

*Article*

## Towards Life Cycle Sustainability Assessment

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**Abstract:** Sustainability is nowadays accepted by all stakeholders as a guiding principle for both public policy making and corporate strategies. However, the biggest challenge for most organizations remains in the real and substantial implementation of the sustainability concept. The core of the implementation challenge is the question, how sustainability performance can be measured, especially for products and processes. This paper explores the current status of Life Cycle Sustainability Assessment (LCSA) for products and processes. For the environmental dimension well established tools like Life Cycle Assessment are available. For the economic and social dimension, there is still need for consistent and robust indicators and methods. In addition to measuring the individual sustainability dimensions, another challenge is a comprehensive, yet understandable presentation of the results. The “Life Cycle Sustainability Dashboard” and the “Life Cycle Sustainability Triangle” are presented as examples for communication tools for both experts and non expert stakeholders.

**Keywords:** life cycle sustainability assessment; life cycle assessment; life cycle costing; social LCA

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### 1. Introduction

The main drivers for the scientific developments towards Life Cycle Sustainability Assessment (LCSA) are the paradigm shift from environmental protection towards sustainability (see Section 1.1)

# Towards Life Cycle Sustainability Management

**Tomayess Issa, Theodora Issa, Touma  
B. Issa, Pedro Isaias**



## **Towards Life Cycle Sustainability Management:**

**Towards Life Cycle Sustainability Management** Matthias Finkbeiner, 2011-07-23 This book is a selection of the most relevant contributions to the LCM 2011 conference in Berlin The material explores scientific and practical solutions to incorporating life cycle approaches into strategic and operational decision making There are several sections addressing methodological topics such as LCSM approaches methods and tools while more application oriented sections deal with the implementation of these approaches in relevant industrial sectors including agriculture and food packaging energy electronics and ICT and mobility

*Life Cycle Management* Guido Sonnemann, Manuele Margni, 2015-07-16 This book provides insight into the Life Cycle Management LCM concept and the progress in its implementation LCM is a management concept applied in industrial and service sectors to improve products and services while enhancing the overall sustainability performance of business and its value chains In this regard LCM is an opportunity to differentiate through sustainability performance on the market place working with all departments of a company such as research and development procurement and marketing and to enhance the collaboration with stakeholders along a company's value chain LCM is used beyond short term business success and aims at long term achievements by minimizing environmental and socio economic burden while maximizing economic and social value

**Life Cycle Sustainability Assessment for Decision-Making** Jingzheng Ren, Sara Toniolo, 2019-11-19 Life Cycle Sustainability Assessment for Decision Making Methodologies and Case Studies gives readers a comprehensive introduction to life cycle sustainability assessment LCSA methodology for sustainability measurement of industrial systems proposing an efficiency methodology for stakeholders and decision makers Featuring the latest methods and case studies the book will assist researchers in environmental sciences and energy to develop the best methods for LCA as well as aiding those practitioners who are responsible for making decisions for promoting sustainable development The past current status and future of LCSA Life Cycle Assessment method LCA Life Cycle Costing LCC Social Life Cycle Assessment SLCA the methodology of LCSA typical LCSA case studies limitations of LCSA and life cycle aggregated sustainability index methods are all covered in this multidisciplinary book Includes models for assessing sustainability in environmental energy engineering and economic scenarios Features case studies that help define the advantages and obstacles of real world applications Presents a complete view from theory to practice of a life cycle approach by exploring the methods and tools of sustainability assessment analysis and design of sustainability assessment

Background and Future Prospects in Life Cycle Assessment Walter Klöpffer, 2014-03-20 Life Cycle Assessment LCA has become the recognized instrument to assess the ecological burdens and human health impacts connected with the complete life cycle creation use end of life of products processes and activities enabling the assessor to model the entire system from which products are derived or in which processes and activities operate This volume introduces the major new book series LCA Compendium The Complete World of Life Cycle Assessment In this volume the main drivers in the development of LCA

are explored The volume also discusses strengths and limitations in LCA as well as challenges and gaps thus offering an unbiased picture of the state of the art and future of LCA      **Handbook on Life Cycle Sustainability Assessment** Guido Sonnemann, Sonia Valdivia, 2024-04-12 This Handbook presents the state of the art of Life Cycle Sustainability Assessment LCA practice and provides guidance for its implementation and outlook for future work Spotighting sustainability analysts managers and overall decision makers from private and public sectors as well as experts in academia it covers the historical background and current global context for life cycle sustainability assessment methods and data management advancements

