DME Synthesis and Stranded Natural Gas....44
XLII. LCA of Sewage Treatment Plants Based on Advanced BNR Processes....45
Sponsors 46
Silver Sponsor....46
Associate Sponsor....46
Badge Sponsor....46
Partners 46
About the Organizer-FICCI 47

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 even more significant as technical issues relevant to the host country drive the ILCM agenda.

ILCM 2017 is organized in association with Ministry of Environment Forests and Climate Change, Department of Science and Technology, Bureau of Indian Standards (BIS), Government of India and Life Cycle Initiative. The sixth edition of ILCM has a special focus on Sustainable Development Goals and on India-specific challenges (e.g. energy security, urban waste management, sanitation) and how Life Cycle knowledge can help classify/identify innovative/applied sustainability content that embraces this new era post 2016.

Theme and Focus Areas

Contributions for ILCM 2017 were invited under the following focus areas:

1. Complementing Circular Economy with Life Cycle Knowledge
2. Integrating Life Cycle Knowledge in Business Strategy
3. Life Cycle Thinking for addressing India Specific challenges
4. Advancing Sustainable Consumption through Life Cycle Information
5. Using Life Cycle approaches for achievement of SDGs
6. Design for Sustainability through Life Cycle Thinking

Program

Conference Agenda

Day 1: Monday, 9 October	
08:30 onwards	**Registration**
09:45 – 10:45	**Inaugural Session**
	Welcome Remarks *Ms Rita Roy Choudhury, Assistant Secretary General, FICCI*
	Keynote Address *Mr. Janardhanan Ramanujalu, Vice President and Regional Head, South Asia & ANZ SABIC*
	Special Address *Dr. Amir Safaei, International Project Manager, ecoinvent Centre*
	Inaugural Address *Shri Arun Kumar Mehta, Additional Secretary, Ministry of Environment Forest and Climate Change, Government of India*
	Vote of Thanks *Mr. Rajpal Singh, Director, FICCI*
10:45 – 11:00	**Networking Break | Poster Session**
11:00 – 12:00	**Session 1: Using Life Cycle Knowledge for Circular Economy** **Chair: Dr. Sanjeevan Bajaj, Adviser FICCI Quality Forum and** **FICCI Representative - UN Environment Life Cycle Initiative Steering Committee**
	Circular Economy – Opportunities for the plastics industry *Ananda Sekar, SABIC (India)*
	Promoting Circular Economy Strategies of Regions through Hybrid Input-Output Analysis *Yasushi Kondo, Waseda University (Japan)*
	How life cycle thinking is transforming the apparel and textile industry towards circularity *Rajat Batra, Stenum Asia (India)*
12:00 – 13:00	**Panel Discussion:** <u>Strategy on Resource Efficiency & Circular Economy - Policy Innovations and Developments in India</u> The panel discussion will highlight the work of Indian Resource Panel (InRP) and bring out the emerging scenario of RE & CE in India. It will provide insight into the principles underlying NITI Aayog's recently released Strategy paper on the topic and explore the role of Life Cycle knowledge as a critical element in realizing RE and CE strategies. The session is organized by GIZ under EU Resource Efficiency Initiative project. *Opening Remarks: Mr. Ravi Agarwal, Director – Toxics Link, Member – Indian Resource Panel* *Topics:* *Emerging Scenario of RE & CE globally and lessons for India: Ms. Cecile Leemans, Representative – Environment, Energy & Climate Change, EU Delegation* *Insight into the principles underlying NITI Aayog's recently released RE Strategy: Dr Rachna Arora, Project Coordinator, EU-REI* *Framework & Implementation of Extended Producer Responsibility in Managing Plastics & Packaging Waste and linkages across life-cycle – Mr Jai Kumar Gaurav, adelphi*

13:00 – 14:00	**Lunch | Networking Break | Breakout Session 'LCA for Beginners'**
14:00 – 15:15	**Session 2: LCA Case Studies**
	Chair: Dr. Brajesh Dubey, Associate Professor, *Indian Institute of Technology* Kharagpur
	Well-To-Wheel Analysis of Fuel Options for Automotive Vehicles; Case Study of India *Sachin Nande, TATA Motors (India)*
	Environmental Sustainability Analysis of selected textiles using-life cycle assessment *Madhuri Nigam, Lady Irwin College (India)*
	Strategic analysis of microalgae based CO2 sequestration and concomitant production of biodiesel and biogas: a life cycle perspective *Sandeep N Mudliar, CSIR- Central Food Technological Research Institute (India)*
	Environmental Risk and Opportunity Considering Life Cycle Perspective *RK Sharma, India Glycols Ltd. (India)*
15:15 – 15:30	**Networking Break | Poster Session**
15:30 – 16:30	**Session 3: Creating Value from Waste by using Life Cycle Knowledge**
	Chair: Dr. Amir Safaei, International Project Manager, ecoinvent Centre
	Life Cycle thinking to explore business models in Circular Economy *Ram Babu, RSM Advisory Services (India)*
	Using Life Cycle Thinking for Improving Circular Economy in Urban Water Systems *Pradip Kalbar, Indian Institute of Technology Bombay (India)*
	Life Cycle Approach and Ash Utilization at NTPC *Tauqir Ahmad Abbasi, NTPC (India)*
Group Photo	
Day 2: Tuesday, 10 October	
09:30 - 10:30	**Welcome Tea | Breakout Session 'LCA for Beginners'**
10:30 – 11:45	**CSO Dialogue:** <u>Creating the Circular Economy Advantage</u> The dialogue will bring out alternative interpretations of Circular Economy and directions for India *Moderator: Dr Rajnish Karki, CEO, Karki Associates* *Panelists:* *Mr. Anirban Ghosh, Chief Sustainability Officer, Mahindra & Mahindra* *Mr. Sanjib Bezbaroa, Executive Vice President, Corporate EHS, ITC Ltd.* *Dr S Majumdar, Chief Sustainability Officer, JSW Group* *Dr. Ashok Menon, Global Technology Leader, Life Cycle Assessment, Corporate Sustainability, SABIC*
11:45 – 12:00	**Networking Break | Poster Session**
12:00 – 13:00	**Session 4: Enabling Life Cycle Thinking Implementation**
	Chair: Dr. Sanjeevan Bajaj, Adviser FICCI Quality Forum and FICCI Representative UN Environment Life Cycle Initiative Steering Committee
	Organizing LCA Practice – Creating a Center of Excellence *Avantika Shastri, SABIC (India)*
	Joint National Effort - For Successful Integration of Life Cycle Knowledge in Business and Policy *Carl Karheiding, Swedish Life Cycle Centre (Sweden)*
	Applying Life Cycle Thinking Towards a Sustainable Future *Llorenc Mila I Canals, UN Environment (Via Skype)*

13:00 – 14:00	**Lunch | Networking Break**
14:00 – 15:00	**Session 5: Life Cycle Knowledge for Consumer Communication**
	Chair: Prof. Pradip Kalbar, Assistant Professor, Indian Institute of Technology Bombay
	Sustainable Consumption through Life Cycle Information in the Consumer Perspective: Issues, Challenges and Change Management through the 3Rs (Re-cycle, Re-use and Re-charge) *N Natarajan, Department of Consumer Affairs, Govt. of India (India)*
	Eco-Labels in Garments – Are Consumers Informed or Confused? *Chalaka Fernando, University of Moratuwa (Sri Lanka)*
	Sustainability Marketing: A Way Towards Life Cycle Management *Payal Trivedi, MICA (India)*
15:00 – 15:30	**Networking Break | Poster Session**
15:30 – 16:45	**Session 6: LCA Data as a fundamental necessity**
	Chair: Dr. Yasushi Kondo, Waseda University, Japan
	Sustainable Recycling Industries Project; Regionalized Consistent LCI Data for India *Amir Safaei, ecoinvent (Switzerland)*
	Global Life Cycle Inventory Data for Steel Products *Aniket Bodewar, World Steel Association (India)*
	Life Cycle Assessment: Assessing the Environmental Impacts of a Human Being *Marcel Goermer, TU Berlin (Germany)*
	Socio-Economic Life-Cycle Assessment (SLCA) of Street Children in India: A Framework analyzing Causal Factors and Plausible Solutions for their Dismal Living Conditions *Kriti Bhalla, M.S. Ramaiah Institute of Technology (India)*
16:45 - 17:00	**Conference Closure**
	International collaborations and LCA capacity building activities in India *Dr. Sanjeevan Bajaj, Adviser FICCI Quality Forum, FICCI Representative UN Environment Life Cycle Initiative Steering Committee, and Scientific Manager-SRI Project on LCA capacity building in India*
	Best Poster Announcement | Group Photo

Posters	
1.	From Product EPDs to Building LCA's– LEED v4: Benchmarking the sustainability paradigm *Neha Koul, Green Business Certification Institute*
2.	Life Cycle Analysis of Shrimp Aquaculture Production Systems: Challenges and Opportunities *M Murlidhar, ICAR-Central Institute of Brackish Water Aquaculture*
3.	A Sustainable Urban-Design Solution for The Indian Garment Industry Using Life-Cycle Assessment Approach *Ms Jananee Ranagswamy M.S. Ramaiah Institute of Technology*
4.	A Life-Cycle Based Comparative Study of Electrical Vehicles (EVS) versus Internal Combustion Engine Vehicles (ICVS) as a Sustainable Means of Transportation in India *Ms Jananee Ranagswamy M.S. Ramaiah Institute of Technology*
5.	Approaches to Promoting Life Cycle Thinking in A Large Organization – A SABIC Case Study *Suchira Sen, SABIC*
6.	Life Cycle Analysis of DME Synthesis from Stranded Natural Gas *Vineet Rathore, IIT Roorkee*
7.	Socio-Economic Life-Cycle Assessment (SLCA) of Rural Khadi Handloom Industry (RKHI): A Model for Empowerment of Rural Women *Kriti Bhalla, M.S. Ramaiah Institute of Technology*
8.	Integration of Life Cycle Approach for Achieving Bioethanol Blending Target of Pan India *Sujata Bhaker, TERI University*
9.	LCA of Sewage Treatment Plants Based on Advanced BNR Processes *Rana Pratap Singh, IIT Roorkee*

Abstracts

I. Circular Economy – Opportunities for the Plastics Industry

Authors: Neena Chandramathy, Rajesh Mehta, Ananda Sekar
Organization: SABIC Research & Technology Pvt Ltd, Bengaluru, India.

Abstract

With the tremendous resource pressure faced by the world today, Circular Economy is slated to be the economy of the future, wherein the value of products and materials are retained for as long as possible, and waste is significantly minimized1.

