Alexis Laurent - DTU Orbit (17/05/2018)
Alexis Laurent

Organisations

Associate Professor, Department of Management Engineering
17/08/2009 → present
alau@dtu.dk
VIP

Quantitative Sustainability Assessment
25/02/2012 → present
VIP

Transport DTU
18/03/2017 → 23/05/2017 Former
VIP

Publications:

Learning-by-doing: experience from 20 years of teaching LCA to future engineers
Purpose: In support of the sustainable development of our societies, future engineers should have elementary knowledge in sustainability assessment and use of life cycle assessment. Publications on pedagogical experience with teaching life cycle assessment (LCA) in high-level education are however scarce. Here, we describe and discuss 20 years of experience in teaching LCA at MSc level in an engineering university with the ambition to share our insights and inspire teaching of LCA as part of a university curriculum. Methods: We detail the design of an LCA course taught at the Technical University of Denmark since 1997. The course structure relies on (i) a structured combination of theoretical teaching, practical assignments and hands-on practice on LCA case studies, and (ii) the conduct of real-life LCA case studies in collaboration with companies or other organisations. Through the semester-long duration of the course, students from different engineering backgrounds perform full-fledged LCA studies in groups, passing through two iterations—a screening LCA supporting a more targeted LCA. Results and discussion: The course design, which relies on a learning-by-doing principle, is transparently described to inspire LCA teachers among the readers. Historical evolution and statistics about the course, including its 192 case studies run in collaboration with 105 companies and institutions, are analysed and serve as basis to discuss the benefits and challenges of its different components, such as the theory acquisition, the assignment work, the LCA software learning, the conduct of case studies, the merits of industrial collaborations and grading approaches. Conclusions: We demonstrate the win-win situation created by the setting of the course, in which the students are actively engaged and learn efficiently how to perform an LCA while the collaborating companies often get useful insights into their analysed case studies. The course can also be an eye opener for companies unfamiliar with LCA, who get introduced to life cycle thinking and the potential benefits of LCA. We have no hesitation in recommending industries and LCA teachers to engage into such collaborations even in the fundamental teaching of LCA techniques.

General information
State: Accepted/In press
Organisations: Department of Management Engineering, Quantitative Sustainability Assessment, Irstea
Authors: Cosme, N. (Intern), Hauschild, M. Z. (Intern), Molin, C. (Intern), Rosenbaum, R. K. (Intern), Laurent, A. (Intern)
Number of pages: 13
Publication date: 28 Mar 2018
Main Research Area: Technical/natural sciences

Publication information
Journal: International Journal of Life Cycle Assessment
ISSN (Print): 0948-3349
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.43 SJR 1.328 SNIP 1.423
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.504 SNIP 1.554 CiteScore 3.49

General information
State: Published
Organisations: Department of Energy Conversion and Storage, Quantitative Sustainability Assessment, Department of Management Engineering, Western Macedonia University of Applied Sciences
Goal Definition

The goal definition is the first phase of an LCA and determines the purpose of a study in detail. This chapter teaches how to perform the six aspects of a goal definition: (1) Intended applications of the results, (2) Limitations due to methodological choices, (3) Decision context and reasons for carrying out the study, (4) Target audience, (5) Comparative studies to be disclosed to the public and (6) Commissioner of the study and other influential actors. The instructions address both the conduct and reporting of a goal definition and are largely based on the ILCD guidance document (EC-JRC in European Commission—Joint Research Centre—Institute for Environment and Sustainability: International Reference Life Cycle Data System (ILCD) Handbook—General Guide for Life Cycle Assessment—Detailed Guidance. Publications Office of the European Union, Luxembourg 2010).

General information

State: Published
Organisations: Department of Management Engineering, Quantitative Sustainability Assessment, Transport DTU
Authors: Bjørn, A. (Intern), Laurent, A. (Intern), Owsianiak, M. (Intern), Olsen, S. I. (Intern)
Pages: 67-74
Publication date: 2018

Host publication information

Title of host publication: Life Cycle Assessment: Theory and practice
Publisher: Springer
ISBN (Print): 9783319564746
ISBN (Electronic): 9783319564753
Chapter: 7
Series: Life Cycle Assessment
Main Research Area: Technical/natural sciences
Business and Management, Sustainability Management, Sustainable Development, Renewable and Green Energy, Manufacturing, Machines, Tools, Operating Procedures, Materials Treatment
DOIs: 10.1007/978-3-319-56475-3_7
Source: FindIt
Source-ID: 2373522935
Publication: Research - peer-review › Book chapter – Annual report year: 2017

LCA Applications

The chapter gives examples of applications of LCA by the central societal actors in government, industry and citizens, and discusses major motivations and challenges for the use of LCA to support science-based decision-making from their respective perspectives. We highlight applications of LCA in policy formulation, implementation and evaluation, present different purposes of LCA application in industry at both product and corporate levels, and discuss challenges for LCA applications in small- and medium-sized enterprises. Our synthesis demonstrates the importance of LCA as a tool to quantify environmental impacts of products and systems and support decisions around production and consumption and highlights factors that prevent its even more widespread application.

General information

State: Published
Organisations: Department of Management Engineering, Quantitative Sustainability Assessment
Authors: Owsianiak, M. (Intern), Bjørn, A. (Intern), Laurent, A. (Intern), Molin, C. (Intern), Ryberg, M. (Intern)
Pages: 31-41
Publication date: 2018

Host publication information

Title of host publication: Edit Life Cycle Assessment: Theory and practice
Publisher: Springer
ISBN (Print): 9783319564746
ISBN (Electronic): 9783319564753
LCA of Energy Systems

Energy systems are essential in the support of modern societies' activities, and can span a wide spectrum of electricity and heat generation systems and cooling systems. Along with their central role and large diversity, these systems have been demonstrated to cause serious impacts on human health, ecosystems and natural resources. Over the past two decades, energy systems have thus been the focus of more than 1000 LCA studies, with the aim to identify and reduce these impacts. This chapter addresses LCA applications to energy systems for generation of electricity and heat. The chapter gives insight into the LCA practice related to such systems, offering a critical review of (i) central methodological aspects, including the definition of the goals and scopes of the studies, their coverage of the system life cycle and the environmental impacts, and (ii) key findings of the studies, particularly aimed at identifying environmental hotspots and impact patterns across different energy sources. Based on this literature review recommendations and guidelines are issued to LCA practitioners on key methodological aspects that are important for a proper conduct of LCA studies of energy systems and thus ensuring the reliability of the LCA results provided to decision- and policy-makers.

LCA of Solid Waste Management Systems

The chapter explores the application of LCA to solid waste management systems through the review of published studies on the subject. The environmental implications of choices involved in the modelling setup of waste management systems are increasingly in the spotlight, due to public health concerns and new legislation addressing the impacts from managing our waste. The application of LCA to solid waste management systems, sometimes called “waste LCA”, is distinctive in that system boundaries are rigorously defined to exclude all life cycle stages except from the end-of-life. Moreover, specific methodological challenges arise when investigating waste systems, such as the allocation of impacts and the consideration of long-term emissions. The complexity of waste LCAs is mainly derived from the variability of the object under study (waste) which is made of different materials that may require different treatments. This chapter attempts to address these challenges by identifying common misconceptions and by providing methodological guidance for alleviating the associated uncertainty. Readers are also provided with the list of studies reviewed and key sources for reference to implement LCA on solid waste systems.
Life Cycle Impact Assessment

This chapter is dedicated to the third phase of an LCA study, the Life Cycle Impact Assessment (LCIA) where the life cycle inventory’s information on elementary flows is translated into environmental impact scores. In contrast to the three other LCA phases, LCIA is in practice largely automated by LCA software, but the underlying principles, models and factors should still be well understood by practitioners to ensure the insight that is needed for a qualified interpretation of the results. This chapter teaches the fundamentals of LCIA and opens the black box of LCIA with its characterisation models and factors to inform the reader about: (1) the main purpose and characteristics of LCIA, (2) the mandatory and optional steps of LCIA according to the ISO standard, and (3) the science and methods underlying the assessment for each environmental impact category. For each impact category, the reader is taken through (a) the underlying environmental problem, (b) the underlying environmental mechanism and its fundamental modelling principles, (c) the main anthropogenic sources causing the problem and (d) the main methods available in LCIA. An annex to this book offers a comprehensive qualitative comparison of the main elements and properties of the most widely used and also the latest LCIA methods for each impact category, to further assist the advanced practitioner to make an informed choice between LCIA methods.

General information

State: Published
Organisations: Department of Management Engineering, Quantitative Sustainability Assessment, University of Sherbrooke, IRSTEA ELSA - PACT, PRé Consultants B.V.
Pages: 167-270
Publication date: 2018

Host publication information

Title of host publication: Life Cycle Assessment: Theory and practice
Publisher: Springer
ISBN (Print): 9783319564753
ISBN (Electronic): 9783319564746
Chapter: 10
Main Research Area: Technical/natural sciences
Business and Management, Sustainability Management, Sustainable Development, Renewable and Green Energy, Manufacturing, Machines, Tools, Operating Procedures, Materials Treatment
DOIs:
10.1007/978-3-319-56475-3_10
Source: FindIt
Source-ID: 2373522926
Publication: Research - peer-review › Book chapter – Annual report year: 2017

Life Cycle Inventory Analysis

The inventory analysis is the third and often most time-consuming part of an LCA. The analysis is guided by the goal and scope definition, and its core activity is the collection and compilation of data on elementary flows from all processes in the studied product system(s) drawing on a combination of different sources. The output is a compiled inventory of elementary flows that is used as basis of the subsequent life cycle impact assessment phase. This chapter teaches how to carry out this task through six steps: (1) identifying processes for the LCI model of the product system; (2) planning and collecting data; (3) constructing and quality checking unit processes; (4) constructing LCI model and calculating LCI results; (5) preparing the basis for uncertainty management and sensitivity analysis; and (6) reporting.

General information

State: Published
Organisations: Department of Management Engineering, Quantitative Sustainability Assessment, Transport DTU, Technical University of Denmark
Authors: Bjørn, A. (Intern), Moltesen, A. (Ekstern), Laurent, A. (Intern), Owssianiak, M. (Intern), Corona, A. (Intern), Birkved, M. (Intern), Hauschild, M. Z. (Intern)
Main Characteristics of LCA

Life cycle assessment (LCA) has a number of defining characteristics that enables it to address questions that no other assessment tools can address. This chapter begins by demonstrating how the use of LCA in the late 2000s led to a drastic shift in the dominant perception that biofuels were "green", "sustainable" or "carbon neutral", which led to a change in biofuel policies. This is followed by a grouping of the LCA characteristics into four headlines and an explanation of these: (1) takes a life cycle perspective, (2) covers a broad range of environmental issues, (3) is quantitative, (4) is based on science. From the insights of the LCA characteristics we then consider the strengths and limitations of LCA and end the chapter by listing 10 questions that LCA can answer and 3 that it cannot.

Report Template

To ensure consistent reporting of life cycle assessment (LCA), we provide a report template. The report includes elements of an LCA study as recommended but the ILCD Handbook. Illustrative case study reported according to this template is presented in Chap. 39.
Scope Definition

The scope definition is the second phase of an LCA. It determines what product systems are to be assessed and how this assessment should take place. This chapter teaches how to perform a scope definition. First, important terminology and key concepts of LCA are introduced. Then, the nine items making up a scope definition are elaborately explained: (1) Deliverables. (2) Object of assessment, (3) LCI modelling framework and handling of multifunctional processes, (4) System boundaries and completeness requirements, (5) Representativeness of LCI data, (6) Preparing the basis for the impact assessment, (7) Special requirements for system comparisons, (8) Critical review needs and (9) Planning reporting of results. The instructions relate both to the performance and reporting of a scope definition and are largely based on ILCD.