**Special Types of Life Cycle Assessment** Matthias Finkbeiner, 2016-07-27 This book presents specialised methods and tools built on classical LCA In the first book length overview their importance for the further growth and application of LCA is demonstrated for some of the most prominent species of this emerging trend Carbon footprinting Water footprinting Eco efficiency assessment Resource efficiency assessment Input output and hybrid LCA Material flow analysis Organizational LCA Carbon footprinting was a huge driver for the market expansion of simplified LCA The discussions led to an ample proliferation of different guidelines and standards including ISO TS 14067 on Carbon Footprint of Product Atsushi Inaba Kogakuin University Tokyo Japan and his eight co authors provide an up to date status of Carbon Footprint of Products The increasing relevance of Water Footprinting and the diverse methods were the drivers to develop the ISO 14046 as international water footprint standard Markus Berger Technische Universit t Berlin Germany Stephan Pfister ETH Zurich Switzerland and Masaharu Motoshita Agency of Industrial Science and Technology Tsukuba Japan present a status of water resources and demands from a global and regional perspective A core part is the discussion and comparison of the different water footprint methods databases and tools Peter Saling from BASF SE in Ludwigshafen Germany broadens the perspective towards Eco efficiency Assessment He describes the BASF specific type of eco efficiency analysis plus adaptations like the so called SEEBALANCE and AgBalance applications Laura Schneider Vanessa Bach and Matthias Finkbeiner Technische Universit t Berlin Germany address multi dimensional LCA perspectives in the form of Resource Efficiency Assessment Research needs and proposed methodological developments for abiotic resource efficiency assessment and especially for the less developed area of biotic resources are discussed The fundamentals of Input output and Hybrid LCA are covered by Shinichiro Nakamura Waseda University Tokyo Japan and Keisuke Nansai National Institute for Environmental Studies Tsukuba Japan The concepts of environmentally extended IO different types of hybrid IO LCA and the waste model are introduced David Laner and Helmut Rechberger Vienna University of Technology Austria present the basic terms and procedures of Material Flow Analysis methodology The combination of MFA and LCA is discussed as a promising approach for environmental decision support Julia Mart nez Blanco Technische Universit t Berlin Germany now at In dit Barcelona Spain Atsushi Inaba Kogakuin University Tokyo Japan and Matthias Finkbeiner Technische Universit t Berlin Germany introduce a recent development which could develop a new trend namely the LCA of Organizations      **Change Management Towards**