Circular economy, which is restorative and regenerative in nature, encompasses a large number of concepts like recycle, energy recovery, reuse, sustainable sourcing, decarbonization, etc. However, due to lack of well-established guidelines, making informed choices to implement the circular economy concepts become extremely challenging. Within this framework, EU has recognized plastics as one of the five priority areas2. Since plastics encompass a broad spectrum of uses, from short cycle single use disposables to integral components of durable goods, different strategies are required to address and enhance resource efficiency and value preservation in these diverse applications. This paper will demonstrate with several examples based on life cycle assessment, the potential of plastics in a circular economy. This will include relevant concepts such as resource depletion, alternative feedstocks, modeling of material loops for mechanical and chemical recycling, design for sustainability and innovative solutions.

References

1. Ellen Mcarthur Foundation https://www.ellenmacarthurfoundation.org/
2. Closing the loop – An EU action plan for the circular economy, 2015

II. Promoting Circular Economy Strategies of Regions through Hybrid Input-Output Analysis

Author: Yasushi Kondo
Organization: Waseda University, Tokyo, Japan

Introduction

A growing demand for the promotion of circular economy naturally calls for an integrated analysis of the environment and economy through life-cycle thinking. Whereas the input-output analysis (IOA) has been widely used in the life-cycle analysis, its major advantage that has been fully utilized is limited to a clearly defined and broad system boundary.1 However, social issues related to international trade has recently been studied by the method of footprint analysis.2, 3 It is important to note that intermediate flows, in the terminology of life-cycle assessment, should be explicitly considered for promoting circular economy, whereas the footprint analysis is suitable, at least from the methodological point of view, for analyzing elementary flows. With this background, we share our experience of waste input-output (WIO) analysis4 of Japanese economy from circular economy perspective and introduce our new three-year project to develop a framework with which a local government in Japan can make its strategies for promoting proper waste management and circular economy.

Method

The WIO analysis4 is a unique framework of hybrid input-output analysis (IOA), consisting of an accounting system and analytical models. Using WIO, hybrid LCA studies can be conducted with an explicit consideration of waste/by-product flow. In developing our database, we extensively use the data that local governments already have collected for management purposes, but not utilized in systems analysis for policy making.

Discussion

Different types of waste and scrap should be managed in different ways. For example, it seems that further extensive recycling of metal scrap would be conducted in a national scale market and organic waste can be recycled in a smaller regional scale management. Our framework can contribute to management of various types of waste in different regional scales.

Acknowledgements

This study was supported by the Environment Research and Technology Development Fund (3-1704) of Environmental Restoration and Conservation Agency, Japan.

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1. S. Suh, M. Lenzen, G.J. Treloar, H. Hondo, A. Horvath, G. Huppes, O. Jolliet, U. Klann, W. Krewitt, Y. Moriguchi, J. Munksgaard, G. Norris (2004) Environ Sci Technol 38(3), 657–664
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4. S. Nakamura, Y. Kondo (2002) J Ind Ecol 6(1), 39–63

III. How Life Cycle Thinking is Transforming the Apparel and Textile Industry Towards Circularity

Authors: Christina Raab[1], Rajat Batra[2]
Organization: 1. ZDHC (Zero Discharge of Hazardous Chemicals) Foundation (Netherlands), 2. STENUM Asia Sustainable Development Society (India) [2]

Aim and introduction

The circular economy seeks to keep products and materials at their highest utility and value at all times. Applying sustainability and lifecycle thinking to materials management is key to achieving enhanced product circularity and to reducing negative impacts on the environment and society. The apparel, textile and footwear industry has a key role to play in applying innovative solutions for closing the material loop, involving each life cycle stage from product design and manufacturing to recycling technologies and end-of-use consumer engagement.

Scope

The choice of fibers, dyes, finishes and process chemicals in the apparel and textile industry is essential for circular fashion and has wide-ranging implications: it determines if the apparel can be safely recycled, composted or reused; it influences the amount of energy required for making garments; it affects the amount of air pollution, water used and quality of wastewater; and influences health and well-being of factory workers, communities and customers. The ZDHC programme is the leading global industry collaboration that rethinks the sector in terms of input stream management and advances the zero discharge and replacement of hazardous chemicals in fabric and garment processes. The programme builds on a holistic approach to sustainable chemicals management at each stage of the product life cycle following principles of recognized industry guidelines and tools, collaborative implementation and supply chain transparency. We will showcase international best practices as well as traditional and latest pioneering Indian initiatives for a circular fashion system. We will also cover practical approaches on how circular business model can be collectively reinforced by different stakeholders in the apparel value chain.

Conclusion

Knowledge about the life cycle steps of a garment can greatly drive environmental stewardship, technological advancements and innovation in material development and production processes, thereby moving the apparel and textile industry towards integrated circularity.

IV. Well-To-Wheel Analysis of fuel Options for Automotive Vehicles; Case Study of India

Author: Sachin Nande
Organization: Tata Motors, Pune, India

Aim

India joined hands together with other nations in Paris climate treaty 2015 to reduce their greenhouse gas (GHG) emissions by year 2030, and different environmental strategies are converging towards this target. A particular promising step that can reduce GHG emissions from the transportation sector is by promoting electric vehicles (EV) as substitute to conventional internal combustion engines (ICE) vehicles. Automotive OEMs aligned themselves for EVs technology to bring vehicles on road; however, infrastructure setup & source of energy are big challenge to make EVs run on Indian road. This paper will discuss current & future projected electricity source available for EVs to run on road & associated environmental impact against benchmark ICE fuel driven vehicles.

Scope

The well-to-wheel (WTW) fuel study is simplified life cycle assessment (LCA) approach that focuses specifically on fuel life cycle, ignoring other stages of a vehicle's life cycle like raw material & part production, vehicle assembly &vehicle end of life. In this study, Indian electricity projection1 mapped into 4 classes based on time projection & Green source adoption namely reference (2014), evaluation (2020), resolution (2030) & ambition (2040). Environmental impact of these scenarios are compared with existing ICV fuel options to make informed decision for EVs roadmap development & extra steps needed for green electricity source adoption.

Conclusion

In present case, ICE (Diesel) vehicle has the lowest GHG emissions 29% lower than EVs (reference case). Over time interval of 24 years, Green source contribution will increase from 29% to 47% helping to reduce EVs GHG impact by 30% (ambition scenario). This show EVs by 2040 are just 2% better than present ICVs. At first glance, EV looks sustainable options as no direct tailpipe emissions observed but we need to account indirect emissions involved in fuel processing. EV are green provided electricity production technology has major share of renewable source.

Reference

IEO (2015) India Energy Outlook, World Energy Outlook Special Report.

V. Environmental Sustainability Analysis of Selected Textiles Using Life-Cycle Assessment.

Authors: Madhuri Nigam[1], Prasad Mandade[2], Sabina Sethi[3]
Organization: 1,3 University of Delhi, India, 2. Indian Institute of Technology, Mumbai, India

Introduction

It is a well-recognised fact that the consumption and production of textiles has increased enormously in the last two decades. Fast fashion and growing technology and economy have helped boost the growth of this industry worldwide. India is among the leading manufacturers of textiles. Though cotton is the most used natural fibre in the world, there is a constant discussion on its sustainability.

Aim

This study is an attempt to make a comparative Life Cycle Analysis of the environmental impacts of Cotton fabric and compare it with some alternative fibres, such as - Flax, Sunnhemp and Jute.

Scope

The study was conducted in "Cradle to Gate" boundary, including crop production, yarn production and fabric production with intermittent transport. The study has generated the life cycle inventory of the considered fabrics and analysed the associated environmental impacts.

Methods

Life Cycle Assessment tool is used for assessing the environmental impacts of the selected textile products and identifying key areas in their life cycle. This study presents, life cycle impacts of selected products using indicators such as Climate change, Ozone Depletion, Acidification, Eutrophication, Water requirement and toxicity. Present study analyses the selected product systems by using the different allocation approaches and sensitivity analysis.

Major contribution from the study is compilation of Life Cycle data. Data generated during the study has been submitted to Ecoinvent, and will be available as life cycle datasets. Outcomes of the Life Cycle Assessment have been utilised to prepare a set of recommendations and guidelines for the selected product systems. The textile industry is expected to benefit, from the development Life Cycle Inventory, hot spot analysis and recommendations evolved from the study, for improving its overall impacts.

Conclusion

The results would reveal the environmental sustainability of selected fabrics. The comparison would help the consumers to understand the life cycle impacts of each fabric and make informed choices at point of purchase. The comparison would also enable designers, manufacturers, and policy makers understand and select textiles in light of their environmental sustainability.

VI. Environmental Risk and Opportunity considering Life Cycle Perspective

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

Abstract

Environmental impact evaluation is a major issue that faces by industries. Corporate sustainability initiatives have grown in number, scope and size in recent years. Stakeholders are aware that 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 or indirect. LCA can be best suitable methodology in this case as it quantifies these direct and indirect effects of various Environmental Impact of the products.

Life Cycle Assessment aims at specifying the environmental consequences of products or services from cradle to grave/gate. LCA is defined as the "compilation and evaluation of the inputs, outputs, and potential environmental impacts of a product system throughout its life cycle".

Organizations of different sectors in India are already working on LCA. India Glycols Limited (IGL) has started working on LCA from 2011. The LCA is carried out by IGL for Bio-Ethanol, Bio-Ethylene Oxide, Bio-Glycols, Bio-Glycol Ethers, Ethoxylate products and Utilities at cradle to gate level. LCA for other products are under progress.

As per updated High Level Structure Environmental Management System (ISO 14001:2015) Environmental Risk and Opportunity need to be identified considering Life Cycle Perspective. Life Cycle Assessment as per IPCC 2013 GWP 100a single issue methodology shows that CFP (CO2eq) of Bio- Glycols. Other relevant environmental parameters are reviewed using Environmental Product Declaration (EPD) methodology.

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.

The Environmental risks are identified through life cycle of products. Initiatives for control of risk during production are identified based on hot spot identification during LCA as opportunities and objectives. Action plan of identified opportunities and objectives for responsible Consumption and Production, is prepared accordingly.

It gives the approach for continual improvement of environment and sustainable development.

VII. Strategic analysis of microalgae based CO2 sequestration and concomitant production of biodiesel and biogas: a life cycle perspective

Authors: M. Maneesh Kumar, B. K. Bhavana, T. Sarat Chandra, V. S. Chauhan, R. Sarada, S. N. Mudliar
Organization: CSIR- Central Food Technological Research Institute, Mysuru, Karnataka

Introduction

Increasing levels of carbon dioxide (CO2) in the atmosphere is one of the major cause of climate change and CO2 capture and storage processes are receiving great attention. Microalgae are regarded as a promising choice for mitigation of CO2 due to their ability to convert CO2 into biomass via photosynthesis at much higher rates than conventional terrestrial land-based crops.