General information
State: Published
Organisations: Department of Management Engineering, Quantitative Sustainability Assessment, Transport DTU
Pages: 75-116
Publication date: 2018

Host publication information
Title of host publication: Life Cycle Assessment: Theory and practice
Publisher: Springer
Chapter: 8
Main Research Area: Technical/natural sciences

Correction to Development of Comparative Toxicity Potentials of TiO₂ Nanoparticles for Use in Life Cycle Assessment

General information
State: Published
Organisations: Quantitative Sustainability Assessment, Department of Environmental Engineering, Environmental Chemistry, Department of Management Engineering, Technical University of Denmark, Quantis, Radboud University Nijmegen
Authors: Ettrup, K. (Ekstern), Kounina, A. (Ekstern), Hansen, S. F. (Intern), Meesters, J. A. J. (Ekstern), Blikra Vea, E. (Ekstern), Laurent, A. (Intern)
Pages: 7295-7295
Publication date: 2017
Main Research Area: Technical/natural sciences

Publication information
Journal: Environmental Science and Technology
Volume: 51
Issue number: 12
ISSN (Print): 0013-936X
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 6.26 SJR 2.538 SNIP 1.889
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.584 SNIP 1.828 CiteScore 5.61
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.777 SNIP 2.017 CiteScore 5.5
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.956 SNIP 2.103 CiteScore 5.52
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 3.146 SNIP 2.056 CiteScore 5.17
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 3.178 SNIP 1.953 CiteScore 5.16
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.964 SNIP 1.729
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 2.835 SNIP 1.803
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 2.943 SNIP 1.942
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 2.8 SNIP 1.927
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 2.541 SNIP 1.901
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 2.604 SNIP 2.014
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 2.863 SNIP 2.046
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 2.545 SNIP 2.071
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 2.353 SNIP 1.953
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 2.419 SNIP 1.977
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 2.474 SNIP 2.334
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 3.466 SNIP 2.359

Original language: English

Electronic versions:

Pages_from_Ettrup_et_al._Manuscript_correction_postprint_1_.pdf. Embargo ended: 07/03/2018

DOIs:
10.1021/acs.est.7b02697

Source: FindIt
Source-ID: 2370906949

Publication: Research - peer-review › Journal article – Annual report year: 2017
Cost-competitiveness of organic photovoltaics for electricity self-consumption at residential buildings: A comparative study of Denmark and Greece under real market conditions

To address sustainability challenges, photovoltaics (PV) are regarded as a promising renewable energy technology. Decreasing PV module costs and increasing residential electricity prices have made self-consumption of PV-generated electricity financially more attractive than exporting to the grid. Organic photovoltaics (OPV) are an emerging thin-film PV technology that shows promise of greatly improving the environmental and economic performances of PV technologies. Previous studies have estimated the current and future costs of OPV technologies, but the attractiveness of investing in OPV systems has not been evaluated under real market conditions, especially under PV self-consumption schemes. In this study, we investigate the self-consumption of electricity generation from conventional and organic PV systems installed at residential houses in two different countries, Denmark and Greece, under current PV regulatory frameworks. We then focus on modelling and assessing the cost-competitiveness of organic PV technologies based on cost estimations for existing pilot-scale (kW-range), and projected scale-up (100MW) and industrial-scale (100GW) manufacturing capacity levels. Our generic results applying to all PV technologies show that PV systems installed at residential houses in Greece perform economically better than those in Denmark do in terms of self-sufficiency and gross electricity bill savings (i.e. excluding PV costs). Using the two country cases, which present very different settings, we characterise and discuss the influence of three key parameters of the economic performance of PV systems, namely the PV regulatory scheme, the solar irradiation level and the temporal match between the electricity consumption and solar irradiation profiles. Focusing on organic PV systems developed in an industrial-scale cost setting (1.53€/Wp), we find that they deliver significant electricity bill savings for residential houses in Greece (38%) under current conditions, while they may not be sufficiently attractive for residential houses in Denmark (6.5%) due to mainly the different PV regulatory schemes. Based on these findings, we therefore recommend investors interested in renewable energy technologies to pursue scaling up the manufacturing capacity of OPV technologies, as well as assess a large number of countries to identify and prioritise financially attractive settings for PV self-consumption.

General information

State: Published
Organisations: Department of Energy Conversion and Storage, Organic Energy Materials, Quantitative Sustainability Assessment, Department of Management Engineering, University of Western Macedonia
Authors: Chatzisideris, M. D. (Intern), Laurent, A. (Intern), Christoforidis, G. C. (Ekstern), Krebs, F. C. (Intern)
Pages: 471-479
Publication date: 2017
Main Research Area: Technical/natural sciences

Publication information

Journal: Applied Energy
Volume: 208
ISSN (Print): 0306-2619
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 7.78 SJR 3.058 SNIP 2.573
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.912 SNIP 2.61 CiteScore 6.4
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 3.254 SNIP 3.28 CiteScore 6.93
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 3.164 SNIP 3.777 CiteScore 6.59
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 2.854 SNIP 3.108 CiteScore 5.69
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
Critical review of life cycle assessments conducted on aquaculture systems: identification of environmental improvements

General information
State: Published
Organisations: Department of Management Engineering, Quantitative Sustainability Assessment
Authors: Bohnes, F. A. (Intern), Hauschild, M. Z. (Intern), Schlundt, J. (Intern), Laurent, A. (Intern)
Number of pages: 1
Publication date: 2017

Host publication information
Title of host publication: Book of Abstracts, Sustain 2017
Publisher: Technical University of Denmark (DTU)
Article number: F-1
Main Research Area: Technical/natural sciences
Conference: Sustain 2017, Kgs. Lyngby, Denmark, 06/12/2017 - 06/12/2017
Electronic versions: SustainAbstracts2017c.compressed_59.pdf
Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2017

Development of Comparative Toxicity Potentials of TiO₂ Nanoparticles for Use in Life Cycle Assessment
Studies have shown that releases of nanoparticles may take place through the life cycle of products embedding nanomaterials, thus resulting in potential impacts on ecosystems and human health. While several life cycle assessment (LCA) studies have assessed such products, only a few of them have quantitatively addressed the toxic impacts caused by released nanoparticles, thus leading to potential biases in their conclusions. Here, we address this gap and aim to provide a framework for calculating characterization factors or comparative toxicity potentials (CTP) for nanoparticles and
derive CTP values for TiO2 nanoparticles (TiO2-NP) for use in LCA. We adapted the USEtox 2.0 consensus model to integrate the SimpleBox4Nano fate model, and we populated the resulting model with TiO2-NP specific data. We thus calculated CTP values for TiO2 nanoparticles for air, water, and soil emission compartments for freshwater ecotoxicity and human toxicity, both cancer effects and noncancer effects. Our results appeared plausible after benchmarking with CTPs for other nanoparticles and substances present in the USEtox database, while large differences were observed with CTP values for TiO2 nanoparticles published in earlier studies. Assumptions, which were performed in those previous studies because of lack of data and knowledge at the time they were made, primarily explain such discrepancies. For future assessment of potential toxic impacts of TiO2 nanoparticles in LCA studies, we therefore recommend the use of our calculated CTP.

General information
State: Published
Organisations: Department of Environmental Engineering, Environmental Chemistry, Department of Management Engineering, Quantitative Sustainability Assessment, Technical University of Denmark, Quantis, Radboud University Nijmegen
Authors: Ettrup, K. (Ekstern), Kounina, A. (Ekstern), Hansen, S. F. (Intern), Meesters, J. A. J. (Ekstern), Blikra Vea, E. (Ekstern), Laurent, A. (Intern)
Pages: 4027-4037
Publication date: 2017
Main Research Area: Technical/natural sciences

Publication information
Journal: Environmental Science and Technology
Volume: 51
Issue number: 7
ISSN (Print): 0013-936X
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 6.26 SJR 2.538 SNIP 1.889
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.584 SNIP 1.828 CiteScore 5.61
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.777 SNIP 2.017 CiteScore 5.5
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.956 SNIP 2.103 CiteScore 5.52
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 3.146 SNIP 2.056 CiteScore 5.17
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 3.178 SNIP 1.953 CiteScore 5.16
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.964 SNIP 1.729
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 2.835 SNIP 1.803
Web of Science (2009): Indexed yes
Environmental impacts of electricity self-consumption from organic photovoltaic battery systems at industrial facilities in Denmark

Organic photovoltaics (OPV) show promise of greatly improving the environmental and economic performance of PV compared to conventional silicon. Life cycle assessment studies have assessed the environmental impacts of OPV, but not under a self-consumption scheme for industrial facilities. We investigate the life cycle environmental impacts of electricity self-consumption from an OPV system coupled with a sodium/nickel chloride battery at an iron/metal industry in Denmark. Results show that an OPV system without storage could decrease the carbon footprint of the industry; installation of the battery increases climate change and human toxicity impacts. We discuss sensitive modelling parameters and provide recommendations.
Environmental impacts of future urban deployment of electric vehicles: Assessment framework and case study of Copenhagen for 2016-2030

To move towards environmentally-sustainable transport systems, electric vehicles (EVs) are increasingly seen as viable alternatives to internal combustion vehicles (ICVs). To ensure effectiveness of such deployment, holistic assessments of environmental impacts can help decision-makers determine optimised urban strategies in a long-term perspective. However, explicit guidance and conduct of such assessments are currently missing. Here, we therefore propose a framework using life cycle assessment that enables the quantification of environmental impacts of a transport system at full urban scale from a fleet-based, foresight perspective. The analysis of the passenger car fleet development in the city of Copenhagen for the years 2016-2030 is used as a proof-of-concept. We modelled and compared five powertrain technologies, and we assessed four fleet-based scenarios for the entire city. Our results showed relative environmental benefits from range-extended and fuel-cell EVs over ICVs and standard EVs. These results were found to be sensitive to local settings, like electricity grid mix, which could alter the relative environmental performances across EV technologies. The comprehensive framework developed here can be applied to other geographic areas and contexts to assess the environmental sustainability of transport systems.
Aiming for a more efficient use of resources, the European Commission encourages the use of animal manure as a fertilizer providing nutrients and organic matter to improve crop productivity and soil fertility [1,2]. However livestock manure contains traces from pathogens, veterinary medicines and feed additives (e.g. antibiotics and heavy metals), which may cause damages to ecosystems and human health. To prevent large damages from happening, tools such as Environmental risk assessment (ERA) and life cycle assessment (LCA) are used to evaluate the environmental risks and impacts of the pollutant emissions resulting from manure application. Both methodologies first require an estimation of the emissions to soil as part of their respective stages of exposure assessment and life cycle inventory analysis.

To provide consistent support to high level policy-makers, e.g. supporting regulations on the use of such substances in livestock production, large-scale assessments are required. To date, the total emissions of harmful substances resulting from the application of manure at country level have however been rarely quantified. We therefore developed a framework

**Estimating soil emissions and toxicity impacts from the application of livestock manure: application to heavy metals at national scale**

Aiming for a more efficient use of resources, the European Commission encourages the use of animal manure as a fertilizer providing nutrients and organic matter to improve crop productivity and soil fertility [1,2]. However livestock manure contains traces from pathogens, veterinary medicines and feed additives (e.g. antibiotics and heavy metals), which may cause damages to ecosystems and human health. To prevent large damages from happening, tools such as Environmental risk assessment (ERA) and life cycle assessment (LCA) are used to evaluate the environmental risks and impacts of the pollutant emissions resulting from manure application. Both methodologies first require an estimation of the emissions to soil as part of their respective stages of exposure assessment and life cycle inventory analysis.