**Life Cycle AE(C) Practice** Anna Dalla Valle, 2021-03-15 The book explores how architectural engineering and construction AEC firms have been adapting and changing to effectively address key environmental challenges focusing on Life Cycle Thinking and related methodologies Life Cycle Assessments and Life Cycle Costing Starting from current practice the book outlines the necessary change management to turn into life cycle AE C practice switching from a product technology mindset to a life cycle thinking and holistic approach Although the primary audience of the book are Architectural and Engineering firms the broad range of topics encourages readers from different backgrounds to explore the latest advancements in construction sector Service companies and software developers can find inspiration to develop innovative tools and solutions clients can find ways to demand sustainability as key target for building design and universities can align academic programmes to address new industry challenges *Re-engineering Manufacturing for Sustainability* Andrew Y. C. Nee, Bin Song, Soh-Khim Ong, 2013-04-08 This edited volume presents the proceedings of the 20th CIRP LCE Conference which cover various areas in life cycle engineering such as life cycle design end of life management manufacturing processes manufacturing systems methods and tools for sustainability social sustainability supply chain management remanufacturing etc [An Introduction to Circular Economy](#) Lerwen Liu, Seeram Ramakrishna, 2020-12-18 This book is purposefully styled as an introductory textbook on circular economy CE for the benefit of educators and students of universities It provides comprehensive knowledge exemplified by practices from policy education R restorative innovations business opportunities financing instruments regulation assessment and experiential education programs It connects a CE transformation for reaching the SDGs2030 and highlights youth leadership and entrepreneurship at all levels in driving the sustainability transformation **Life Cycle Assessment in the Agri-food Sector** Bruno Notarnicola, Roberta Salomone, Luigia Petti, Pietro A. Renzulli, Rocco Roma, Alessandro K. Cerutti, 2015-01-06 The book presents an overview of the International practices and state of the art of LCA studies in the agri food sector both in terms of adopted methodologies and application to particular products the final purpose is to characterise and put order within the methodological issues connected to some important agri food products wine olive oil cereals and derived products meat and fruit and also defining practical guidelines for the implementation of LCAs in this particular sector The first chapter entails an overview of the application of LCA to the food sector the role of the different actors of the food supply chain and the methodological issues at a general level The other chapters each with a particular reference to the main foods of the five sectors under study have a common structure which entails the review of LCA case studies of such agri food products the methodological issues the ways with which they have been faced and the suggestion of practical guidelines *Life Cycle Assessment Handbook* Mary Ann Curran, 2012-10-08 The first book of its kind the Life Cycle Assessment Handbook A Guide for Environmentally Sustainable Products will become an invaluable resource for environmentally progressive manufacturers and suppliers product and process designers executives and managers and government officials who want to learn about this essential component of environmental sustainability As

the last several decades have seen a dramatic rise in the application of Life Cycle Assessment LCA in decision making the interest in the life cycle concept as an environmental management and sustainability tool continues to grow The LCA Handbook offers a look at the role that life cycle information in the hands of companies governments and consumers may have in improving the environmental performance of products and technologies It concisely and clearly presents the various aspects of LCA in order to help the reader better understand the subject The content of the book was designed with a certain flow in mind After a high level overview to describe current views and state of the practice of LCA it presents chapters that address specific LCA methodological issues including creating life cycle inventory life cycle impact assessment and capturing eco systems services These are followed by example applications of LCA in the agri food industry sustainable supply chain management solid waste management mining and mineral extraction forest products buildings product innovation and sustainable chemistry and engineering The international success of the sustainability paradigm needs the participation of many stakeholders including citizens corporations academia and NGOs The handbook links LCA and responsible decision making and how the life cycle concept is a critical element in environmental sustainability It covers issues such as building capacity in developing countries and emerging economies so that they are more capable of harnessing the potential in LCA for sustainable development Governments play a very important role with the leverage they have through procurement regulation international treaties tax incentives public outreach and other policy tools This compilation points to the clear trend for incorporating life cycle information into the design and development processes for products and policies just as quality and safety concerns are now addressed throughout product design and development **Advances in**

**Manufacturing Technology XXXII** P. Thorvald, K. Case, 2018-08-29 The urgent need to keep pace with the accelerating globalization of manufacturing in the 21st century has produced rapid advancements in technology research and innovation This book presents the proceedings of the 16th International Conference on Manufacturing Research incorporating the 33rd National Conference on Manufacturing Research ICMR 2018 held in Skövde Sweden in September 2018 The aim of the conference is to create a friendly and inclusive environment bringing together researchers academics and industrialists with practical and theoretical knowledge to share and discuss emerging trends and new challenges The book is divided into 12 parts covering areas such as the manufacturing process robots product design and development smart manufacturing and lean among others Covering both cutting edge research and recent industrial applications the book will appeal to all those with an interest in recent advances in manufacturing technology *Life Cycle Sustainability Assessment (LCSA)*

Subramanian Senthilkannan Muthu, 2021-09-21 Environmental Life Cycle Assessment ELCA that was developed about three decades ago demands a broadening of its scope to include lifecycle costing and social aspects of life cycle assessment as well drawing on the three pillar or triple bottom line model of sustainability which is the result of the development of the Life Cycle Sustainability Assessment LCSA LCSA refers to the evaluation of all environmental social and economic negative

impacts and benefits in decision making processes towards more sustainable products throughout their life cycle  
Combination of environmental and social life cycle assessments along with life cycle costing leads to life cycle sustainability assessment LCSA This book highlights various aspects of life cycle sustainability assessment LCSA **Sustainability**