Materials and Methods

Life cycle assessment (LCA) of various scenarios for microalgae (Scenedesmus dimorphs) mediated CO2 sequestration for sequential biodiesel and biogas generation were simulated using GaBi software. The process steps in modelled scenarios included algal cultivation in raceway ponds and airlift photobioreactor (PBR), harvesting by flocculation and downstream processing for different scenarios to biodiesel and biogas. The scenarios were analyzed for energy demand, emissions and environmental impacts within the boundary conditions grounded on "cradle to gate" inventory. Sensitivity analysis was performed with varied biomass productivity and Net Emission Ratio (NER) of CO2 of all the scenarios were estimated.

Results and Discussion

LCA results for CO2 sequestration by microalgae suggests that biogas production route can be an environmentally viable and sustainable option with optimal mode of culture mixing and nutrient recycle. Among all the processes involved in the scenarios, cultivation via airlift PBR was found to be the most energy intensive process. The energy demand for scenarios with 100% nutrient recycle was lower by 25.48% compared to that with no nutrient recycle. Global warming potential and Eutrophication potential was the found to be major environmental impact among the modelled scenarios. Nutrient supplementation along with 100% recycle had the higher NER among all the scenarios and indicates the positive effect with reference to CO2 sequestration. NER's represent the net CO2 sequestration capability of the process and need to be >1 to make the system sustainable and LCA analysis indicated that higher algal productivity is desirable.

VIII. Using Life Cycle Thinking for Improving Circular Economy in Urban Water Systems

Authors: Pradip P. Kalbar[1], Jesper Sanderbo[2]
Organization: 1. Centre for Urban Science and Engineering (CUSE), 2. Technical University of Denmark

Abstract

India is presently facing challenges of water quantity and quality at all metros and major cities. The problem is becoming more severe with changes in demand and lifestyles of urban citizens. Water systems in urban areas are well connected and hence there is a need for a holistic approach for devising strategies to being any improvement. The Circular Economy (CE) framework provides an appropriate set of principles and thinking for addressing the challenges related to urban water systems. In the present work, CE thinking is applied for devising strategies for improving urban water systems sustainability. We have explored the Phosphorous (P) cycle using Material Flow Analysis (MFA). Using field data, the base scenario was established and all the flows of the P cycle are quantified. Prospective scenarios were envisaged, and a huge potential for recycling of P flows is identified. The study demonstrates how life cycle thinking can provide decision support to improve the CE in urban water systems.

IX. Life Cycle Approach and Ash utilization at NTPC

Authors: Tauqir Ahmad Abbasi
Organization: NTPC Ltd, India

Introduction

NTPC is India's largest power utility with an installed capacity of 51,635 MW, plans to become a 130 GW company by 2032. Established in 1975, NTPC aims to be the world's largest and best power major. NTPC was ranked 400th in the '2016, Forbes Global 2000' ranking of the World's biggest companies. Though coal is the basic fuel used for power generation at NTPC, clean energy is now integrated part of portfolio and is going to be added enormously in coming years. During the entire process of power generation i.e cradle to grave thrust is to minimize negative impacts on society, environment and nature.

Aim

In process of power generation ash is the major waste generated by NTPC power plant. In this paper topic covered is innovative practices adopted by NTPC to utilize ash in environment friendly way and to produce economy through its use avoiding any landfill or any other pollution.

APPROACH

KEY AREAS OF ASH UTILIZATION

- Mine filling/ stowing
- Roads embankment construction
- Ash based bricks, blocks, tiles manufacturing
- Bottom ash as a replacement of sand
- Low lying land and wasteland development
- Issue to industry: Cement & Concrete

NTPC is constantly looking at innovative and new ways to utilize the ash generated. Following research studies have been / are being conducted for development of new segments having long term potential of ash utilization:

- Railway Embankment
- Mine Filling
- Pre-stressed Railway Concrete Sleeper
- Ash based Bituminous Road
- Flux bonded Bricks/Tiles
- HDPE Products
- Showcase Projects on use of Ash in Agriculture

Conclusion

During FY-2016, 588.28 lakh tonnes of ash was generated and 41.35% viz. 243.24 lakh tonnes of ash had been utilized productively avoiding hazard to environment.

X. Modeling Valorization of Water Hyacinth for Sustainable use as Engineering Materials and Weed Control

Authors: Oluwatobi Emoruwa[1], Toscanini Seimodei[1,2], Ife Adewumi[1,2]
Organization: 1. Department of Civil Engineering, Niger Delta University, Wilberforce Island, Nigeria. 2.Greener Environment and Materials Sustainability Initiative (GEMS)

Background
Globally *Eichornia crassipes,* water hyacinth (WH) remains a prolific waterway weeds affecting navigation and economic lives of riverine fishermen. While several methods have been proposed and used for its control/management, chemical use of herbicides increases hazard and toxicity of water bodies to aquatic lives. The present effort is to explore engineering use of WH.

Methodology
Adequate quantity of WH were harvested from water bodies and brought to the laboratory for processing. The plants were weighed, quartered into leaves, stems and roots and pressed for further drying after washing. The resulting fibres were then mixed with varying percentages of boiled maize starch between 5 – 15% which an earlier study found had higher bonding property than cassava starch[1]. The matrix and binder were homogenized before being pressed under uniform loading in an ELE crushing machine for 1 h and then air-dried. The whole procedure was replicated thrice. The stability of the board to water absorption and other rheological properties were determined and the mean values determined (Figs 1-6).

Results and Discussion
The boards produced have good bonding property and were stable to water absorption at 7% w/w of starch binder to WH fiber beyond which the starch is no longer economical. The aspect ratio of the dry fibre (12.5) showed good bonding surface with good strength to the final product that can be used as ceiling board or partition board depending upon the finished board thickness and dimensions.

Conclusion
The study showed WH could be harvested and used as raw materials for production of partition and ceiling boards, especially the composite fibre-POP boards. Harvesting, Quartering and fibre extraction are viable small scale businesses that could service a particle board manufacturing industry and thus empower restive youth especially in troubled areas of Niger Delta Region.

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Keywords: lifecycle management of water hyacinth (WH), valorization of WH, waste-to-wealth, particle and ceiling board from WH, engineering materials development, youth empowerment.

XI. Organizing LCA Practice – Creating a Centre of Excellence

Authors: Avantika Shastri[1], Ashok Menon[1], Ananda Sekar[1], Neena Chandramathy[1], Rajesh Mehta[1], RaviTeja Pabbisetty[1], Suchira Sen[1], Martin Baitz[2], Rajesh Singh[3], Ritesh Agrawal[3]
Organization: 1. SABIC Research and Technology Pvt Ltd, India, 2.Thinkstep AG, Germany, 3.Thinkstep Sustainability Solutions Pvt Ltd, India

Abstract
At SABIC, a global leader in diversified chemicals, sustainability is a foundation stone of our core strategy[1]. Over the past decade, we have successfully incorporated Life Cycle Assessment (LCA) across our organization for varied applications like product marketing, development, operational excellence, assessing avoided emissions scope-3 emissions etc.

Sustainability is a journey for our business that requires continuous learning, adaptation, and improvement of our processes in response to the priorities of our diverse stakeholders and a rapidly changing global environment. This paper describes how we re-organized our LCA practice to evolve alongside in order to meet evolving current and future business needs.

In collaboration with Thinkstep (an international leader in sustainability tools and strategic consultancy), we conducted a detailed review of the LCA practices at SABIC to benchmark against global best practices. In order to meet the desired objectives and address the identified gaps progressively over time, we designed an operating framework with four key pillars – Database Management, Knowledge Management, LCA Practitioner Handbook and LCA Communications Protocol. Upon complete implementation, we expect to increase the speed of LCA execution while maintaining and even improving the quality. Across the LCA team, this will enable consistent use of the right rigor of LCA according to the decision context, consistent methodologies and data choices, compliance with standards[2], consistent documentation and audit readiness. We will also have a platform for seamlessly leveraging data, models and best practices across our LCA team.

We will share significant elements of the designed process, the challenges we faced, learnings and best practices that can help other organizations with similar needs.

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XII. Joint National Effort – for Successful Integration of Life Cycle Knowledge in Business and Policy

Authors: Anna Wikstrom[1], Carl Karheiding[1], Sara Palander[1]
Organization: 1. Chalmers University of Technology, Centre for Environment and Sustainability, Swedish Life Cycle Center

This paper shows how a unique collaboration between business, government, academia and research institutes in Sweden has fostered the application of life cycle knowledge, through development and use of tools, competence and knowledge building activities and common research projects, into decision making in industry and policy.

Swedish Life Cycle Center, hosted by Chalmers University of Technology, was founded in 1996 and is a joint collaboration platform for universities, industries, research institutes and government agencies for competence building and exchange of experience to move the life cycle field forward. The center gathers researchers and practitioners in working and expert groups, network and communications activities and in common research projects to develop tools and methods, discuss and share experiences and best practices.

The use of life cycle knowledge has led to better decision within business and policies. Examples from government agencies and businesses, will be illustrated to show how policy and business can collaborate through a platform with common motives and goals. Results from the collaboration includes: 1) Development of ISO standard on monetary valuation of environmental impacts 2) National coordination to influence the European Product Environmental Footprint process 3) Tool to include externalities 4) National coordination towards a Swedish LCA-database 5) Methods to handle loss of biodiversity along the life cycle.[1]

An evaluation, shows that added values of being a partner of the center and hosted by a university includes: 1) Importance of cooperation to build scientifically based knowledge and tools 2) Access to contacts and short take off for projects 3) Increased opportunity to make an impact.[2]

To conclude, this 20-year-long cooperation has been successful for the integration of life cycle knowledge in business and policy in Sweden, and provides a solid platform to meet our great challenge to ensure sustainable consumption and production patterns.

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XIII. Applying Life Cycle Thinking Towards a Sustainable Future

Authors: Llorenç Milà i Canals[1], Feng Wan[1], Kristina Bowers[1], Janet Salem[2], Vijay Samnotra[3]
Organization: 1. Economy Division, UN Environment, Paris, France, 2. UN Environment Asia Pacific, Bangkok, Thailand, 3. UN Environment India Office, New Delhi, India

The global community has set 2030 as the target year for achieving the Sustainable Development Goals, which calls for all countries and all stakeholders, acting in collaborative partnership. Decision making considering a full life cycle perspective and broader implications on the environmental, economic and social pillars of a healthy planet, allows to address unintended trade-offs between these pillars, and focus the attention on the key drivers of change (hotspots). As a result, progress towards sustainable development is faster and more efficient than when decisions are made in isolation.