To provide consistent support to high level policy-makers, e.g. supporting regulations on the use of such substances in livestock production, large-scale assessments are required. To date, the total emissions of harmful substances resulting from the application of manure at country level have however been rarely quantified. We therefore developed a framework
to estimate these releases to soil in a systematic way. We applied it to emissions of 8 heavy metals (HMs) in 215 countries from 2000 to 2014 and analysed the resulting environmental toxicity-related impacts based on life cycle impact assessment.

**General information**
*State: Published*
*Organisations: Department of Management Engineering, Quantitative Sustainability Assessment*
*Authors: Leclerc, A. S. C. (Intern), Laurent, A. (Intern)*
*Number of pages: 2*
*Publication date: 2017*

**Host publication information**
*Title of host publication: SETAC Europe: 27th Annual Meeting – Environmental Quality Through Transdisciplinary Collaboration*
*Main Research Area: Technical/natural sciences*
*Conference: SETAC Europe: 27th Annual Meeting – Environmental Quality Through Transdisciplinary Collaboration, Brussels, Belgium, 07/05/2017 - 07/05/2017*

**Evaluating Climate Change Mitigation Potential of Carbonaceous Materials: Do Different Indicators Point to the Same Conclusion?**

**General information**
*State: Published*
*Organisations: Department of Management Engineering, Quantitative Sustainability Assessment, Technical University of Denmark, Universidad Politecnica de Valencia*
*Authors: Owsianiak, M. (Intern), Brooks, J. (Ekstern), Renz, M. (Ekstern), Laurent, A. (Intern)*
*Number of pages: 1*
*Publication date: 2017*

**Host publication information**
*Title of host publication: Book of Abstracts, Sustain 2017*
*Publisher: Technical University of Denmark (DTU)*
*Article number: R-10*
*Main Research Area: Technical/natural sciences*
*Conference: Sustain 2017, Kgs. Lyngby, Denmark, 06/12/2017 - 06/12/2017*

**Evaluating climate change mitigation potential of hydrochars: compounding insights from three different indicators**

We employed life cycle assessment to evaluate the use of hydrochars, prospective soil conditioners produced from biowaste using hydrothermal carbonization, as an approach to improving agriculture while reusing carbon present in the biowaste. We considered six different crops (barley, wheat, sugar beet, fava bean, onion and lucerne) and two different countries (Spain and Germany), and used three different indicators of climate change: global warming potential (GWP), global temperature change potential (GTP), and climate tipping potential (CTP). We found that although climate change benefits (GWP) from just sequestration and temporary storage of carbon are sufficient to outweigh impacts stemming from hydrochar production and transportation to the field, even greater benefits stem from replacing climate-inefficient biowaste management treatment options, like composting in Spain. By contrast, hydrochar addition to soil is not a good approach to improving agriculture in countries where incineration with energy recovery is the dominant treatment option for biowaste, like in Germany. Relatively small, but statistically significant differences in impact scores were found between crops. Although these conclusions remained the same in our study, potential benefits from replacing composting were smaller in the GTP approach, which due to its long-term perspective gives less weight to short-lived GHGs like methane. Using CTP as indicator we also found that there is a risk of contributing to crossing of a short-term climatic target, the tipping point corresponding to an atmospheric GHG concentration of 450 ppm CO2 equivalents, unless hydrochar stability in the soil is optimized. Our results highlight the need for considering complementary perspectives that different climate change indicators offer, and overall provide a foundation for assessing climate change mitigation potential of hydrochars used in agriculture.

**General information**
*State: Accepted/In press*
Livestock manure is commonly applied on agricultural land for its fertilising properties. However, the presence of toxic substances in animal manure such as pathogens, antibiotics and heavy metals, can result in damages to ecosystems and human health. To date, although relevant for policy-making, e.g. regulation framing, their releases to agricultural land have been incompletely and inconsistently quantified at global and national scales. Here, we thus developed a generic framework for estimating such releases based on the quantities of manure applied and concentrations of toxic substances. Applying this framework, we built a global release inventory for arsenic, cadmium, chromium, copper, mercury, nickel, lead and zinc differentiated into 215 countries and 15 years (period 2000-2014). Comparisons with more narrowly-focused inventories showed overall consistency in our inventory results, although a number of uncertainties and limitations were identified. In particular, the need for harmonising sampling and analytical methods for estimating heavy metal contents in manure and generating more country-differentiated data, especially for developing countries, should be prioritised by future research studies. Using life cycle impact assessment methods, it was additionally found that mercury, zinc and copper are the substances contributing the most to the toxic impacts on human health and freshwater ecosystems resulting from manure application to land. While countries such as China, India, Russia, Brazil and the United States of America contributed to half the heavy metal releases from manure application worldwide, the impact intensity per area of agricultural land was observed to be highest for island countries, the European Union and South-East Asia because of higher per-area applications of manure. These findings demonstrate the need to perform country-specific impact assessment to support policy-making regulating the concentrations of toxic substances such as heavy metals in utilised manure.
Main Research Area: Technical/natural sciences

Publication information
Journal: Science of the Total Environment
Volume: 590-591
ISSN (Print): 0048-9697
Ratings:
- BFI (2018): BFI-level 2
- Web of Science (2018): Indexed yes
- BFI (2017): BFI-level 2
- Web of Science (2017): Indexed yes
- BFI (2016): BFI-level 2
- Scopus rating (2016): CiteScore 5.09 SJR 1.621 SNIP 1.849
- Web of Science (2016): Indexed yes
- BFI (2015): BFI-level 2
- Scopus rating (2015): SJR 1.674 SNIP 1.642 CiteScore 4.33
- Web of Science (2015): Indexed yes
- BFI (2014): BFI-level 2
- Scopus rating (2014): SJR 1.635 SNIP 1.847 CiteScore 4.2
- Web of Science (2014): Indexed yes
- BFI (2013): BFI-level 2
- Scopus rating (2013): SJR 1.527 SNIP 1.759 CiteScore 3.73
- ISI indexed (2013): ISI indexed yes
- Web of Science (2013): Indexed yes
- BFI (2012): BFI-level 2
- Scopus rating (2012): SJR 1.773 SNIP 1.811 CiteScore 3.7
- ISI indexed (2012): ISI indexed yes
- Web of Science (2012): Indexed yes
- BFI (2011): BFI-level 2
- Scopus rating (2011): SJR 1.798 SNIP 1.681 CiteScore 3.61
- ISI indexed (2011): ISI indexed yes
- Web of Science (2011): Indexed yes
- BFI (2010): BFI-level 2
- Scopus rating (2010): SJR 1.644 SNIP 1.513
- Web of Science (2010): Indexed yes
- BFI (2009): BFI-level 1
- Scopus rating (2009): SJR 1.571 SNIP 1.602
- BFI (2008): BFI-level 2
- Scopus rating (2008): SJR 1.463 SNIP 1.501
- Web of Science (2008): Indexed yes
- Scopus rating (2007): SJR 1.407 SNIP 1.491
- Web of Science (2007): Indexed yes
- Scopus rating (2006): SJR 1.515 SNIP 1.605
- Web of Science (2006): Indexed yes
- Scopus rating (2005): SJR 1.442 SNIP 1.508
- Web of Science (2005): Indexed yes
- Scopus rating (2004): SJR 1.123 SNIP 1.305
- Web of Science (2004): Indexed yes
- Scopus rating (2003): SJR 1.164 SNIP 1.369
- Web of Science (2003): Indexed yes
- Scopus rating (2002): SJR 1.168 SNIP 1.352
- Web of Science (2002): Indexed yes
- Scopus rating (2001): SJR 1.063 SNIP 1.081
- Web of Science (2001): Indexed yes
Human health no-effect levels of TiO2 nanoparticles as a function of their primary size

As engineered nanomaterials are increasingly introduced on the market into a broad range of commodities or nanoproducts, there is a need for operational, reliable tool, enabling to consistently assess the risks and impacts associated with the releases of nanoparticles. The lack of a developed metric that accurately represents their toxic effects while capturing the influence of the most relevant physicochemical properties is one of the major impediments. Here, we investigate the relationships between the toxic responses of nano-sized and micro-sized particles in in vivo toxicological studies and their physicochemical properties. Our results for TiO2 particles indicate statistically significant associations between the primary particle size and their toxicity responses for combined inhalation and ingestion exposure routes, although the numerical values should be considered with care due to the inability to encompass influences from other relevant physicochemical properties like surface coatings. These findings allow for expressing mass-based adverse effect levels as a continuous function of the primary size of particles. This meaningful, exploratory metric can thus be used for screening purposes and pave the way for reaching adaptive, robust risk assessments of nanomaterials, e.g. for setting up consistent threshold levels, as well as consistent life cycle assessments of nanoproducts. We provide examples of such applications.

General information
State: Published
Organisations: Department of Management Engineering, Quantitative Sustainability Assessment, Department of Informatics and Mathematical Modeling, Department of Environmental Engineering, Michigan State University, Technical University of Denmark, University of Michigan-Dearborn
Authors: Laurent, A. (Intern), Harkema, J. (Ekstern), Andersen, E. W. (Intern), Owsianiak, M. (Intern), Blikra Vea, E. (Ekstern), Jolliet, O. (Ekstern)
Number of pages: 15
Publication date: 2017
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Nanoparticle Research
Volume: 19
Issue number: 130
ISSN (Print): 1388-0764
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.74 SJR 0.485 SNIP 0.555
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.569 SNIP 0.689 CiteScore 1.97
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.663 SNIP 0.868 CiteScore 2.17
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.749 SNIP 1.013 CiteScore 2.54
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Titanium dioxide, Particle size, Toxicity, Nanotoxicology, Risk assessment, Life cycle assessment, Environmental and safety effects

LCIA framework and cross-cutting issues guidance within the UNEP-SETAC Life Cycle Initiative

Increasing needs for decision support and advances in scientific knowledge within life cycle assessment (LCA) led to substantial efforts to provide global guidance on environmental life cycle impact assessment (LCIA) indicators under the auspices of the UNEP-SETAC Life Cycle Initiative. As part of these efforts, a dedicated task force focused on addressing several LCIA cross-cutting issues as aspects spanning several impact categories, including spatiotemporal aspects, reference states, normalization and weighting, and uncertainty assessment. Here, findings of the cross-cutting issues task force are presented along with an update of the existing UNEP-SETAC LCIA emission-to-damage framework. Specific recommendations are provided with respect to metrics for human health (Disability Adjusted Life Years, DALY) and ecosystem quality (Potentially Disappeared Fraction of species, PDF). Additionally, we stress the importance of transparent reporting of characterization models, reference states, and assumptions, in order to facilitate cross-comparison between chosen methods and indicators. We recommend developing spatially regionalized characterization models, whenever the nature of impacts shows spatial variability and related spatial data are available. Standard formats should be used for reporting spatially differentiated models, and choices regarding spatiotemporal scales should be clearly communicated. For normalization, we recommend using external normalization references. Over the next two years, the task force will continue its effort with a focus on providing guidance for LCA practitioners on how to use the UNEP-SETAC LCIA framework as well as for method developers on how to consistently extend and further improve this framework.