**Awareness and Green Information Technologies** Tomayess Issa, Theodora Issa, Touma B. Issa, Pedro Isaias, 2020-09-17

This book addresses several aspects of environmental sustainability awareness and prioritization explores ways to use resources and processes more responsibly and describes the strategies models and tools required to overcome various challenges Sustainable and green IT are used to minimize the current ICT recycling problems which are harming our planet The book discusses the new green information technologies as alternatives to conventional ICT which have significantly harmed nature and examines how to make recent technologies such as cloud computing social networking smart technology blockchains IoT internet of things and big data sustainable Exploring sustainability awareness and importance among individuals and organizations in the developed and developing countries most of the contributions conclude that sustainability should be considered a duty in order to change mindsets attitudes and actions so as to preserve our planet Furthermore it examines the green information technology strategies and models **Integrated Life-Cycle and Risk**

**Assessment for Industrial Processes and Products** Guido Sonnemann, Michael Tsang, Marta Schuhmacher, 2018-10-10

Life cycle assessment is a methodology used to evaluate the environmental impacts of a product process or service during its life cycle and risk assessment is a tool to evaluate potential hazards to human health and the environment introduced by pollutant emissions The United Nations Sustainable Development Goals call for among other objectives responsible consumption and production by decoupling environmental resource use and environmental impacts from economic growth and human well being Life cycle assessment and risk assessment are both analytical system approaches that allow scientists and other decision makers to address these issues and objectives according to the current understanding of environmental mechanisms This book is the first attempt to illustrate the existing interfaces between life cycle assessment and risk assessment and to indicate options for further integration of both tools The second edition Focuses on sustainability Considers new developments in life cycle assessment and environmental risk assessment over the last ten years at the international level Introduces broader concepts and discussions on integrative versus the complementary use of life cycle and risk assessments Extends the scope of integrated life cycle and risk assessments to critical raw materials Includes more case studies and discusses engineered nanomaterials Featuring contributions from leading experts Integrated Life Cycle and Risk Assessment for Industrial Processes and Products is a great reference for graduate students and professionals in environmental management and intends to catalyze communication between life cycle assessment and risk assessment experts and scientists in academia industry and governmental agencies The practical format of the book illustrated with flowcharts examples exercises and concrete applications makes it a useful manual for analyzing situations and making

decisions      **Sustainable Product Development** Daizhong Su,2020-05-12 This book offers a comprehensive review of sustainability and product design providing useful information on the relevant regulations and standards for industries to meet increasing market demands for eco products while reducing their impact on the environment The examples and methods presented allow readers to gain insights into sustainable products The authors also explain how to develop products with sustainability features by applying tools and methods for sustainable design and manufacture These tools methods include Regulations directives related to sustainable product development Popular lifecycle analysis software packages Environmental and social lifecycle impact assessment methods Lifecycle inventory databases Eco point and eco accounting infrastructure ICT and traceability technologies for sustainable product development Sustainable design and manufacture Integrated approach for sustainable product development A description of each sustainability tool is accompanied by easy to understand guidelines as well as sustainable product development methods Five different case studies are also presented to illustrate how to apply the tools and methods into the development of real sustainable products In view of the increasing pressure on industries to meet the sometimes conflicting demands of the market and environment this book is a valuable resource for engineers and managers in manufacturing companies wishing to update their knowledge of sustainable product development It is also suitable for researchers and consultants who are involved or interested in sustainable product development as well as for students studying sustainable development production and engineering management      **Edible Oils** Smain Chemat,2017-07-12 Global oilseeds industry is expected to expand in the future but would also constitute a platform for a variety of other products from processing waste such as protein meals and aromatic compounds Edible Oils Extraction Processing and Applications intends to present up to date technologies that are currently used for the extraction and refining of Edible Oils while proposing potential applications for its derivatives This contribution pushes to consider market transformation driven by environmental concerns and customer s envy to bring quality attributes energy efficiency and waste disposal into the heart of innovation This work is aimed at professionals and academics including researchers engineers and managers engaged in food and green engineering disciplines and ambitions to stand as a reference for students and lecturers The readers will find a wealth of knowledge about the fundamentals of unit operations such as extraction and separation while presenting concepts of biorefinery for product and value creation from certain edible seeds Novelties includes novel approaches for green solvent development in extraction and examples of life cycle assessment of production systems for certain vegetable oils comprising product service and waste management systems Furthermore this book focuses attention to production processing and current applications of palm oil as an important commodity in Asia and addresses global market changes and important factors that influence its future prospects      *Sustainable Food Systems from Agriculture to Industry* Charis M. Galanakis,2018-01-02 Sustainable Food Systems from Agriculture to Industry Improving Production and Processing addresses the principle that food supply needs of the present must be met without