The Life Cycle Initiative is a public-private, multi-stakeholder partnership fostering progress towards sustainable development. Life Cycle Initiative can play a pivotal role to meet the growing need for more life cycle knowledge from global policy and business agendas, and serve as an interface between users and experts of life cycle approaches. In 2017, the Life Cycle Initiative has adopted a new strategy, which aims to bringing Life Cycle Thinking to the mindsets of decision makers with the practical knowledge and tools to enhance the sustainability of their decisions. This vision will be achieved through (1) advancing the understanding of life cycle thinking by private and public decision makers and of the decision-making process by life cycle experts, in order to improve decisions that need assessing, and comparing products, technologies, lifestyles and economy-wide choices; and (2) building consensus on and facilitating the access to environmental, social and economic life cycle knowledge (LCA data, methods, indicators, etc.).

With a more focused delivery, transparent governance, more inclusive membership, and ambitious fund-raising strategy, the Life Cycle Initiative will contribute to the efficient achievement of the Sustainable Development Goals, as well as other global policy and business agendas. This presentation will provide an overview of the new Life Cycle Initiative strategy, and explore ways in which you can engage and partner with us.

XIV. Sustainable Consumption through Life Cycle Information in the Consumer Perspective: Issues, Challenges and Change Management through the 3Rs (Re-cycle, Re-use and Re-charge)

Author: N. Natarajan
Organization: NIC Cell, Department of Consumer Affairs, Government of India

Aim

To discuss the prevailing pattern of consumption of depleting resources and the cascading effect of the same on human life and environment; to discuss methodologies to bring awareness among consumers and plan a holistic approach to bring a recyclable and re-usable mechanism to re-charge the depleting resources; to discuss the expected policy measures for advancing sustainable consumption through life cycle information.

Scope

The scope of the paper is limited to discuss issues in the consumer perspective and ways to disseminate Life Cycle Knowledge to consumers to make informed choices and adapting to Sustainable Consumption.

Introduction

Consumption of goods and services in the last 50 years is more than the combined total of all previous generations (Tillard 2000). It has catalyzed the economic growth. On the other hand, the environmental degradation is telling upon the health of human life and on flora and fauna. According to Tillard (2000), the richest one fifth of the world accounts for 86% of consumption whilst the poorest one fifth account for about one percent of consumption.

Un- replenishable consumption patterns are posing great threat to the environment. They result in depleting natural resources and there by contributing to various social ailments. Sustainable consumption compliments sustainable production practices and achievements. Sustainable consumption requires a multidisciplinary and multinational participatory approach. Teams composed from various disciplines are required to create and implement policies.

Conclusion

Implementation of sustainable consumption will not only help to achieve development plans but also play a vital role in assuring the future generation to the use of services and related products of basic needs. The key words to be environmental friendly are Re-cycling, Re-use and Recharge. In this paper, we will discuss required policy measures and interventions at all key stakeholder level such as policy makers, Industry bodies, researchers, retailers, consumers, and others. Methods for awareness-raising and educating consumers to make them understand issues involved in and prepare them to meet the challenges will be discussed.

Sustainable Consumption through Life Cycle Information is a goal to be achieved by the involvement of various agencies. The mission could be achieved both by voluntary and mandatory changes in the existing mechanism.

XV. Eco-labels in Garments – Are Consumers Informed or Confused?

Author: Chalaka Fernando
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Introduction
Sustainable production and consumption are two equally important pillars in sustainability. Enabling consumers through 'informed decisions' is the primary step for sustainable consumerism. Eco-labels which initiated in 1992, is such emerging consumer awareness tool. The International Organization for Standardization (ISO) has standardized three types of labels under ISO14020 family. Finding global market presence, trend and use of eco-labels in garments were kept as the research objectives.

Materials & methods
An internet based survey on available eco-labels in garments, their (effective) use, easy to understand and history was researched. Few Sri Lanka apparel experts and selected apparel brands (via email) were interviewed.

Results
There are 108 textile/apparel based eco-labeling schemes out of total 465 spread across 25 industry types . Most of them are Type II self-declared and few Type I and Type III. Eco-labels are promoted and used as a market enabler by several top apparel brands. However eco-labels for promoting technical features such as GOTS (Global Organic Textile Standards) are commonly practiced.

Discussion and Conclusion
Garment (textile or/and apparel) sector dominates the eco-label market and presence in both Northern America and European regions. This is mainly due to brands' directions which are influenced by various stakeholders. However, there is a higher tendency in confusing end consumers due to complex information which are difficult for the consumers to comprehend. Additionally, there is no common mechanism to compare the efficacy of various ecolabels. In some cases, even the scope of analysis (example: cradle to gate) was not presented. A comparison in between labels is not an easy task. Looking at available garment eco-labels, three main impact categories: energy (interpreted through GHG), water consumption and chemical management are generally presented. One of the effective way of communication was found to be an index or pictogram made simple and efficient interpretation without complicating the consumer which was very few.

XVI. ESI – Single Indicator Solution for Life Cycle Assessment

Authors: Mr. Kshitij Tiwari[1], Mr. Shobhit Aggarwal[1], Mr. Aniket Bodewar[2]
Organization: 1. Indian Institute of Technology, Roorkee, 2. Research and Development, Tata Steel Limited

Introduction
Life Cycle Assessment has been a holistic and robust tool to assess the impact of a product or a service on the environment. Be the design phase or post analysis of the products to identify the hotspots, LCA has proved to be useful[1, 2]. Impacts are given in the form of potential[3], for e.g.: global warming potential, ozone depletion potential, acidification potential, eutrophication potential, resource depletion etc. As one might see, to interpret these results and further analysing the environmental sustainability of the product is not easy. Decision makers (who are generally not proficient in LCA) are unable to choose a particular alternative, on the basis of LCA results.

This brings us to our problem statement, i.e., to develop a methodology that converts LCA results into a single indicator, enabling easy decision making.

Proposal

Keeping in mind the existing methods[4] of normalization and weighting, and their pros, and cons, we have come up with a new model named **ESI (Environment Sustainability Index)**. ESI converts LCA results into a single indicator which is in a scale of 1 to 5, 1 being the worst and 5 being the best.

Method

The model is novel in ways, such as it uses distance to target approach, where targets are derived from a scientific basis. Further, difficulty to achieve the target at the present state is considered to award weights to categories using the historic trends of LCA Inventory. Normalization has been performed by using product benchmarks. Finally, the normalized values and weights are aggregated using Weighted Product Method[5]. The above methods have been applied from an Indian context.

Conclusion

The model is believed to have its major applications for three stakeholders, namely the product design and manufacturing firms, the regulators and the product consumers[6]. The model will allow these stakeholders to promote the production, and use of environmentally sustainable products, which was restricted till now due to limited comprehension of LCA, by all the stakeholders mentioned above.

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XVII. Sustainability Marketing: A Way Towards Life Cycle Management

Authors: Payal Trivedi, Rasananda Panda
Organization: MICA – The School of Ideas, Ahmedabad

Introduction

In the age of circular economy, natural resources are finite in nature. The depletion of the natural resources occurs due to constant degradation of ecosystems. The degradation, wastage, and emission of confined resources can primarily be minimized by developing innovative techniques to maintain, to refurbish and to recycle the discarded resources. It is essential to rethink, re-examine and revitalize the ecosystem of the businesses to attain the sustainability.

Sustainability marketing is an approach, can be exercised to fulfill the present requirements of the customers without sacrificing its ability to satisfy the needs of future generations. It is an extended form of conventional marketing which focuses on triple bottom line concept. It emphasizes on the adoption of a minimalistic approach that insists customers to purchase products and services based on its functional value rather than aspirational value.

Objective

This paper attempts to understand theories and approaches to sustainability marketing. It highlights the key challenges of the businesses to mainstream sustainability marketing practices.

Scope

This paper reflects upon theories and approaches such as resource advantage theory, leapfrogging of ideological lock-in theory, rethinking and re-examining of conventional marketing theories, redefinition of marketing of frugality etc. to attain life cycle management through sustainability marketing.

Method

This paper conceptually analyses theories and approaches to sustainability marketing available in the literature.

Conclusion

Inability to provide immediate satisfaction of short term profit, vagueness and biases in the concept of sustainability, and difficulty in execution are some of the prominent challenges that businesses face. To achieve competitive advantage, sustainability can be attained by implementing aforementioned theories and approaches. The adaptation of conventional marketing theories will be helpful to achieve environmental quality, social equity, and economic prosperity.

Key Words: Sustainability marketing, Life cycle management, Circular economy, Triple bottom line

XVIII. Life Sustainable Recycling Industries Project; Regionalized Consistent LCI Data for India

Authors: Amir Safaei
Organization: ecoinvent

International trade is a major contributor to the global economic development, and trade from emerging economies is expected to grow significantly in the coming years. At the same time, there is an ever-increasing concern over the environmental impacts of the products and services by both consumers and producers. The integration of environmental aspects into decision making has thus become an important topic for industries, where the producers should not only meet traditional criteria such as functionality and costs, but should also regard, report and minimize the extent of impacts on the environment.

Life Cycle Assessment (LCA) can be employed to assess and mitigate the environmental impacts of supply chains. A sound LCA requires sound Life Cycle Inventory (LCI) data. Yet, there is a lack of sufficient LCI data for emerging economies including India, and employing the existing LCI data does not reflect the situation in these regions. This underlines the critical role of sound regionalized LCI data for emerging economies, one that reflects the local practices and can be employed to conduct LCAs and report on environmental impacts.

The creation of reliable, consistent and transparent regionalized LCIs represents a core purpose of the Sustainable Recycling Industries-Life Cycle Inventories (SRI-LCI) project. SRI-LCI is funded by Swiss State Secretariat of Economic Affairs (SECO) and implemented by ecoinvent across selected regions including India. SRI-LCI SRI gathers and provides local LCI data through the enhancement of local and regional LCA expertise and a coordinated effort by international and local experts.

This paper presents the SRI-LCI project, its goals, status and hitherto progress in capacity building and LCI data collection activities, including the preliminary obtained LCI data and their implications for India. Future activities in capacity building and data collection, and the synergies for collaboration are also discussed.