General information
State: Published
Organisations: Department of Management Engineering, Quantitative Sustainability Assessment, Norwegian University of Science and Technology, National Risk Management Research Laboratory, Universite du Quebec a Montreal, treeze Ltd., ETH Zurich, Noblis, University of Michigan, Ecole Polytechnique Federale de Lausanne (EPFL), Fraunhofer Institute for Building Physics, University of Alberta, Ecole Polytechnique de Montreal, National Institute of Public Health and the Environment, Leiden University, Commonwealth Scientific and Industrial Research Organisation, Iristea, European Commission - Joint Research Center, Universidade Tecnologica Federal do Parana, PRé Consultants B.V.
Normalisation and weighting in life cycle assessment: quo vadis?

Purpose: Building on the rhetoric question "quo vadis?" (literally "Where are you going?"), this article critically investigates the state of the art of normalisation and weighting approaches within life cycle assessment. It aims at identifying purposes, current practises, pros and cons, as well as research gaps in normalisation and weighting. Based on this information, the article wants to provide guidance to developers and practitioners. The underlying work was conducted under the umbrella of the UNEP-SETAC Life Cycle Initiative, Task Force on Cross-Cutting issues in life cycle impact assessment (LCIA).

Methods: The empirical work consisted in (i) an online survey to investigate the perception of the LCA community regarding the scientific quality and current practice concerning normalisation and weighting; (ii) a classification followed by systematic expert-based assessment of existing methods for normalisation and weighting according to a set of five criteria: scientific robustness, documentation, coverage, uncertainty and complexity. Results and discussion: The survey results showed that normalised results and weighting scores are perceived as relevant for decision-making, but further development is needed to improve uncertainty and robustness. The classification and systematic assessment of methods allowed for the identification of specific advantages and limitations. Conclusions: Based on the results, recommendations are provided to practitioners that desire to apply normalisation and weighting as well as to developers of the underlying methods.
On the importance of including a life cycle perspective in assessing the environmental performances of renewable energies

General information
State: Published
Organisations: Department of Management Engineering, Quantitative Sustainability Assessment
Authors: Niero, M. (Intern), Olsen, S. I. (Intern), Laurent, A. (Intern)
Number of pages: 1
Publication date: 2017

Host publication information
Title of host publication: Book of Abstracts Sustain 2017
Potentials and limitations of footprints for gauging environmental sustainability

To address the sustainability challenge, a large variety of footprints, aiming at capturing specific impacts of human activities on natural environment, have emerged. But, how do they fit into our addressing of environmental sustainability? Here, we build on a critical literature review to (1) provide an overview of existing footprints; (2) define their roles; (3) position them within the broad spectrum of known environmental problems and control variables of the planetary boundaries; and (4) argue for the need of consistent thresholds to benchmark footprint scores against absolute sustainability measures defined using science-based sustainability targets. Potentials, limitations and research needs are highlighted along these four points.
Renewable Energy and Carbon Management in the Cradle-to-Cradle Certification: Limitations and Opportunities

As part of the Cradle to Cradle® (C2C) certification program, the C2C certification criterion, Renewable Energy and Carbon Management (RE&CM), focuses on use of electricity from renewable energy (RE) and direct greenhouse gas offsets in the manufacturing stage and, to a limited extent, on the cradle to gate only at the highest level of certification. The aim of this study is to provide decision makers with a quantified overview of possible limitations of that C2C certification requirement and potential gains by introducing a full lifecycle assessment (LCA) perspective to the scheme. Scenario analysis was used to perform an LCA of an aluminum can system representing different levels of the C2C certification criterion, RE&CM, considering different strategies to achieve 100% RE in the manufacturing stage. The adoption of a broader life cycle RE perspective was considered through the implementation of electricity from renewable sources from cradle to grave. Our results show that compliance with the current RE&CM certification framework offers limited benefits, that is, significant reduction for climate change, but negligible reductions for other environmental impacts (e.g., particulate matter and acidification). However, increasing the share of RE in the primary aluminum production from a full life cycle perspective can greatly increase the environmental benefits brought up by the C2C certification not only for climate change, but also for the broader range of impact categories. In our striving toward environmental sustainability, which often cannot be approximated by climate-change impacts alone, we therefore recommend decision makers in industries to combine the C2C certification with LCA when they define strategies for the selection of RE and raw materials suppliers.

General information
State: Published
Organisations: Department of Management Engineering, Quantitative Sustainability Assessment
Authors: Niero, M. (Intern), Olsen, S. I. (Intern), Laurent, A. (Intern)
Number of pages: 13
Publication date: 2017
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Industrial Ecology
ISSN (Print): 1088-1980
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.14 SJR 1.244 SNIP 1.32
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.44 SNIP 1.689 CiteScore 3.82
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.628 SNIP 1.706 CiteScore 3.07
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.171 SNIP 1.405 CiteScore 2.47
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.03 SNIP 1.529 CiteScore 2.24
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.031 SNIP 1.228 CiteScore 2.13
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 0.891 SNIP 1.329
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.192 SNIP 1.411
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 1.226 SNIP 1.624
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.165 SNIP 1.686
Scopus rating (2006): SJR 1.039 SNIP 1.531
Scopus rating (2005): SJR 0.614 SNIP 1.503
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 1.164 SNIP 1.946
Scopus rating (2003): SJR 0.61 SNIP 1.131
Scopus rating (2002): SJR 0.433 SNIP 1.147
Scopus rating (2001): SJR 0.744 SNIP 1.591
Scopus rating (2000): SJR 1.17 SNIP 1.573
Scopus rating (1999): SJR 0.609 SNIP 1.31
Original language: English
Aluminium, Circular economy, Cradle-to-Cradle (C2C), Industrial ecology, Life cycle assessment (LCA), Packaging
DOIs:
10.1111/jiec.12594
Source: FindIt
Source-ID: 2371221159
Publication: Research - peer-review › Journal article – Annual report year: 2017

Bringing the life cycle perspective into the Cradle-to-Cradle certification: the case study of aluminium cans

General information
State: Published
Organisations: Department of Chemical and Biochemical Engineering, Department of Management Engineering, Quantitative Sustainability Assessment
Authors: Niero, M. (Intern), Olsen, S. I. (Intern), Laurent, A. (Intern)
Pages: 109
Publication date: 2016

Host publication information
Title of host publication: SETAC EUROPE 22nd LCA Case Study Symposium : Life Cycle Innovation for the Transition to a Sustainable Society
Main Research Area: Technical/natural sciences
Conference: 22nd SETAC Europe LCA Case Study Symposium , Montpellier, France, 20/09/2016 - 20/09/2016
Electronic versions:
LCA2016_programme_book_V4_DD.pdf
Source: PublicationPreSubmission
Source-ID: 126833068
Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2016

Ecodesign perspectives of thin-film photovoltaic technologies: A review of life cycle assessment studies

Here, we review 33 life cycle assessment (LCA) studies of thin-film photovoltaic (PV) technologies that have had a holistic coverage in their assessments and/or have included ecodesign aspects. Only five of them were found to have a comprehensive life cycle and impact coverage, and their analyses highlighted the importance of (i) including the entire life cycle of the PV system, in particular the often-omitted disposal stage, and (ii) assessing all relevant impact categories and not just climate change or energy requirements to minimise the risk of burden-shifting. Out of the 28 studies embracing ecodesign considerations in parts of the PV life cycle, the analysis of the eleven of them addressing primary energy demand during module production suggests that electricity consumption during the metal deposition processes is a top contributor and should be prioritised by PV technology developers. A similar analysis of the ten studies having included the balance of system components (BOS) in the assessments showed that these contribute significantly to most environmental impact categories. Beyond recommending that stakeholders in the PV field rely on LCA to support decision-making and to guide scientific research and technological development, we strongly advocate LCA practitioners to include the entire PV system, including the BOS, to identify ecodesign opportunities without risking potential burden-shifting across the different parts of the system and across impact categories.

General information
State: Published
Organisations: Department of Energy Conversion and Storage, Functional organic materials, Quantitative Sustainability Assessment, Department of Management Engineering
Effect factors for terrestrial acidification in Brazil

To support the increased use of existing Life Cycle Impact Assessment (LCIA) methodologies across the world, new methodological elements have been developed towards spatially resolved impact assessment. Spatially resolved methods could better capture the differences of regional environmental conditions, which is an essential approach considering countries like Brazil, with high biodiversity. Previous studies have assessed the impacts of terrestrial acidification from the estimations of the potential losses of vascular plants species richness as a result of exposure to acidifying substances for 13 biomes, with 2409 species addressed for whole world. In this context this work aims to provide spatially-differentiated effect factors (EF) for terrestrial acidification in Brazil and support the development of spatially-differentiated characterization factors for Brazil. In order to maintain compatibility with existing LCIA methods the effect factors were developed using the framework adopted by LC-Impact and Impact World+ methods. Soil pH was used as an indicator of soil acidity to predict plant occurrences. From the number of plant species occurring at each 0.1 pH unit response relationships of species richness and soil pH were developed. The species richness in each ecoregion were transformed into an empirical potentially not occurring fraction, which is a zero-to-one measure used to represent the presence or absence of species. The set of data consists of 976345 records of plants occurrences in Brazil, represented by 33167 species, indicating that this is a comprehensive study. Maps of soil pH in Brazil were extracted at 1-km resolution and pH values were extracted for the depth range of 0-30cm. For each ecoregion, species richness was plotted against soil pH and the exposure-response curves for acidification described the behavior of plant species in a certain region when it is exposed to acidic conditions. From these curves it was possible to derive the effect factors for terrestrial acidification. The results of this work show that spatial differentiation is meaningful when it is possible to combine fine spatial resolutions and highly representative data and this approach can be applied for other impact categories and regions, and contribute to the development of spatial differentiated LCIA methodologies.

General information
State: Published
Organisations: Department of Management Engineering, Quantitative Sustainability Assessment
Authors: Crespo Mendes, N. (Intern), Laurent, A. (Intern), Hauschild, M. Z. (Intern)
Publication date: 2016
Event: Abstract from SETAC Europe 26th Annual Meeting, Nantes, France.
Main Research Area: Technical/natural sciences
Electronic versions: SETAC2016_short_ncme.pdf
Source: PublicationPreSubmission
Source-ID: 127049440
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2016

Ethical aspects of life cycle assessments of diets
Since the turn of the century a growing chorus of researchers has been espousing reduced meat and dairy intake as a partial strategy to transition towards a sustainable food system. Many of these studies have been predicated on a life-cycle assessment (LCA) methodology and though transparent in communicating their work within that framework, it has largely gone unmentioned that LCA involves a number of choices by the assessor and LCA methodology developers that are ultimately subjective. This study uses a consequential LCA of the average Danish diet in comparison to model vegetarian and vegan diets, leveraging the cultural perspectives afforded by the ReCiPe methodology, as starting point to explore the ways that subjectivity influences the LCA process and to test the robustness of the results against these different viewpoints. Mirroring earlier studies, we find vegetarian and vegan diets generally perform better environmentally compared to a standard Danish diet, but that there was minimal difference between the two no-meat options. Results were resilient to varying cultural perspectives applied in the model. LCA methodology, though loaded with value judgments, remains a dependable tool for assessing environmental dietary performance, but is less suited for estimating environmental pressures that are highly dependent on local conditions (e.g. chemical toxicity).
How to consistently make your product, technology or system more environmentally-sustainable?