compromising the ability of future generations to meet their needs Responding to sustainability goals requires maximum utilization of all raw materials produced and integration of activities throughout all production to consumption stages This book covers production stage activities to reduce postharvest losses and increase use of by products streams waste food manufacturing and beyond presenting insights to ensure energy water and other resources are used efficiently and environmental impacts are minimized The book presents the latest research and advancements in efficient cost effective and environmentally friendly food production and ways they can be implemented within the food industry Filling the knowledge gap between understanding and applying these advancements this team of expert authors from around the globe offer both academic and industry perspectives and a real world view of the challenges and potential solutions that exist for feeding the world in the future The book will guide industry professionals and researchers in ways to improve the efficiency and sustainability of food systems Addresses why food waste recovery improves sustainability of food systems how these issues can be adapted by the food industry and the role of policy making in ensuring sustainable food production Describes in detail the latest understanding of food processing food production and waste reduction issues Includes emerging topics such as sustainable organic food production and computer aided process engineering Analyzes the potential and sustainability of already commercialized processes and products

**Waste Valorisation** Carol Sze Ki Lin, Guneet Kaur, Chong Li, Xiaofeng Yang, 2020-09-18 A guide to the wide variety of waste valorisation techniques related to various biomass waste materials and by products Waste Valorisation provides a comprehensive review of waste chemistry and its application to the generation of value added products The authors noted experts on the topic offer a clear understanding of waste diversity drivers and policies governing its valorisation based on the location The book provides information on the principles behind various valorisation schemes and offers a description of general treatment options with their evaluation guidelines in terms of cost energy consumption and waste generation Each of the book's chapters contain an introduction which summarises the current production and processing methods yields energy sources and other pertinent information for each specific type of waste The authors focus on the most relevant novel technologies for value added processing of waste streams or industrial by products which can readily be integrated into current waste management systems They also provide the pertinent technical economic social and environmental evaluations of bioconversions as future sustainable technologies in a biorefinery This important book Presents the most current technologies which integrate waste and or by product valorisation Includes discussions on end product purity and life cycle assessment challenges Explores relevant novel technologies for value added processing of waste streams or industrial by products which can be integrated into current waste management systems Offers a guide to waste reuse a key sustainability goal for existing biorefineries wishing to reduce material and environmental costs Written for academic researchers and industrial scientists working in agricultural and food production bioconversions and waste management professionals Waste Valorisation is an authoritative guide to the chemistry and applications of waste materials

and provides an overview of the most recent developments in the field      Sustainability and Innovation Salah M. El-Haggag, 2016-05-04 One of the most urgent problems facing the world today is environmental sustainability Current practices of pollution control waste treatment and environmental protection are not only hugely expensive and a burden on development but also unsustainable in the long run for their steady depletion of the world's natural resources Any solutions must have proven economic benefits be technologically viable and meet prevailing environmental and social perspectives The main objective of this new set of studies is to describe methods that help to protect the environment and conserve natural resources This can be achieved by applying the cradle to cradle concept which aims to use materials in closed cyclic loops without generating any type of waste or pollution The authors provide the reader with an introduction to basic concepts of sustainable development describe the mechanisms and benefits of related technologies and suggest potential uses on a practical level by examining innovations developed in the mechanical engineering laboratories of the American University in Cairo Particular focus is placed on innovation as a vital means of attaining sustainability A timely contribution to the debate on environmentally sustainable practices this book will be indispensable to environmentalists scientists economists engineers development specialists and policy makers as well as being of interest to the lay reader

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