XIX. Global Life Cycle Inventory Data for Steel Products

Authors: Clare Broadbent[1], Aniket Bodewar[2]
Organization: 1. World Steel Association, 2. Tata Steel India

Introduction
The global steel industry has been publishing life cycle inventory data since the mid-1990s when materials were being selected based on their 'perceived' environmental performance. The steel industry was one of the first global industry associations to publish an LCI database in 1995 which has since been updated in 2001 and 2010. The World Steel Association is publishing its most recent database in 2017, for 16 steel products from hot rolled coil to tinplated steel, plate, steel sections, wire rod and pipes.

Scope
The data now being published represents steel production from 34 companies in 28 countries and covers 109 operating sites – this can include up to 15 processes as well as ancillary processes on site. Both regional and global data is available. worldsteel is also providing an LCI dataset that can be used to account for the credits and burdens associated with recycling steel scrap or using it in the steelmaking process – this ensures that a full LCA study can be carried out, from cradle to grave.

Conclusion
The World Steel Association makes its data available free of charge via its website. All 46 LCI datasets are also currently available as part of the GaBi LCA software – this makes it readily accessible for anyone using GaBi to directly use the worldsteel LCI data.

Due to the importance of having high quality data available, as well as the huge amount of work it takes to update data on a global level, the World Steel Association will move to an annual data collection programme to ensure that data can be released on a regular basis. This will also mean that older data will be updated to make sure that it remains applicable for use in all LCA studies.

XX. Life² Cycle Assessment: Assessing the Environmental Impacts of a Human Being

Authors: Marcel Goermer[1], Annekatrin Lehmann[1], Matthias Finkbeiner[1]
Organization: Technische Universität Berlin, Chair of Sustainable Engineering

Introduction

The Life Cycle Assessment (LCA) method nowadays is usually applied to products. However, the potential and demand for extending its application also to other levels (e.g. organizations[1]) are high. In this context, quantifying the environmental damage caused by individuals via LCAs might be another relevant application. Such a Life-LCA (L²CA) would raise environmental awareness and thus, build future sustainable growth on a more solid basis – the society.
As human beings consume huge amounts of various products over their lifetime and as also consumption patterns change over time, this is no easy task that raises several methodological questions. The aim of this study is to present the results of a case study and, based on this, to sum up these methodological challenges.

Materials and Methods

Object of the case study was a German middle aged man. Data for consumption of short-living products, like foodstuff, were collected in a two-month monitoring phase while data for long- living products were collected separately. A bottom-up approach was chosen for product clustering. Impact assessment results were calculated for five impact categories by applying the CML 2001 method[2].

Results

In total, 211 product clusters were defined over ten main categories. Traveling (esp. transport by car), direct energy use (esp. thermal energy) and foodstuff (esp. meat and dairy products) were recognized as the dominant groups over almost all impact categories. However, also other product categories like cosmetics have a significant influence while packages of goods have a negligible effect on the overall results.

Conclusion

The outcomes of this work provide a first base for developing a general concept for 'L²CA' studies. The main methodological challenges which need to be further tackled are allocation issues (e.g. between family members), data collection, a bad overall availability of aggregated product datasets and uncertainty regarding past lifestyles.

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XXI. Socio-Economic Life-Cycle Assessment (SLCA) of Street Children in India: A Framework analyzing Casual Factors and Plausible Solutions for their Dismal Living Conditions

Authors: Kriti Bhalla[1], Tarun Kumar[2], Jananee Rangaswamy[1], M.M. Pramodini[1]
Organization: 1. M.S. Ramaiah Institute of Technology, Bangalore, 2. Indian Institute of Science, Bangalore

Aim
This paper aims to investigate the factors contributing to the rise in the number of children in India, forced to live on the streets in dismal living conditions; and to examine the various inherent risk factors through socio-economic Life-cycle Analysis (SLCA).

Introduction
India has an estimated population of about 400,000 children living on the streets. This is a complex problem because of social apathy, human trafficking and poverty. Street children are vulnerable, as they are socially excluded; and belong to the marginalized sections of the society. They are prone to high risk of diseases, physical abuse, malnutrition, sexual violence and are deprived of basic amenities of life. Therefore, there is an urgent need to study the underlying patterns to their challenging living conditions.

Materials and Methods
A comprehensive SLCA was performed on the living conditions of the street children. Moreover, a morphological matrix-based analysis was conducted on the life-cycle stages of street children by examining the risk factors; and by analyzing various government schemes for poverty alleviation and child development. Finally, a framework for improvement of Life-cycle stages of street children was proposed based on case-based references.

Results and Discussions
A public-private partnership (PPP) based foster care system providing adequate facilities with improved living conditions could be implemented. Furthermore, it was observed that the government needs to effectively implement the Right to Education (RTE) Act and various social-inclusion schemes at the grassroots level. Skill-based vocational training and multi-sports training would direct them away from poverty and related evils.

Conclusion
Life-Cycle Management and formulation of risk assessment sheds light on the most dominant causes of the problem. Additionally, this study also contributes in generating a profile suitable for policy formulation; and development of social-welfare program targeting such socially excluded and marginalized section of society.

XXII. Life Cycle Thinking to Achieve Resource Efficiency

Authors: Mahendra Kumar Sharma, Garima Sharma Kapila
Organization: Steel Authority of India Ltd, New Delhi

Introduction
Steel, being a core sector of the economy, contributes around 2% to India's GDP. Driven by rising infrastructure development, steel consumption is expected to reach 104 MT by 2017. India's steel production is expected to increase to 300 MTPA by 2025.

Objective

Steel making is an energy and resource intensive process and is a major contributor to GHG emissions. Life Cycle approach can be a fitting panacea for issues pertaining to sustainability in resource utilisation and cost efficiency. Through this paper, a life cycle perspective would be showcased for achieving the Resource efficiency in the steel making process and gradually migrating towards a circular economy.

Methodology

For achieving resource efficiency in steel manufacturing process, each and every sub-process needs to be relooked from cost efficiency perspective and steps need to be taken to improvise. During Steel making, lot of wastes, return fines, slag, gases are generated and that incurs a cost in storage and subsequent disposal/usage. Tailings/Slimes generated in the ore extraction process, Gases from Coke oven/Blast furnaces, Slag and scrap pose environmental risk on our surroundings and atmosphere. Through LCA, we target the optimised utilisation of available raw material resources and in process generated materials & wastes.

Conclusion

By finding out ways to re-use the slimes/tailings, exploring more usage areas of slag/scrap and beneficiation of fines into pellets which can in turn be used by the Steel Plants in the Blast furnaces/EAFs, we can reduce dependency on Mines and also try to reduce Coke Rate and Slag generation, besides improving the Productivity in our Blast Furnaces.

XXIII. Extended Producers' Responsibility: Supporting LCT in India

Authors: Chintan Vilas Kantute
Organization: Sampurn(e)arth Environment Solutions Pvt. Ltd.

Aim

Understanding the role of Life cycle thinking (LCT) in the implementation of circular economy in general and specifically for Extended Producer's Responsibility (EPR) in the context of the changing policy parameters in India. And its impact on the organized waste management industry.

Scope

Organized Waste Management Networks for Circularity

Taping in and organizing this hugely unorganized network is a key opening to circular economy with the potential to be at the hub of the wheel of resource management where the spokes are multiple stakeholders-producers, waste generators, civic bodies, scrap dealers and recyclers. Along with providing dignified livelihood to the weakest section of urban society these networks provide holistic solution for salvage and recovery of post-consumer products and packaging, with a prerequisite of waste segregation at source.

Extended Producers' Responsibility- PWM 2016

In India, Ministry of Environment, Forest and Climate Change (MoEF & CC), implemented the Plastic Waste Management Rules 2016 (PWM 2016) with the mission of minimizing plastics going to landfills by phasing out use/manufacture of non-recyclable plastics. The rule lays special emphasis on EPR shifting the responsibility for waste management from government to private industry who directly profit from the production of plastics. LCT, empowers producers to holistically envision their products. Technology integration in waste management majorly improves the monitoring and accountability of the system maximizing the rate of salvage and recycling potential. With the generation and observation of this data, producers can directly be held accountable and consequently modify business models to reduce, reuse and recycle post-consumer products.

Discussion

Many industry members are adopting recyclable packaging material for their products. Commercial technologies are being scouted by the industry leaders to be the 1st movers to adopt EPR. If correctly strategized EPR, can be capitalized on by the producers as a renewed branding and packaging opportunity. The PWM 2016 would need to elaborate on certain aspects to make policy practically implementable.

XXIV. A Life-Cycle Based Comparative Study of Electrical vehicles (EVS) Versus Internal Combustion Engine Vehicles (ICVS) as a Sustainable means of Transportation in India

Authors: Jananee Rangaswamy[1], M.M. Pramodini[2], Tarun Kumar[1], Kriti Bhalla[1]*

Organization: 1. Ramaiah Institute of Technology, Bangalore, 2. Indian Institute of Science, Bangalore

Aim

This study examines the features of Electrical Vehicles (EVs) as compared to those of conventional Internal Combustion Engine Vehicles (ICVs) by using life-cycle assessment method.

Scope

The automobile population, is growing faster than the human population, with no saturation point. Fuel burnt by ICV releases various kinds of emissions like sulphur, lead, unburnt hydrocarbons and carbon-dioxide to the environment; which results in deteriorating health conditions such as respiratory disorders, dermatological conditions, Lung cancer and heart diseases. Though EVs have zero emissions, their widespread usage is restricted by various limitations.

Methodology

A Life-cycle assessment was performed to compare the carbon footprints and embodied energy for both, EVs and ICVs, in the Indian context. The characteristics of usage and emissions of ICVs and EVs were studied using case-based references. Furthermore, a critical study of the urban infrastructure and policy measures supporting EVs, was done by using morphological analysis.

Results

Interestingly, it was observed that the carbon footprints of EVs were comparable to that of ICVs, because of the coal-based electricity production and huge transmission losses. Lack of charging stations, service capabilities, high cost and less drive per charge are the current constraints of EVs.

Discussions

Solar-panel integrated charging-stations can be provided at adequate intervals in the cities and on highways. The high cost of EVs will eventually reduce by mass production and improvements in urban infrastructural systems.

Conclusions

EVs are the future of sustainable transportation systems in India provided that, a) clean energy is used at charging stations; b) proper infrastructure for charging stations are provided; c) Efficient electricity storage systems for night-charging are installed; d) Building integrated Photo-Voltaic (BiPV) strategies are incorporated to charging stations; e) improved engine technology and trained service personnel are made available and; f) competitive features compared to commercial ICVs are provided.