Human activities are currently unsustainable, causing many damages to ecosystems, human health and natural resources. In this setting, the development of new products and technologies has been increasingly required to relate to sustainability and ensure that such development goes hand
-in-hand with low environmental impacts, low-carbon emissions, low environmental footprints or more sustainability as a whole. To enable a scientifically-sound and consistent documentation of such sustainable development, quantitative assessments of all environmental impacts are needed. Life cycle assessment (LCA) is recognized as the most holistic tool to address that need. LCA has two main strengths: (1) the ability to quantify all relevant environmental impacts – not just climate change, but also metal depletion, water use, toxicity exerted by pollutants on ecosystems and human health, etc.; and (2) making the assessment of the product/technology in a life cycle perspective, from the extraction of raw materials through production and use/operation of the product up to its final disposal. Fully embracing these 2 features enables to minimize the risk of burden-shifting, e.g. if impacts on climate change are being reduced while increasing other relevant environmental impacts or if impacts are shifted from the use stage of a product to the manufacturing stage as a result of a change in the product composition. Here, we provide a glimpse at how LCA can help for eco-design purposes, moving towards the use of low-impact materials, identifying environmental hotspots parts of the life cycle with largest environmental impacts), making prospective simulations through scenario analyses, comparing and selecting most environmentally-friendly product/technology alternatives, reporting on the environmental performances of the system. We rely on state-of-the-art science in the food sector, the aquaculture sector and the energy sector to showcase and illustrate the potential of LCA to undertake the environmental sustainability challenge and support product/technology/system development.

**General information**
State: Published
Organisations: Department of Management Engineering, Quantitative Sustainability Assessment
Authors: Laurent, A. (Intern), Cosme, N. M. D. (Intern), Molin, C. (Intern), Niero, M. (Intern), Hauschild, M. Z. (Intern)
Publication date: 2016
Main Research Area: Technical/natural sciences
Electronic versions: Sustain2016abstract_AL.pdf
Source: PublicationPreSubmission
Source-ID: 127806359
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2016

**LCA as a support for energy-policy-making: Multi-scale analysis of environmental impacts of electricity generation in the world from 1980 to 2010**

**General information**
State: Published
Organisations: Department of Management Engineering, Quantitative Sustainability Assessment
Authors: Laurent, A. (Intern), Espinosa Martinez, N. (Intern)
Publication date: 2016
Event: Abstract from 22nd SETAC Europe LCA Case Study Symposium, Montpellier, France.
Main Research Area: Technical/natural sciences
Source: PublicationPreSubmission
Source-ID: 127028762
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2016

**LCA of time-differentiated electric vehicle deployment in Copenhagen between 2016 and 2030**

**General information**
State: Published
Organisations: Department of Management Engineering, Quantitative Sustainability Assessment, Systems Analysis
Authors: Bohnes, F. A. (Intern), Gregg, J. S. (Intern), Laurent, A. (Intern)
Publication date: 2016
Event: Abstract from 22nd SETAC Europe LCA Case Study Symposium, Montpellier, France.
Main Research Area: Technical/natural sciences
Source: PublicationPreSubmission
Source-ID: 127028799
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2016

**LCIA framework and modelling guidance [TF 1 Crosscutting issues]**

**General information**
State: Published
Organisations: Department of Management Engineering, Quantitative Sustainability Assessment, Transport DTU, Norwegian University of Science and Technology, University of Michigan, Commonwealth Scientific and Industrial Research Organisation, Universidade Tecnologica Federal do Parana, Swiss Federal Institute of Technology
Life cycle assessment for policy-making: Case of the human health impacts from national NMVOC emissions in the EU-27 between 2000 and 2010

This study aims to assess the environmental impacts related to the provision of 1 kWh to the grid from wind power in Europe and to suggest how life cycle assessment can inform technology development and system planning. Four representative power plants onshore (with 2.3 and 3.2 MW turbines) and offshore (4.0 and 6.0 MW turbines) with 2015 state-of-the-art technology data provided by Siemens Wind Power were assessed. The energy payback time was found to be less than 1 year for all technologies. The emissions of greenhouse gases amounted to less than 7 g CO2-eq/kWh for onshore and 11 g CO2-eq/kWh for offshore. Climate change impacts were found to be a good indicator for overall hotspot identification however attention should also be drawn to human toxicity and impacts from respiratory inorganics. The overall higher impact of offshore plants, compared to onshore ones, is mainly due to larger high impact material requirements for capital infrastructure. In both markets the bigger turbines with more advanced direct drive generator technology is shown to perform better than the smaller geared ones. Capital infrastructure is the most impactful life cycle stage across impacts. It accounts for more than 79% and 70% of climate change impacts onshore and offshore respectively. The end-of-life treatment could lead to significant savings due to recycling, ca. 20-30% for climate change. In the manufacturing stage the impacts due to operations at the case company do not exceed 1% of the total life cycle impacts. This finding highlights the shared responsibility across multiple stakeholders and calls for collaborative efforts for comprehensive environmental management across organizations in the value chain. Real life examples are given in order to showcase how LCA results can inform decisions, e.g. for concept and product development and supply chain management. On a systems level the results can be used by energy planners when comparing with alternative energy sources. (C) 2016 Elsevier Ltd. All rights reserved.

Life cycle assessment of onshore and offshore wind energy - from theory to application

This study aims to assess the environmental impacts related to the provision of 1 kWh to the grid from wind power in Europe and to suggest how life cycle assessment can inform technology development and system planning. Four representative power plants onshore (with 2.3 and 3.2 MW turbines) and offshore (4.0 and 6.0 MW turbines) with 2015 state-of-the-art technology data provided by Siemens Wind Power were assessed. The energy payback time was found to be less than 1 year for all technologies. The emissions of greenhouse gases amounted to less than 7 g CO2-eq/kWh for onshore and 11 g CO2-eq/kWh for offshore. Climate change impacts were found to be a good indicator for overall hotspot identification however attention should also be drawn to human toxicity and impacts from respiratory inorganics. The overall higher impact of offshore plants, compared to onshore ones, is mainly due to larger high impact material requirements for capital infrastructure. In both markets the bigger turbines with more advanced direct drive generator technology is shown to perform better than the smaller geared ones. Capital infrastructure is the most impactful life cycle stage across impacts. It accounts for more than 79% and 70% of climate change impacts onshore and offshore respectively. The end-of-life treatment could lead to significant savings due to recycling, ca. 20-30% for climate change. In the manufacturing stage the impacts due to operations at the case company do not exceed 1% of the total life cycle impacts. This finding highlights the shared responsibility across multiple stakeholders and calls for collaborative efforts for comprehensive environmental management across organizations in the value chain. Real life examples are given in order to showcase how LCA results can inform decisions, e.g. for concept and product development and supply chain management. On a systems level the results can be used by energy planners when comparing with alternative energy sources. (C) 2016 Elsevier Ltd. All rights reserved.
planning, power plants, Siemens Wind Power, energy payback time, greenhouse gases, climate change impacts, human toxicity, respiratory inorganics

DOIs:
10.1016/j.apenergy.2016.07.058
Source: FindIt
Source-ID: 2307093651
Publication: Research - peer-review › Journal article – Annual report year: 2016

Reaching consensus on cross-cutting issues in life cycle impact assessment (LCIA)

General information
State: Published
Organisations: Department of Management Engineering, Quantitative Sustainability Assessment, Universidade Tecnologica Federal do Paraña, Norwegian University of Science and Technology, University of Michigan, Commonwealth Scientific and Industrial Research Organisation, Swiss Federal Institute of Technology
Authors: Verones, F. (Ekstern), Henderson, A. (Ekstern), Laurent, A. (Intern), Ridoutt, B. (Ekstern), Ugaya, C. (Ekstern), Hellweg, S. (Ekstern)
Publication date: 2016
Main Research Area: Technical/natural sciences
Source: PublicationPreSubmission
Source-ID: 127028842
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2016

Use of digestate from a decentralized on-farm biogas plant as fertilizer in soils: An ecotoxicological study for future indicators in risk and life cycle assessment

Over the last decade, the number of decentralized farm biogas plants has increased significantly in the EU. This development leads not only to an increasing amount of biogas produced, but also to a higher amount of digestate obtained. One of the most attractive options to manage the digestate is to apply it as biofertilizer to the soil, because this gives the opportunity of recovering the nutrients, primarily nitrogen and phosphorus, and of attenuating the loss of organic matter suffered by soils under agricultural exploitation. Studies have claimed that digestates can present a residual biodegradability, and contain complex organic elements, salts or pathogenic bacteria that can damage terrestrial organisms. However few ecotoxicological studies have been performed to evaluate the ecological impact of digestate application on soil. In this study, the use of digestate as biofertilizer in agriculture was assessed by a battery of ecotoxicological tests considering the potential pollutants present in the digestate as a whole by using the “matrix-based” approach (also known as “whole effluent toxicity” for eluates or waste water effluents). The directand indirect tests included plant bioassays with Lepidium sativum, earthworm bioassays with Eisenia fetida, aquatic organisms (Artemia sp. and Daphnia magna) and luminescent bacteria bioassays (Vibrio fischeri). Direct tests occurred to be more sensitive than indirect tests. The earthworm bioassays did not show serious negative effects for concentrations up to 15% (dry weight/dry weight percent, w/w dm) and the plant bioassays showed no negative effect, but rather a positive one for concentrations lower than 20% (w/w dm), which encourages the use of digestate as a biofertilizer in agriculture provided that proper concentrations are used. The indirect tests, on the eluate, with the using aquatic organisms and luminescent bacteria showed an LC50 value of 13.61% volume/volume percent, v/v) for D. magna and no toxicity for Artemia sp. and V. fischeri. The ecotoxicological parameters obtained from the experimental activity have been analyzed so that they could serve in both ecological risk assessment (ERA) and life cycle assessment (LCA) to assess the risks and impacts of using digestate as a biofertilizer in agriculture. An interim effect factor of 1.17E3m3/kg-in-soil is advocated and can be used in life cycle impact assessment modelling of terrestrial ecotoxicity. A predicted non-effect concentration for soil organisms was defined at 341 mg-digestate/kg-soil and can be used for the dose–response assessment step in ERA. Although these values are recommended for use in ERA and LCA applications, it should be stressed that they underlie important uncertainties, which should be reduced by increasing the number of toxicological tests, in particular of chronic studies conducted at different trophic levels.

General information
State: Published
Organisations: Department of Management Engineering, Quantitative Sustainability Assessment, University of Padova, University of Huddersfield
Authors: Pivato, A. (Ekstern), Vanin, S. (Ekstern), Raga, R. (Ekstern), Lavagnolo, M. C. (Ekstern), Barausse, A. (Ekstern), Rieple, A. (Ekstern), Laurent, A. (Intern), Cossu, R. (Ekstern)
Pages: 387-389
Publication date: 2016
Main Research Area: Technical/natural sciences
Publication information
Journal: Waste Management
Volume: 49
Digestate, Ecotoxicity tests, Risk assessment, Life cycle assessment

Electronic versions:
Pivato_et_al_2016_WM.pdf
Which Electrode Materials to Select for More Environmentally Friendly Organic Photovoltaics?

General information
State: Published
Organisations: Department of Energy Conversion and Storage, Functional organic materials, Department of Management Engineering, Quantitative Sustainability Assessment
Authors: Espinosa Martinez, N. (Intern), Laurent, A. (Intern), Benatto, G. A. D. R. (Intern), Hösel, M. (Intern), Krebs, F. C. (Intern)
Number of pages: 6
Pages: 490-495
Publication date: 2016
Main Research Area: Technical/natural sciences

Publication information
Journal: Advanced Engineering Materials
Volume: 18
Issue number: 4
ISSN (Print): 1438-1656
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.07 SJR 0.826 SNIP 1.083
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.807 SNIP 1.045 CiteScore 1.82
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.805 SNIP 1.089 CiteScore 1.66
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.733 SNIP 0.843 CiteScore 1.59
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.779 SNIP 0.959 CiteScore 1.46
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.828 SNIP 1.035 CiteScore 1.58
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.097 SNIP 1.14
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.283 SNIP 1.106
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.267 SNIP 1.153
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.014 SNIP 1.157
Active Learning in Sustainability Teaching

General information
State: Published
Organisations: Department of Management Engineering, Quantitative Sustainability Assessment, Office for Study Programmes and Student Affairs
Authors: Laurent, A. (Intern), Olsen, S. I. (Intern), Fantke, P. (Intern), Andersson, P. H. (Intern)
Pages: 77-78
Publication date: 2015

Host publication information
Title of host publication: Book of abstracts
Publisher: DTU Skylab
Main Research Area: Technical/natural sciences
Electronic versions:
Exploring_Teaching_for_Active_Learning.pdf
Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2015

Ecodesign of organic photovoltaic modules from Danish and Chinese perspectives
The life cycle of a solar park made using organic photovoltaic (OPV) technology is assessed here. The modules have been fabricated in a pilot scale plant and they have been installed together with other components to evaluate the balance of system, in a solar park located in Denmark. Three possible waste management practices have been contemplated for the end of life of the solar park: recycling, incineration or the average local mix. The assessment of the environmental impacts of such a system reveals that silver used in the electrodes is overall the largest source of impacts, such as chemical pollution and metal depletion. The establishment of resource recovery systems for the end-of-life management of the OPV modules is therefore crucial to reduce overall environmental impacts. Liability on the manufacturers or on the operators should be implemented. The electricity produced from OPV solar parks yields similar footprints to other traditional energy technologies; e.g. coal and natural gas. However, when the efficiency of the OPV modules is increased from 1% to 5% they are comparable to other mature PV technologies already on the market. The effects of outsourcing or exporting the production of the OPV modules from Denmark to China have additionally been studied to determine the most advantageous configuration. The stakeholders should aim at anchoring the manufacturing of solar parks in countries with stringent emission standards and/or high technology efficiencies, e.g. Denmark, and at deploying them in countries with high solar radiation to maximise the environmental benefits of the PV technology.

General information
State: Published
Organisations: Department of Energy Conversion and Storage, Functional organic materials, Department of Management Engineering, Quantitative Sustainability Assessment
Environmental impacts of electricity generation at global, regional and national scales in 1980–2011: What can we learn for future energy planning?

The generation of electricity has been known to cause important damages to ecosystems and human health. The recognition of the global challenges posed by climate change and energy security has guided several countries to change their electricity policies over the past decades. However, have such changes entailed reduced or increased environmental impacts? Are there any identifiable patterns that could serve for steering future energy planning? To address these questions, we applied life cycle assessment to quantify a whole spectrum of environmental impacts caused by electricity generation in 199 countries for the period 1980–2011, with national differentiation of energy sources and, wherever possible, technology efficiencies. The results show that (i) environmental impact burden-shifting has occurred in the past for several countries as a result of national policies, (ii) all environmental impacts have globally increased since 1980 but with faster increase rates over the last decade, and (iii) important variations exist in the impact trends across countries and across impact categories. Our findings therefore demonstrate the need for integrating quantitative assessments of all relevant environmental impacts associated with foreseen energy systems when identifying the most sustainable energy pathways. We provide recommendations on the use of life cycle assessment for such purposes with a strong focus on...
application at the country level so that it can directly support national energy policy-making.

**General information**
State: Published
Organisations: Department of Management Engineering, Quantitative Sustainability Assessment, Department of Energy Conversion and Storage, Functional organic materials
Authors: Laurent, A. (Intern), Espinosa Martinez, N. (Intern)
Pages: 689–701
Publication date: 2015
Main Research Area: Technical/natural sciences

**Publication information**
Journal: Energy & Environmental Science
Volume: 8
ISSN (Print): 1754-5692
Ratings:
- BFI (2018): BFI-level 2
- Web of Science (2018): Indexed yes
- BFI (2017): BFI-level 2
- Web of Science (2017): Indexed yes
- BFI (2016): BFI-level 2
- Web of Science (2016): Indexed yes
- BFI (2015): BFI-level 2
- Scopus rating (2015): SJR 10.027 SNIP 4.275 CiteScore 23.85
- Web of Science (2015): Indexed yes
- BFI (2014): BFI-level 2
- Scopus rating (2014): SJR 7.792 SNIP 4.034 CiteScore 19.28
- Web of Science (2014): Indexed yes
- BFI (2013): BFI-level 1
- Scopus rating (2013): SJR 6.02 SNIP 3.011 CiteScore 14.81
- ISI indexed (2013): ISI indexed yes
- Web of Science (2013): Indexed yes
- BFI (2012): BFI-level 1
- Scopus rating (2012): SJR 5.86 SNIP 2.594 CiteScore 11.84
- ISI indexed (2012): ISI indexed yes
- Web of Science (2012): Indexed yes
- BFI (2011): BFI-level 1
- Scopus rating (2011): SJR 3.743 SNIP 2.513 CiteScore 9.96
- ISI indexed (2011): ISI indexed no
- Web of Science (2011): Indexed yes
- Scopus rating (2010): SJR 3.861 SNIP 2.41
- Web of Science (2010): Indexed yes
- Scopus rating (2009): SJR 2.045 SNIP 1.139
Original language: English
Electronic versions:
Laurent_et_al._2015_EES_postprint.pdf
DOIs:
10.1039/c4ee03832k
Source: PublicationPreSubmission
Source-ID: 106429874
Publication: Research - peer-review › Journal article – Annual report year: 2015

**Fate factors for airborne contributions to acidification, eutrophication and photochemical ozone formation in Brazil**

**General information**
State: Published
Organisations: Department of Management Engineering, Quantitative Sustainability Assessment, Universidade de Sao Paulo
Power generation from chemically cleaned coals: do environmental benefits of firing cleaner coal outweigh environmental burden of cleaning?

Power generation from high-ash coals is a niche technology for power generation, but coal cleaning is deemed necessary to avoid problems associated with low combustion efficiencies and to minimize environmental burdens associated with emissions of pollutants originating from ash. Here, chemical beneficiation of coals using acid and alkali–acid leaching procedures is evaluated as a potential coal cleaning technology employing life cycle assessment (LCA). Taking into account the environmental benefits from firing cleaner coal in pulverized coal power plants and the environmental burden of the cleaning itself, it is demonstrated that for a wide range of cleaning procedures and types of coal, chemical cleaning generally performs worse than combustion of the raw coals and physical cleaning using dense medium separation. These findings apply for many relevant impact categories, including climate change. Chemical cleaning can be optimized with regard to electricity, heat and methanol use for the hydrothermal washing step, and could have environmental impact comparable to that of physical cleaning if the overall resource intensiveness of chemical cleaning is reduced by a factor 5 to 10, depending on the impact category. The largest potential of the technology is observed for high-ash lignites, with initial ash content above 30%, for which the environmental benefits from firing cleaner coal can outweigh the environmental burden of cleaning for some impact categories. Overall, we recommend to policy makers that coal cleaning using acid or alkali–acid leaching procedures should not be considered for direct implementation as a coal beneficiation technology. We encourage further research on chemical cleaning and its optimization, however, as chemical cleaning has advantages that might make it attractive for cleaning of difficult to treat coals when compared to the less efficient option of physical cleaning.
20 years of LCA applied to waste management systems: what can we learn?
Assessing the environmental impacts of using demineralized coal for electricity generation

The energy sector is the source of two-thirds of global greenhouse-gas emissions, and is the main target of climate policies among authorities and governments. The share of fossil coals (hard coal and lignite) in world total net electricity generation is 40% in 2010. Demineralization or ash removal of the coal is thought to be beneficial for reducing ash-related problems, such as slagging and fouling in the combustion chamber, increasing the heating value, increasing thermal efficiency and reducing airborne emissions. A novel method for removing ash is alkali-acid leaching where the coal is washed in alkaline and acidic solution to dissolve and remove the ash. This process is well-studied on lab scale but has only to a small extent been tried on a full scale. This assessment is conducted as an aid for further developing the technology, allowing for early identification of environmental impacts and possible improvements. Experimental studies conducted so far have shown better performance of demineralized coal than its original raw coal during combustion, gasification, and coke making process. However a thorough analysis of the impacts from demineralization has not yet been conducted. We take a life cycle perspective, to assess the environmental impacts from removing ash in coal, and assess how this affects the combustion in terms of higher thermal efficiency. We assess 260 different data points applying alkali-acid leaching or acid leaching and assess how the treatment and subsequent energy generation will affect the environment. The results showed that demineralization in some cases were beneficial for regional impacts such as particulate matter formation because emission of particles and SO2 were reduced. In the contrary global impacts such as climate change did not benefit from demineralization because of the large energy use for running the demineralization process. Local and regional environmental impacts were shown to improve from demineralization for low ranking coals or lignite where the ash content is above ≈25 % and the carbon content is less than ≈50 %. Overall, it can be concluded that demineralization of coal is not advised for high quality coals as the additional energy required for removing the ash outweighs the benefits from the increase thermal efficiency.

Building and characterizing regional and global emission inventories of toxic pollutants

To define consistent strategies for managing the environmental sustainability of chemicals, it is important to quantify the magnitude of their emissions and their associated impacts. Not all countries monitor and report emissions related to their activities. This is particularly the case for chemical emissions, whose toxic impacts on human health and ecosystems cannot be readily determined due to gaps in the available data. Emission data that can be retrieved from publicly available databases are typically restricted to a limited number of toxic substances, for a few countries, or for aggregated regions. Extrapolation strategies are thus needed to fill in those data gaps and to move from the consideration of single countries or regions to the world scale. Little is known about how effective these strategies are in extrapolating emissions. Using emission data available in public databases in the world, the current work explores different opportunities to compile representative inventories of toxic emissions. In this study, we build global and European emission inventories using three extrapolation proxies, namely the gross domestic product, the emissions of carbon dioxide, and the emissions of mercury. The three proxies are compared and their efficacy tested statistically to identify the best performer for specific classes of substances. The potential impacts associated to the emissions in the European and global inventory are further tested by using an impact system adopted for the comparative assessment of chemicals in the field of life cycle assessment (LCA).
Can carbon footprint be an acceptable indicator of environmental sustainability?

General information
State: Published
Organisations: Department of Management Engineering, Quantitative Sustainability Assessment
Authors: Laurent, A. (Intern), Olsen, S. I. (Intern), Hauschild, M. Z. (Intern)
Publication date: 2014
Event: Abstract from Sustainability Science Congress 2014, Copenhagen, Denmark.
Main Research Area: Technical/natural sciences

Environmental impacts of global and regional electricity generation from 1980 to 2010: What can we learn for sound energy transition plannings?