XXV. Environmental footprint of cooking fuels: a life cycle assessment of ten fuel sources used in Indian households

Authors: Punam Singh[1], Haripriya Gundimeda[1], Matthias Stucki[2]
Organization: 1. Indian Institute of Technology, Powai, Mumbai, India, 2. Zurich Univ. of Appl. Sciences, Wadenswil, Switzerland

Abstract
Background, scope and purpose Cooking energy is an essential requirement of any human dwelling. With the recent upsurge in petroleum prices coupled with intrinsic volatility of international oil markets, it is fast turning into a 'politico-socio-economic dilemma' for India to sustain subsidies in future on liquefied petroleum gas (LPG) and kerosene. The aim of this paper is to evaluate and compare the environmental performance of various cooking fuel options namely, LPG, kerosene, coal, electricity, firewood, crop residue, dung cake, charcoal and biogas in Indian context. The purpose of this study is to find environmentally suitable alternatives to LPG and kerosene for rural and urban areas of the country.

Methods
The performance of the cooking fuels is assessed on thirteen ReCiPe environmental impact categories using the life cycle assessment (LCA) methodology. The system boundary for each fuel is modelled based on the Indian scenario and a detailed life cycle inventory for each cooking fuel has been prepared based on emission factors obtained from standard resources. The functional unit is 1 GJ of heat energy transferred to cooking pot.

Results and discussion
The cooking fuel with lowest life cycle environmental impacts is biogas followed by LPG, kerosene and charcoal. The environmental impacts of using LPG are about 15 to 18% lower than kerosene for most environmental impact categories. LPG derived from natural gas contributes about 20 to 30% less than those derived from crude oil. Coal and dung cake are the worst performing cooking fuels because of its significant contribution to climate change and particulates formation, respectively. Charcoal produced from renewable wood supply performs better than kerosene on most impact categories except photochemical oxidation, where its contribution is 19 times higher than kerosene.

Conclusion
Biogas and charcoal can be viewed as a potentially sustainable cooking fuel options in Indian context because of its environmental benefits and other associated co-benefits such as land farming, local employment opportunities, skill development etc.

Recommendations and perspective
Based on the outcome of this study, it can be recommended that for rural areas kerosene, biogas and charcoal and for urban areas LPG, kerosene and biogas are environmentally sustainable fuel options for meeting household cooking energy demands in India.

Keywords: Cooking energy, LCA, LCIA, Climate change, ReCiPe, Traditional fuels, Fossil fuels, Household biogas, Dung cake, Charcoal

XXVI. Integration of Life Cycle Approach for Achieving Bioethanol Blending Target of Pan India

Authors: Sujata[1]*, Priyanka Kaushal*[2]
Organization: TERI University, India

Introduction

India being a resource stress country took the decision to use molasses as raw material for fuel ethanol production with aim of reducing country dependence on oil imports and improving energy security. To integrate bioethanol into energy system Government of India has started ethanol-blending program in 2003 with 5% blending target and scaled up to 10 and 20%, to promote its use as alternative fuel1,2. Recently India has also committed in an Intended Nationally Determined Contribution to reduce its carbon emission relatives to its GDP by 33% to 35% from 2005 levels by 2030.

Methodology

India's biofuel programme relies on the ethanol availability for blending into gasoline. Author has done a reality check to analyze the raw material availability (molasses), infrastructure for processing (distillation capacity) and ethanol demand in the market. From analysis, author observed that we are deficit with infrastructures for processing of available raw material. To meet ethanol demand for 20% blending, author has done the detail analysis of infrastructure for Pan India using GIS (Geographical Information System) methodology. Quantification of carbon emissions and the energy consumption was also evaluated for Pan India using a functional unit i.e. 1 ton of fuel grade ethanol using Life cycle assessment (LCA) tool with ISO 14040 guidelines3,4.

Result and Discussion

GIS mapping of Pan India was done to analyze the processing facility with capacity as shown in Figure 1. It helps in identification of new location for the surplus unprocessed raw material. As per analysis, Maharashtra and Uttar Pradesh are required 13 distillation facilities with capacity in range of 120-200 kilo liter per day. For Pan India, 29 new facilities were identified for processing the raw materials.

LCA of existing and new infrastructure was compared and observed that new infrastructure facilities will have 59% less carbon emission and 37% more energy efficient (mainly from sugarcane milling and ethanol conversion process) along the production chain. This study also observed that ethanol can be produced from both sugarcane and bagasse. But, when GHG emissions are considered, the production of electricity from bagasse is better option than ethanol.

Conclusion

GIS and LCA study will help policy makers to take meaningful decisions for feasibility of ethanol in future.

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XXVII. Social hotspots analysis and environmental LCA of a boiler

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This study proposes the first implementation of Social Life cycle assessment (S-LCA) [1] to a biomass boiler (46 kW) for heating and domestic hot water purposes.

The main materials used to produce the boiler are: steel (around 400 kg) and limited quantities of cast iron (20 kg). The manufacturing of the boiler is based on the processes of cutting, turning and folding of steel sheets, welding of metal parts and components, painting, assembly and packaging. Different kinds of solid fuel can be used to feed the boiler as wood, pellets, almond shells, pine nut shells, and pistachio shells. Moreover, the boiler can also use liquid bio-fuels.

The social risk assessment has been performed by using combined data from the social hotspots database[2] and the USGS database[3].

A comparison and the S-LCA and the environmental Life Cycle Assessment (LCA)[4] production stage was performed. The most relevant contribution to both analyses comes from the extraction, production and cutting of steel. In particular, for the environmental LCA, this is due to the highest contribution in terms of mass input, while for the S-LCA, the highest producer of steel in the world is China, considered an area of social hotspots for several indicators.

About the steel extraction, production and cutting, the environmental indicators reporting the highest impacts are global energy requirement, climate change, ozone depletion, human toxicity-cancer effects (above 75% of the whole production stage impacts).

For the social approach the highest impacts are found in the indicators: Risk of child labour, Risk that a country lacks or does not enforce Collective Bargaining rights and Association rights, Gender inequality, Risk of fragility in the legal system.

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XXVIII. Developing Baseline for Lifecycle Thinking in the Activities of Newly Established Resource Efficiency and Cleaner Production Centers in Nigeria

Authors: Ife Adewumi[1,2], Chuks Diji[1,3], Musa Awoyemi[1,3], Ganiyu Ajikanle[4], Wale Akala[5]
Organization: 1. Greener Environment and Materials Sustainability Initiative (GEMS), Nigeria, 2. Niger Delta University, Nigeria, 3. University of Ibadan, Ibadan, Nigeria, 4.Obafemi Awolowo University, Ile-Ife, Nigeria, 5.Federal Resource Efficiency and Cleaner Production Centre, Abuja, Nigeria, 5.Osun State Resource Efficiency and Cleaner Production Centre, Osogbo, Nigeria.

Introduction

Nigeria recently (in 2017) after years of expectation embraced the establishment of Resource Efficiency and Cleaner Production Centers (RECPCs) at the Federal and State levels based on the joint proposal submitted by the Greener Environment and Materials Sustainability Initiative (GEMS), an NGO and Nigeria Chapter of African Roundtable on Sustainable Consumption and Production (ARSCP-Nigeria).

Methodology

The Bottom-Up approach proposed by GEMS/ARSCP-Nigeria and adopted by the government recognizes the need for each of the 774 Local Government Areas (LGAs) in the present 36 States and the Federal Capital Territory (FCT) to focus on promoting sustainable consumption and Production (SCP). The Turton *et al*[1] model of trialogue of good governance is the basis of promoting the new Centers as it is important in getting everyone, government, societies and scientific bodies to cooperate for achievement of development. GEMS/ARSCP-RECPC Interface would serve as platform. Earlier studies by GEMS to monitor Water Footprint in selected major Breweries in Nigeria[2], on life cycle management of electronic wastes[3] and of piggery wastes[4] showed the need to focus on life cycle management LCM), Water Foot Printing (WFP), Carbon Foot Printing (CFP) and Industrial Symbiosis (IS) as tools for promoting SCP by the new Centers.

Results and Conclusion

Thee Nigeria's RECP Centers are supported by UNIDO and are expected to promote SCP for improved environment, creation of new or repackaging existing local industries to reduce joblessness and empower young women and youths. A major advantage of this late start in having RECPC by Nigeria's governments is the opportunity of the 37 major Centers to make Life Cycle Thinking (LCT) the focus of promoting SCP and the sustainable development goals (SDGs) in their areas of jurisdiction. How this shapes out will be reviewed in the years ahead.

Keywords: RECP Centers, life cycle thinking (LCT); sustainable consumption and production (SCP); environmental protection; job creation; youth and women empowerment.

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XXIX. Socio-Economic Life Cycle Assessment (SLCA) of Rural Khadi Handloom Industry (rKHI): A Model for empowerment of Rural Women

Authors: Kriti Bhalla[1], Tarun Kumar[2], Jananee Rangaswamy[1], M.M. Pramodini[1]
Organization: 1. M.S. Ramaiah Institute of Technology, Bangalore, 2. Indian Institute of Science, Bangalore

Aim

This paper examines the Life Cycle stages of rural *Khadi* handloom industry (*r*KHI). The objective of this study is to highlight the myriad issues faced by rural female workers, as a socio-economic determinant.

Introduction

Female labour force participation in a developing country like India is quite low as compared to other peer countries. Rural female labour force participation rate (LFPR) accounts for 22.5 percent, against total LFPR of India which is around 40 percent. The LFPR for rural women is approximately half of the male work force. Despite of broad gender gap in LFPR, villages in India experience predominance of female participation. *Khadi* handloom is heritage-based small-scale-sector in Indian Textile economy, having a profound impact on the development of the decentralized sector generating direct and indirect employment.

Materials and Methods

A morphological-analysis of different life-cycle stages of *r*KHI was done employing assessment tools for SLCA. Various Government schemes and policies targeting social protection programs in rural areas were examined to study pattern of rural female LFPR.

Results and Discussions

A design-based reference framework was formulated from the study of different life cycle stages of *r*KHI. Policy level recommendations were given to provide conducive socio-economic and sustainable environment for rural female work force.

Conclusion

Therefore, *r*KHI demonstrates sustainable means of production and strengthen relief programs for poor and marginalized population living in villages. This study points to positive interdependence of protection of small-scale *r*KHI and growing rural female participation. Promotion of gender equity in production sector of an economy is the key to economic prosperity of a developing country and *r*KHI illustrates the same by employing the rural female workforce. Environmentally benign *r*KHI with labor-intensive production system has considerable potential for upsurge in employment, gender equity and poverty alleviation which are important aspects of Sustainable Development Goals.

XXX. Approaches to Promoting Life Cycle Thinking in a Large Organization – A SABIC Case study

Authors: RaviTeja Pabbisetty, Suchira Sen, Avantika Shastri

Organization: SABIC Research & Technology Pvt. Ltd., Bengaluru, India.

Abstract

SABIC is one of the largest petrochemical companies with business spanning across several markets and applications with diverse products that include petrochemical intermediates, specialty and commodity polymers, fertilizers and metals. With such a diverse business portfolio, there is an added complexity in incorporation of sustainability across respective value chains. Life cycle thinking approach is recognized as one of the most holistic ways for assessing and enhancing environmental sustainability. There are a number of approaches a company can choose to pursue to incorporate this life cycle thinking across the organization.

In this presentation, we will highlight some approaches taken by our corporate sustainability department to reach out and to sensitize various internal stakeholders on the concepts of LCT, ensure retention of learnings and to urge application of LCT concepts in their daily work.

- An online LCA game for helping individuals understand the interactions between sustainability and economics
- Introducing sustainability products and features via a game (sustainability bazaar)
- Online videos and self-learning content introducing LCT and LCA
- Combining Sustainability Day with other platform events, internal groups & network events
- Business specific tools on sustainability
- Technical LCA/LCT trainings for individuals to enable use of SABIC scorecards & other program requirements

XXXI. Application of Life Cycle Knowledge to Integrate Sustainability in Business Strategy: A Case Study from Sri Lankan Dairy Sector

Authors: Ms. Uthpala Sankalpani[1], Ms. Sachira Vilochani[1], Mr. Samantha Kumarasena[1]
Organization: 1. National Cleaner Production Centre, Sri Lanka

Introduction

Profit maximization is the top priority of a business. Businesses establish their strategy to achieve the same. Strategy in business context defines the long term game plan of a company to achieve their ultimate objective. Integrating sustainability to strategy is lifting up in the global agenda with the rise of environmental and social issues.

Issue

Few, especially renowned global companies adopt sustainability at strategy level. For most, especially for Small and Medium Enterprises (SMEs), it remains conceptual. In Sri Lanka, 80% of economic contribution comes from SMEs. They spend their efforts on day to day operations, but not at least establishing a business strategy. Sri Lankan dairy sector faces the same situation and have resulted lower production with low quality. As farmers are moving away from the industry, it is gradually declining. All the stated factors are contributing to lower the contribution to GDP by dairy sector.

Methodology

Eco Innovation is an approach introduced by UN Environment to innovate business models lead by business strategies to achieve sustainability. Methodology is based on Life Cycle Thinking (LCT). Selected company's value chain was studied, hotspots were identified, strategies were revisited and a business model was developed through the project.

Results

Team Eco Innovation developed new value proposition "High quality fresh milk products sustainably sourced from happy farmers while improving their livelihood" and re formulate business strategies. Activities were then streamlined and the project linked government institutions, universities and private institutions to the company to provide extension services to farmers. Through application of LC knowledge to integrate sustainability in business strategy, company could enhance their profitability. By implementation of above methodology, company is expected to operate at 40% higher milk yield.

XXXII. A Sustainable Urban-Design Solution for the Indian Garment Industry Using Life-Cycle Assessment Approach

Authors: Jananee Rangaswamy[1], Tarun Kumar[2], Kriti Bhalla[1], M.M. Pramodini[1]
Organization: 1. M.S. Ramaiah Institute of Technology, Bangalore, 2. Indian Institute of Science, Bangalore

Aim

This study aims to provide an Urban-design solution for the Indian garment industry and assesses provisions for better working conditions, based on the environmental and social impacts along its life cycle.

Introduction

India is the second largest country after China to dominate garment export trade in the world. The Indian garment industry at present employs nearly 51 million people directly and 68 million people indirectly in the trade, where most of them belong to Low-Income groups (LIG) and Below Poverty Line (BPL). This industry poses several environmental hazards such as air, water and land pollution- by way of releasing harmful by-products of fabric processing in to the nearby water bodies; releasing CO2 in to the atmosphere and; dumping solid by-products as landfill- which largely affect the working and living conditions of the factory workers and also the society as a whole.

Methodology

With the help of case-based references, the environmental impacts of the industry on the surrounding spaces and the living and working conditions of the factory workers have been studied. An Integrated design-solution is proposed at the urban-level forming a base for a modular approach which may be replicated in various cities. This module has been developed keeping in mind the fundamentals of life cycle assessment and thereby aiming at reducing the negative environmental and social impacts of the garment industries.

Results and conclusions

The module for an Integrated urban-design solution has a positive cumulative environmental and social impact compared to that of the existing distributed building design systems which were a major contributor to global environmental and social issues. The proposed design module makes it easier to a) keep checks on the environmental issues; b) provide better infrastructure and technology and; c) commute from one garment manufacturing stage to another; thereby making it a sustainable system.

XXXIII. Design for Sustainability through Life Cycle Thinking

Authors: Neha Koul1
Organization: Green Business Certification Inc. (GBCI)

Aim

From Product EPDs to Building LCA's– LEED v4: Benchmarking the sustainability paradigm

Scope

The scope of paper shall be limited to Environmental Product Declarations and Life Cycle analysis for buildings as addressed in LEED v4.

Introduction

"Sustainability" (noun) is intrinsically an idea that goods and services should be produced in ways that do not use resources that cannot be replaced and that do not damage the environment (Cambridge Dictionary). As we are at the behest of a global climate catastrophe, it is this intrinsic quality which needs to be applied across all products and projects to prevent if not disrupt the status quo. However, as the age old adage goes "What cannot be measured cannot be managed". There is a need to identify metrics/tools through which sustainability can be measured, the environmental impacts of entities can be compared and informed decisions can be facilitated.

Discussion

LEED (Leadership in energy and environmental Design) is a green building rating system by U.S. Green Building Council that has been pioneering and setting newer benchmarks in the sustainability movement, since its inception. LEED v4, the recently launched version of LEED, recognises Life Cycle analysis as a tool for measuring and optimizing the environmental impacts and promoting resource efficiency. The following three credits witness valuation of a project for deploying life cycle thinking approach for building materials and building as a whole.

- Building Life Cycle Impact Reduction
- Interior Life Cycle Impact Reduction
- Building Product Disclosure and optimization: Environmental Product Declarations

Objectives

1. Discuss the need for adopting life cycle thinking approach for buildings and building materials
2. Evaluate current market scenario and the value proposition of conducting Life Cycle Assessments
3. Understanding Environmental Product Declarations and differentiating them from Life Cycle Assessments
4. Discuss the standards that bring value to a life cycle assessment report and assure compliance with LEED v4's requirements

XXXIV. Design for Sustainability Through Life Cycle Thinking

Authors: Shubhi Sachan
Organization: Sustainable Material Researcher and Designer

Introduction

My practice is focused on making waste materials come to life again — the rebirth of materials that were once exiled to towering landfills or incinerators. The advent of the mining industry in the industrial era brought about an obsession with virgin materials. Industries see raw material go into powerful machines that turn them into shiny new products, turning a blind eye to the little pieces of 'industrial scrap' produced with each manufacturing operation. Not only is this catastrophic for the environment but large quantities of materials that require highly sophisticated processes, copious amounts of energy and resources for manufacturing in the first place, are wasted.

Materials

The Indian subcontinent has a rich tradition of recycling. Largely informal sector collects and segregates profuse amounts of industrial 'waste' on a daily basis. Many of the materials we regard as waste have the potential to become raw materials for new products and processes.

Methodology

My projects are focused on rethinking the use of industrial waste materials by combining the knowledge & skills of traditional crafts with modern materials. In one process, the sophistication of traditional craft is capable of turning the most unrelenting of materials into fluid surfaces through complex weaves.

The proposed material findings / products aim to generate and sustain a dialogue about the latent value in industrial waste materials that can be harvested through traditional crafts. Designed using non-hazardous waste materials, projects explore such materials through objects that resonate with various aspects of our day-to-day lives. For example — Turning Graphite waste into a conductive surface for everyday use through traditional craft making processes.

Discussion

India's growing manufacturing ambition is going to bring global issues of excessive waste with it. Can rethinking the source of our material quarries help us reduce waste?

XXXV. Life Cycle Assessment based sustainability context analysis of municipal solid waste management in Harare, Zimbabwe

Authors: Trust Nhubu[1] , Edison Muzenda[2], Charles Mbohwa[1], Emma Agbenyeku[1]
Organizations: 1. University of Johannesburg 2. Botswana International University of Science and Technology

Abstract

Harare is experiencing enormous solid waste management challenges. The population in Harare has been on an increase leading to increased waste generation. The population increase coupled with the obtaining economic environment has exerted pressure on Harare Municipality to cope with solid waste generated. Solid waste management challenges in Harare are manifesting in the form of both groundwater and surface water pollution leading to the outbreak of water borne diseases. Numerous waste management studies carried in Harare highlighted the nature of the challenges being faced and recommended the need to have a waste

management paradigm shift in Harare. This study argues for the need to undertake LCA studies to design sustainable waste management options considering Combined Heat and Power Generation for Harare. Six scenarios will be analyzed for eutrophication, global warming, human health and acidification potential impact categories. SimaPro and Ecoinvent database will be used during the LCA. These scenarios include current scenario (A0) irregular collection and dumping of 60% of waste generated at the official waste dumpsite, scenario 1 (A1) disposal of municipal solid waste fraction without any prior treatment in a landfill with energy recovery and treatment of leachate, scenario 2 (A2) incinerates municipal solid waste fraction that would have been indiscriminately collected, scenario 3 (A3) anaerobic treatment of source separated organic waste and incineration of mixed bag municipal solid waste without material recovery and scenario 4 (A4) anaerobic treatment of source separated organic municipal solid waste and incineration of mixed bag of municipal solid waste after material recovery. Scenarios 5 (A5) and 6 (A6) are same as A4 only that in A5 and A6 the non-recovered materials are aerobically stabilized before being incinerated and send to landfill respectively. Scenario 5 is anticipated to have the least impact on all the impact categories.

Keywords: Solid Waste Management. Recycle, Reuse, Reduction, Combined Heat and Power

XXXVI. Life Cycle Oriented Material Selection Process for the Design of Drinking Water Transmission Network

Authors: Mr. M. Valliappan
Organization: Trusty water, Coimbatore, India

Abstract
When drinking water distribution system is designed, it is the interest of water distribution and management to assure every drop of water reaches its destination. In reality, the loss is not only for the quantity, but also the health of people consuming contaminated water. Numerous incidents of drinking water leakage and contamination prompt various stakeholders to have fast response in minimizing water losses in India. Pipeline infrastructure and possible devices coming into contact with water distribution should be made of such material that they do not change the quality of water. Failures reported for the specific material type are influenced by the location specific water composition and operation & maintenance practices. This paper analyses various materials available for drinking water distribution from its life cycle perspective. Hotspots analysis has been employed to design SDG-6 compliant framework suitable for screening material options utilizing criteria such as availability of resources, investment methods, leakage response, quality assurance, operation and maintenance of water distribution.