General information
State: Published
Organisations: Department of Management Engineering, Quantitative Sustainability Assessment, Department of Energy Conversion and Storage, Functional organic materials
Authors: Laurent, A. (Intern), Espinosa, N. (Intern)
Publication date: 2014
Event: Poster session presented at Sustainability Science Congress 2014, Copenhagen, Denmark.
Main Research Area: Technical/natural sciences

Environmental sustainability of electricity supply in the world between 1980 and 2011: Lessons learnt and perspectives

The generation of electricity is known to cause important damages to environment and human health. The political awareness of the global challenges posed by climate change and resource depletion has guided several countries to gradually move from a dominant use of fossil fuels towards more utilisation of renewables. However, has such moves led to burden-shifting from these environmental impacts to others as relevant? Considering the whole spectrum of environmental problems, are there any identifiable patterns across regions or impact categories that could serve to draw recommendations for energy planning? To address these questions, we collected annual data on electricity generation for 199 countries and territories for the period 1980-2011, differentiated per types of energy sources. These data were combined with region-specific life cycle inventories of pollutant emissions and resource consumptions to assess ten environmental impact categories, e.g. climate change, water use or chemical pollution. The results show that, for several regions, the majority of these impacts have increased between 1980 and 2011. Asia and the Middle East – and to a lesser degree, Africa and Latin America – thus show steep increase, up to more than one order of magnitude, in nearly all indicators when compared to their 1980- baseline values. To estimate the "environmental cleanness" of the grid mixes over time, the impact scores were normalized by the electricity generated yearly within each country. This revealed burden-shifting occurrences in almost all regions within the period 1980-2011. For example, in Asia, normalized impacts of particulate matters on human health have more than doubled, while increase in climate change scores have been limited to ca. 35%. Based on our findings, we therefore recommend that electricity planning be accompanied with quantification of all relevant environmental impacts of the foreseen energy systems to prevent or minimise problem-shiftings ensuring an environmentally-sound energy transition.
How does the choice of ILCD’s recommended methods change the assessment of environmental impacts in LCA of products?

The European Commission has launched a recommended set of characterization methods for application in life cycle impact assessment (LCIA). However, it is not known yet whether the choice of the recommended practice, referred to as the ILCD, over existing LCIA methodologies matters for interpretation of LCA results. Here, we compare the ILCD with two of the most frequently used LCIA methodologies, IMPACT 2002+ and ReCiPe 2008, focusing on characterization at midpoint, by applying them on a case study comparing four window design options. First, to see whether the choice of ILCD matters for identification of product with the lowest environmental burden, ranking of the four window options was done for each impact category within each of the three methodologies. Next, impact scores calculated using each of the three methodologies were converted into common metrics for each impact category to see whether the choice of ILCD matters for total impact scores. Results show that apart from toxic impacts on human health and ecosystems, all three methodologies consistently identify the same window option as having the lowest and the highest total environmental impact. This is mainly because production of heat dominates the total impacts and there is a large difference in demand for heat between the compared options. Yet, there were significant differences in impact scores for some of the impact categories after conversion to common metrics: above 3 orders of magnitude for impacts from ionizing radiation on human health and impacts from land use on natural environment; between 1 and 3 orders of magnitude for metal depletion and for toxicity-related impact categories; and within 1 order of magnitude for the remaining impact categories. These differences are caused by the differences in underlying characterization models and/or substance coverage, depending on the impact category. In summary, we showed that different LCIA methods, including the ILCD, are likely to point to the same conclusion with respect to identifying the product with the lowest environmental burden, if one process is driving environmental impacts and there is large difference in demand for output from that process between the compared options. Nevertheless, the choice of ILCD matters the most for assessment of impacts from ionizing radiation, land use, resource depletion (minerals), and all toxicity-related impact categories, where differences between ILCD and alternative methodologies are large.
Human health no-effect levels of (nano)particles as a function of their primary size

General information
State: Published
Organisations: Department of Management Engineering, Quantitative Sustainability Assessment
Authors: Laurent, A. (Intern), Harkema, J. (Ekstern), Jolliet, O. (Ekstern)
Publication date: 2014

IMPACT 2002+, ReCiPe 2008 and ILCD’s recommended practice for characterization modelling in life cycle impact assessment: a case study-based comparison

Purpose The European Commission has launched a recommended set of characterization models and factors for application in life cycle impact assessment (LCIA). However, it is not known how this recommended practice, referred to as the ILCD 2009, performs relative to some of the most frequently used alternative LCIA methodologies. Here, we compare the ILCD 2009 with IMPACT 2002+ and ReCiPe 2008, focusing on characterization at midpoint based on a case study comparing four window design options for use in a residential building.

Methods Ranking of the four window options was done for each impact category within each methodology. To allow comparison across the methodologies both in terms of total impact scores and contribution patterns for individual substances, impact scores were converted into common metrics for each impact category.

Results and discussion Apart from toxic impacts on human health and ecosystems, all studied methodologies consistently identify the same window option as having the lowest and the highest environmental impact. This is mainly because few processes, associated with production of heat, dominate the total impacts, and there is a large difference in demand for heat between the compared options. Despite this general agreement in ranking, differences in impact scores are above 3 orders of magnitude for human health impacts from ionizing radiation and ecosystem impacts from land use, and they lie between 1 and 3 orders of magnitude for metal depletion and for toxicity-related impact categories. The differences are somewhat smaller (within 1 order of magnitude) for the impact categories respiratory inorganics and photochemical ozone formation, and are within a factor of 3 for the remaining impact categories. The differences in impact scores in our case study are brought about by the differences in underlying characterization models and/or substance coverage, depending on the impact category.

Conclusions In spite of substantial differences in impact scores for the individual impact categories, we find that the studied LCIA methods point to the same conclusion with respect to identifying the alternative with the lowest environmental burden and ascribe this to the fact that few processes are driving the main environmental impacts, and there is large difference in demand for output from these processes between the compared options. Even though the overall conclusions remain the same for our case study, the choice of the ILCD’s recommended practice over the existing alternatives does matter for the impact categories ionizing radiation and land use and all toxicity-related impact categories.
Characterization models, Comparison, Impact categories, Impact scores, Interpretation, Life cycle assessment

DOIs:
10.1007/s11367-014-0708-3

Source: dtu

Original language: English
Impacts of NMVOC emissions on human health in European countries for 2000-2010: Use of sector-specific substance profiles

Non-methane volatile organic compounds (NMVOC) are known to cause damages to human health via two main pathways, viz. the direct toxic effects exerted by certain substances (termed here human toxicity) and their indirect effects related to photochemical ozone formation (POF). To comprehensively assess the damages at national level and thus define adequate air pollution abatement policies, substance breakdowns are needed. However, these are not readily available as total NMVOC emissions are only reported at sector level. In this study, we developed a reproducible methodology that combines available speciation profiles, i.e. distributions of substances emitted per type of sources, and sectoral NMVOC information to reach country-specific, substance-specific emission profiles. Annual emission inventories, including 270 single substances and 52 unrefined groups of substances, were determined for 31 European countries within the period 2000e2010. Using life cycle impact assessment methods for POF and human toxicity, impacts on human health were quantified. The results indicated that a strong linear correlation exists between POF impacts and the total NMVOC emissions, suggesting that air pollution abatement policies could use total NMVOC emissions as a proxy for reducing these impacts. Despite underlying uncertainties, the results also demonstrated that the POF impacts from NMVOC are negligible compared to their direct toxic impacts. The analysis of the results revealed that the toxic impacts (i) are caused by few substances, such as formaldehyde, acrolein and furan, (ii) primarily stem from transportation sectors and from residential sources, and (iii) are found not to correlate with total NMVOC emissions. Our findings therefore suggest the need for supporting air pollution abatement strategies with comprehensive impact assessments, which, in addition to complementing emission- and concentration-based indicators, should allow identifying country-specific improvement potentials at substance and sector levels.

© 2013 Elsevier Ltd. All rights reserved.
LCA in support of more qualified air pollution abatement policies: Case of NMVOC emissions in European countries for 2000-2010

General information
State: Published
Organisations: Department of Management Engineering, Quantitative Sustainability Assessment
Authors: Laurent, A. (Intern), Hauschild, M. Z. (Intern)
Publication date: 2014

Host publication information
Title of host publication: Proceedings of SETAC Europe: 24th Annual Meeting – Science across bridges, borders and boundaries
Publisher: SETAC Europe
Main Research Area: Technical/natural sciences
Conference: SETAC Europe 24th Annual Meeting, Basel, Switzerland, 11/05/2014 - 11/05/2014
Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2014

LCA in support of more qualified air pollution abatement policies: Case of NMVOC emissions in European countries for 2000-2010

Non-methane volatile organic compounds, Life cycle impact assessment, National emission inventory, Speciation, Air pollution abatement, DALY

While the generation of solid waste is globally increasing, much effort is concentrated to minimise the environmental impacts related to their management. With respect to nanoproducts (products containing nanomaterials), a growing
amount of ‘nanowaste’ can be expected to enter the waste streams, thus potentially posing problems on human health, e.g. through occupational exposure to engineered nanoparticles. In that setting, through its holistic quantification of environmental impacts, life cycle assessment (LCA) can be a useful decision support tool for managing environmental sustainability of solid waste management systems as well as that of nanoproducts. But how has LCA generally been applied to both fields of solid waste management and nanotechnology until now? In particular, what are the current shortcomings for assessing impacts of released engineered nanoparticles? Is it possible to derive useful preliminary results from currently available data? And, if so, what could be the occupational impacts of engineered nanoparticles taken through the life cycle of nanoproducts including their end-of-life? The answers to these questions form the red thread of the thesis, which is composed by several pieces of work.

Critical reviews were performed to evaluate the current state of LCA application to solid waste management systems and to nanoproducts. The former revealed that, out of 222 reviewed studies, several limitations were identified in the types of LCA application, with a narrow focus on specific waste types and waste management systems, all primarily reflecting situations in economically developed countries. At the same time, methodological practice was found in many studies not to be compliant with current reference guidance, such as the ISO standards and the ILCD Handbook. Likewise, in the application of LCA to nanoproducts, important inconsistencies and shortcomings were noted. While some of them could be prevented by a proper application of the LCA methodology, others were strongly related to the data paucity, particularly with regard to the lack of emission data and characterisation factors for assessing engineered nanoparticles.

To support the impact assessment of engineered nanoparticles in the life cycle of nanoproducts and in solid waste management systems, a comprehensive review of toxicological data for nanosilver and titanium dioxide (TiO2) particles was conducted and it enabled to investigate the influence of some of the physicochemical properties of the particles on their toxic effects. This led to quantify relationships between the primary size and the toxic effects of nanosilver and TiO2 particles that ultimately could be used for deriving consistent, size-dependent no-observed-adverse-effect levels and effect factors applicable in risk assessment and life cycle impact assessment, respectively. The developed effect factors for TiO2 and Ag particles were applied on two simplified LCA case studies, namely the annual consumption of food containing TiO2 nanoparticles in the United Kingdom and a T-shirt embedded with nanosilver. Although highly uncertain because of lack of data, this preliminary assessment suggested that the manufacturing stage may lead to larger occupational impacts from engineered nanoparticles than the disposal stage, and that the occupational exposure to engineered nanoparticles may be negligible when compared to other contributions to human health impacts in the nanoproduct life cycle.