XXXVII. Influence diagrams and scoping for Life Cycle and Sustainability Assessment, an example from sustainable mining

Authors: Andreas Ciroth[1], Jutta Hildenbrand[2]
Organization: 1. GreenDelta, 2.Swerea-IWF

Life Cycle Assessment is a technique typically intended to provide a holistic assessment of environmental and possibly also social impacts over the entire supply chain and life cycle. However, LCA has limitations, for a variety of reasons:

- LCA is not well able to deal with risk and chances

- LCA typically does not model local situations in high resolution, and thus tends to overlook specific local conditions
- LCA is a rather technical approach with high data needs, which are especially difficult to satisfy in regions where LCA is new and no background databases are available; as a consequence, immediate improvement in perilous situations might be better achieved with more "hands-on" tools
- LCA results have the issue to be difficult to understand, and recent alternative approaches such as the circular economy are gaining attraction.

In this situation, it is interesting to investigate, for a given issue, the ideal portfolio of tools to be used, including, but not necessarily limited to, LCA. Moreover, in every LCA, it is in a first step important to specify goal and scope for the analysis.

We introduce influence diagrams and advanced hot spot analysis as a means to both "tailor" the approaches to be applied for assessing the sustainability of a given situation, and also to shape goal and scope of an LCA, where LCA is part of said portfolio.

The analysis will be presented using an example from the mining sector, for specific mine sites in Finland, Portugal, and South Africa, where this approach is currently applied, led by GreenDelta, in the European H2020 research project ITERAMS. In the presentation, it will further be discussed how the approach can be transferred to India.

XXXVIII. Life Cycle Analysis of Shrimp Aquaculture Production Systems: Challenges and Opportunities

Authors: Muralidhar Moturi, Dr. Syama Dayal Jagabattula, Dr.Jayanthi Marappan and Dr.Vijayan Koyadan Kizhakkedath
Organization: ICAR-Central Institute of Brackishwater Aquaculture, Chennai

Introduction
Shrimp aquaculture is the fastest growing food production sectors in the country and recorded a spectacular shrimp production of 4.88 lakh MT during 2015-16 accounting for 64.5% of the total marine products earnings in dollar terms. The sector to remain sustainable, future growth must be met in ways that do not place unacceptable demands on ecological services. It is important to study all the processes involved in shrimp production from cradle to grave which can enable us to intervene to make aquaculture eco-friendly.

Materials and methods

Life Cycle Analysis (LCA) was performed with 'SIMAPRO' software to understand the contribution of shrimp production system with functional unit of 1 ton production towards the environmental impact categories. The unit processes considered in the actual production were kept within the large rectangle while other unit processes are kept outside.

Results
Eutrophication and global warming potential (GWP) impacts are mainly due to feed use, and energy use during feed preparation in feed mill and water pumps and aerators use in the farming, respectively.

Discussion
Use of large quantity feed and other inputs aimed at increasing the shrimp production has made the farming

system more energy intensive. LCA study identified the hotspots, which contributes considerably toward the impact categories.

Conclusion

LCA would require quantified and quality data on the inflow and outflow of the inputs and energy utilization (national energy grid). Replacement of fishmeal with suitable alternative plant proteins and energy efficient pumps and aerators will require new innovations in technologies, but the payoffs may be spectacular in terms of profitability, food and nutrition security and reduced environmental impacts.

XXXIX. Simulation Environment Life Cycle Assessment at Enterprise Level

Authors: Prasad Sudhakar Giri
Organization: Mahindra

Aim

Goal of this project is to understand futuristic Environment Impact Assessment for MSSSPL at Enterprise level.

Abstract

Over the years, there has been increasing commitment from the Indian steel industries to address environmental issues. The prime objective of steel industry is to show and prove the environmental friendliness of the steel production processes and also demonstrate that the Indian Steel Industry is not only going beyond to statutory requirements but also position itself at par with the world class steel plants. So the aim is to document by facts and figures the actual status of the future environmental performance particularly focusing on energy consumption, GHG emissions, air emissions, effluent discharge and waste generation.

In an attempt to understand and study the environmental impact assessment of company operations, Mahindra Sanyo Special Steel Pvt Ltd (MSSSPL) has conducted Simulation ELCA computing for forecasting Environmental Impacts of 2021 with respect to wherein there are production targets and other reduction targets across the various environmental impacts like GHG, Energy, recyclability, waste, renewable materials, other environmental toxins etc. over the complete lifecycle of the products.

In this study we studied overall reduction in GHG per ton over the period of through reduction targets for oil and electricity along with our renewable energy ambition. We adopted ISO 14040 / 44 framework for this entire exercise.

Conclusion

From the study it is understood total GHG reduction achieved by FY 21 from baseline FY 15

- A reduction of 6.22% in GHG emissions can be achieved through electricity is reduced as per the simulation values.
- A total reduction of 9.84% in GHG emissions can be achieved through increase in the share of renewable energy in the total electricity consumption.
- A reduction of 1.97% in GHG emissions can be achieved through specific fuel consumption is reduced as per the simulation values.

XL. Sweet-spot: An Open visualization plug-in for supporting effective interpretation of LCA results

Authors: Praveen Uchil, Amaresh Chakrabarti
Organization: Indian Institute of Science, Bangalore

Using LCA tools to identify significant issues (hotspots) and to trace its underlying causes in an existing LCA study, require the users to perform complex tasks for decision makers such as designers who often do not have prior knowledge of LCA and have limited time to learn& use LCA tools, performing such tasks can be difficult and can be of limited success. To systematically identify what components of the LCA interface are troublesome and to develop redesign strategies we have developed a TCAD framework. TCAD stands for Tasks, Criteria, Data collection, data Analysis. Our framework encompasses tasks derived from ISO 14043 guidelines for LCA interpretation and elements from LCA Practitioners exam of ALCA; Criteria, Data collection and analysis methods derived from the domain of Human-Computer Interaction and Information Visualization. TCAD framework has been applied to evaluate interpretation effectiveness of two popular LCA interfaces ((SimaPro and Open LCA). Our study involved 52 novice designers performing interpretation tasks. The recorded videos of interaction have been coded and analyzed to identify issues with usability and visualization in the interface that affect interpretation. Using these results and using appropriate techniques emerging from information visualization community, we have iteratively redesigned an alternative LCA interface.

The result is a Sweet-spot: a multi- dimensional interactive LCA visualization plugin for Open LCA. We have built Sweet-spot around a newly introduced visualization feature by Green Delta in Open LCA. Sweet-spot can quickly and easily help users to identify hotspots in the context of methodological parameters and to identify environmental pathways underlying the hotspot. Evaluation of interpretation effectiveness of Sweet-spot interface shows significant improvement w.r.t task success rate, task performance and perceived ease of use.

We have demonstrated the application of TCAD framework to identify issues in popular LCA interfaces and develop Sweet-spot. The proposed framework can be extended to effectively support evaluation tasks such as sensitivity checks and trade off analysis. Since our framework and interface redesign process is generic in nature, it can be used by any LCA tool developers to identify the issues with their interfaces, benchmark performance and to improve its effectiveness.

XLI. Life Cycle Analysis of DME Synthesis and Stranded Natural Gas

Authors: Himanshu Singhal, Harsh Singhal, Vineet Kumar Rathore, Prasenjit Mondal
Organization: Indian Institute of Technology, Roorkee, India

Abstract
Dimethyl ether (DME) produces less emission than fossil fuels and has potential to replace LPG, diesel etc. [1]. Natural gas is converted to syngas through reforming, which is further converted to methanol. DME is produced through dehydration of methanol. The methanol synthesis with conventional reactor system is economically feasible only when the plant size is large. However, the economy of methanol synthesis can be made feasible in small scale production if compact reactor with improved heat and mass transfer is designed [2].

The present study deals with the life cycle assessment (LCA) of DME synthesis process using stranded natural gas in small compact reactor. The basis of all the calculations is defined as the DME production rate of 10.9

Kmol/h. The scope of present study includes all the stages starting from the collection of raw natural gas to final production of DME. The usage phase is excluded from the study.

The LCA of the process has been performed as per the protocol of the International Organization for Standardization (ISO 14040:2006, ISO 14044:2006), which consists of four phases: (1) Defining the goal and scope of problem, (2) Life cycle inventory analysis, (3) Life cycle impact assessment, and (4) Interpretation of results (IS/ISO 14040:2006). Appropriate assumptions have been made and the contribution of different unit operations, separator (electricity from grid mix) and heater (electricity from grid mix PE) on environmental impacts, under different impact categories (indicators) are calculated by CML 2001 and TRACI method using GaBi software (V 6.0). The source of different indicators have been identified and quantified. The results obtained with both the methods are found consistent for the impacts assessment.

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XLII. LCA of Sewage Treatment Plants Based on Advanced BNR Processes

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Abstract

Nowadays, wastewater treatment plants (WWTPs) are facing constantly stringent regulations with respect to the environment and human health. Different wastewater treatment options have different performance characteristics and also different direct impacts in the environment. Life Cycle Assessment (LCA) is a technique to measure all the potential environmental impacts of any product, process or a system. The aim of this study is to identify, quantify and compare the environmental impacts associated with two different WWTPs based on biological nutrient removal processes, namely biodenitro process and Anaerobic/anoxic/oxic (A2O) process, using LCA methodology. All of the information gathered is used to prepare life cycle inventories have been used as an input to SimaPro Software for performing LCA using CML-IA baseline V3.02 methodology. For the CML-IA baseline method, the results were processed to express the environmental performance in eleven impact categories including abiotic depletion, abiotic depletion (fossil fuels), global warming, ozone layer depletion, human toxicity, fresh water eco-toxicity, marine aquatic eco-toxicity, terrestrial eco-toxicity, photochemical oxidation, acidification, and eutrophication. A comparative study of LCA results of construction phase as well as operational phase were performed for both the systems. The results showed that the major environmental impacts are caused due to consumption of cement and steel during construction phases whereas consumption of electricity and chemicals during operational phases for both the system however all the impacts observed due to constructional phases were very less as compared to operational phases as in the case for BNR system also. It was observed that the better effluent quality reduced the eutrophication load on environment.

Keywords: LCA, BNR, India, Sewage treatment plant, Wastewater.

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