More than the results themselves, these case studies, along with the developed methodology for investigating the relationships between the physicochemical properties of the particles and their toxic effects, served to pinpoint the data required to perform proper assessment of the impacts of exposure to engineered nanoparticles. In particular, detailed emission data matching the actual processes in both the manufacturing and disposal stages, full characterisations of exposure situations, and the generation of more reliable and relevant toxicological data are highly needed and should urgently be addressed. Integrating these information into LCA practice, for which detailed recommendations are also provided in this thesis, should allow the conduct of consistent LCA studies of waste management systems and nanoproducts, and accurately evaluate the relevance of engineered nanoparticles in the total human health impacts.
Review of LCA studies of solid waste management systems – Part II: Methodological guidance for a better practice

Life cycle assessment (LCA) is increasingly used in waste management to identify strategies that prevent or minimise negative impacts on ecosystems, human health or natural resources. However, the quality of the provided support to decision- and policy-makers is strongly dependent on a proper conduct of the LCA. How has LCA been applied until now? Are there any inconsistencies in the past practice? To answer these questions, we draw on a critical review of 222 published LCA studies of solid waste management systems. We analyse the past practice against the ISO standard requirements and the ILCD Handbook guidelines for each major step within the goal definition, scope definition, inventory analysis, impact assessment, and interpretation phases of the methodology. Results show that malpractices exist in several aspects of the LCA with large differences across studies. Examples are a frequent neglect of the goal definition, a frequent lack of transparency and precision in the definition of the scope of the study, e.g. an unclear delimitation of the system boundaries, a truncated impact coverage, difficulties in capturing influential local specificities such as representative waste compositions into the inventory, and a frequent lack of essential sensitivity and uncertainty analyses. Many of these aspects are important for the reliability of the results. For each of them, we therefore provide detailed recommendations to practitioners of waste management LCAs.

© 2013 Elsevier Ltd. All rights reserved.
Review of LCA studies of solid waste management systems – Part I: Lessons learned and perspectives

The continuously increasing solid waste generation worldwide calls for management strategies that integrate concerns for environmental sustainability. By quantifying environmental impacts of systems, life cycle assessment (LCA) is a tool, which can contribute to answer that call. But how, where and to which extent has it been applied to solid waste management systems (SWMSs) until now, and which lessons can be learnt from the findings of these LCA applications? To address these questions, we performed a critical review of 222 published LCA studies of SWMSs. We first analysed the...
geographic distribution and found that the published studies have primarily been concentrated in Europe with little application in developing countries. In terms of technological coverage, they have largely overlooked application of LCA to waste prevention activities and to relevant waste types apart from household waste, e.g. construction and demolition waste. Waste management practitioners are thus encouraged to abridge these gaps in future applications of LCA. In addition to this contextual analysis, we also evaluated the findings of selected studies of good quality and found that there is little agreement in the conclusions among them. The strong dependence of each SWMS on local conditions, such as waste composition or energy system, prevents a meaningful generalisation of the LCA results as we find it in the waste hierarchy. We therefore recommend stakeholders in solid waste management to regard LCA as a tool, which, by its ability of capturing the local specific conditions in the modelling of environmental impacts and benefits of a SWMS, allows identifying critical problems and proposing improvement options adapted to the local specificities.

© 2013 Elsevier Ltd. All rights reserved.

General information
State: Published
Organisations: Department of Management Engineering, Quantitative Sustainability Assessment, Department of Environmental Engineering, Residual Resource Engineering, Department of Chemical and Biochemical Engineering, Ecosystems Programme, Lund University, Copenhagen Resource Institute
Authors: Laurent, A. (Intern), Bakas, I. (Intern), Clavreul, J. (Intern), Bernstad, A. (Ekstern), Niero, M. (Intern), Gentil, E. (Ekstern), Hauschild, M. Z. (Intern), Christensen, T. H. (Intern)
Pages: 573-588
Publication date: 2014
Main Research Area: Technical/natural sciences

Publication information
Journal: Waste Management
Volume: 34
Issue number: 3
ISSN (Print): 0956-053X
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 4 SJR 1.354 SNIP 2.044
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.739 SNIP 2.256 CiteScore 4.33
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.777 SNIP 2.482 CiteScore 3.43
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.822 SNIP 2.435 CiteScore 3.39
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.611 SNIP 2.184 CiteScore 2.91
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.698 SNIP 2.085 CiteScore 2.99
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.555 SNIP 1.78
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.502 SNIP 1.899
**Will organic photovoltaic technology render benefits in a 30-year horizon?**

**General information**
State: Published
Organisations: Department of Energy Conversion and Storage, Functional organic materials, Department of Management Engineering, Quantitative Sustainability Assessment
Authors: Espinosa Martinez, N. (Intern), Laurent, A. (Intern), Krebs, F. C. (Intern), Hauschild, M. Z. (Intern)
Number of pages: 2
Publication date: 2014
Event: Abstract from SETAC Europe 24th Annual Meeting, Basel, Switzerland.
Main Research Area: Technical/natural sciences

**Relations**
Activities:
Will organic photovoltaic technology render benefits in a near future of a 30 years horizon?
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2014

**A critical review of life cycle assessment applied to solid waste management systems**

**General information**
State: Published
Organisations: Department of Management Engineering, Quantitative Sustainability Assessment, Department of Environmental Engineering, Residual Resource Engineering
Authors: Laurent, A. (Intern), Clavreul, J. (Ekstern), Bakas, I. (Intern), Bernstad, A. (Ekstern), Niero, M. (Intern), Gentil, E. (Ekstern), Hauschild, M. Z. (Intern), Christensen, T. H. (Intern)
Publication date: 2013

**Host publication information**
Title of host publication: Proceedings Sardinia 2013
Publisher: CISA Publisher
Main Research Area: Technical/natural sciences
Complementary use of life cycle assessment and risk assessment for engineered nanomaterials: Lessons learned from chemicals?
Successful strategies to handle the potential health and environmental risks of engineered nanomaterials (ENM) often rely upon the well-established frameworks of life cycle assessment (LCA) and risk assessment (RA). However, current research and specific guidance on how to actually apply these two frameworks are still very much under development. Through an in-depth review, this study evaluates how research efforts have applied LCA and RA together for ENM with a particular emphasis on past “lessons learned” from applying these frameworks to chemicals. Among other results, it appears that current scientific research efforts have taken into account some key lessons learned from past experiences with chemicals at the same time that many key challenges remain to applying these frameworks to ENM. In that setting, two main proposed approaches to use LCA and RA together for ENM are identified: i) LC-based RA, similar to traditional RA applied in a life cycle perspective, and ii) RA-complemented LCA, similar to conventional LCA supplemented by RA in specific life cycle steps. This study finds that these two approaches for using LCA and RA together for ENM are similar to those made for chemicals, and hence, there does not appear to be much progress made specifically for ENM. We therefore provide specific recommendations for applying LCA and RA to ENM, for which the need to establish proper dose metrics within both methods is identified as an important requirement.

Identifying best existing practice for characterization modeling in life cycle impact assessment
Purpose: Life cycle impact assessment (LCIA) is a field of active development. The last decade has seen prolific publication of new impact assessment methods covering many different impact categories and providing characterization factors that often deviate from each other for the same substance and impact. The LCA standard ISO 14044 is rather general and unspecific in its requirements and offers little help to the LCA practitioner who needs to make a choice. With the aim to identify the best among existing characterization models and provide recommendations to the LCA practitioner, a study was performed for the Joint Research Centre of the European Commission (JRC). Methods Existing LCIA methods were collected and their individual characterization models identified at both midpoint and endpoint levels and supplemented with other environmental models of potential use for LCIA. No new developments of characterization models or factors were done in the project. From a total of 156 models, 91 were short listed as possible candidates for a recommendation within their impact category. Criteria were developed for analyzing the models within each impact category. The criteria addressed both scientific qualities and stakeholder acceptance. The criteria were reviewed by external experts and stakeholders and applied in a comprehensive analysis of the short-listed characterization models (the total number of criteria varied between 35 and 50 per impact category). For each impact category, the analysis concluded with identification of the best among the existing characterization models. If the identified model was of sufficient quality, it was recommended by the JRC. Analysis and recommendation process involved hearing of both scientific experts and stakeholders. Results and recommendations: Recommendations were developed for 14 impact categories at midpoint level, and among these recommendations, three were classified as “satisfactory” while ten were “in need of some improvements” and one was so weak that it has “to be applied with caution.” For some of the impact categories, the classification of the recommended model varied with the type of substance. At endpoint level, recommendations were only found relevant for three impact categories. For the rest, the quality of the existing methods was too weak, and the methods that came out best in the analysis were classified as “interim,” i.e., not recommended by the JRC but suitable to provide an initial basis for further development. Discussion, conclusions, and outlook: The level of characterization modeling at midpoint level has improved considerably over the last decade and now also considers important aspects like geographical differentiation and combination of midpoint and endpoint characterization, although the latter is in clear need for further development. With the realization of the potential importance of geographical differentiation comes the need for characterization models that are able to produce characterization factors that are representative for different continents and still support aggregation of impact scores over the whole life cycle. For the impact categories human toxicity and ecotoxicity, we are now able to recommend a model, but the number of chemical substances in common use is so high that there is a need to address the substance data shortage and calculate
characterization factors for many new substances. Another unresolved issue is the need for quantitative information about the uncertainties that accompany the characterization factors. This is still only adequately addressed for one or two impact categories at midpoint, and this should be a focus point in future research. The dynamic character of LCIA research means that what is best practice will change quickly in time. The characterization methods presented in this paper represent what was best practice in 2008–2009.

**General information**

State: Published
Organisations: Department of Management Engineering, Quantitative Sustainability Assessment, PRé Consultants B.V., Universiteit Leiden, Radboud University Nijmegen, University of Michigan, Ecole Polytechnique de Montreal, Ecole Polytechnique Federale de Lausanne (EPFL), European Commission - Joint Research Center

Authors: Hauschild, M. Z. (Intern), Goedkoop, M. (Ekstern), Guinée, J. (Ekstern), Heijungs, R. (Ekstern), Huijbregts, M. (Ekstern), Jolliet, O. (Ekstern), Margni, M. (Ekstern), De Schryver, A. (Ekstern), Humbert, S. (Ekstern), Laurent, A. (Intern), Sala, S. (Ekstern), Pant, R. (Ekstern)

Pages: 683-697
Publication date: 2013
Main Research Area: Technical/natural sciences

**Publication information**

Journal: International Journal of Life Cycle Assessment
Volume: 18
Issue number: 3
ISSN (Print): 0948-3349

Ratings:
- BFI (2018): BFI-level 2
- Web of Science (2018): Indexed yes
- BFI (2017): BFI-level 2
- Web of Science (2017): Indexed yes
- BFI (2016): BFI-level 2
- Scopus rating (2016): CiteScore 3.43 SJR 1.328 SNIP 1.423
- Web of Science (2016): Indexed yes
- BFI (2015): BFI-level 2
- Scopus rating (2015): SJR 1.504 SNIP 1.554 CiteScore 3.49
- Web of Science (2015): Indexed yes
- BFI (2014): BFI-level 2
- Scopus rating (2014): SJR 1.736 SNIP 1.738 CiteScore 3.65
- Web of Science (2014): Indexed yes
- BFI (2013): BFI-level 2
- Scopus rating (2013): SJR 1.666 SNIP 1.979 CiteScore 3.35
- ISI indexed (2013): ISI indexed yes
- Web of Science (2013): Indexed yes
- BFI (2012): BFI-level 2
- Scopus rating (2012): SJR 1.515 SNIP 1.701 CiteScore 2.89
- ISI indexed (2012): ISI indexed yes
- Web of Science (2012): Indexed yes
- BFI (2011): BFI-level 2
- Scopus rating (2011): SJR 1.581 SNIP 1.716 CiteScore 2.82
- ISI indexed (2011): ISI indexed yes
- Web of Science (2011): Indexed yes
- BFI (2010): BFI-level 2
- Scopus rating (2010): SJR 1.447 SNIP 1.861
- Web of Science (2010): Indexed yes
- BFI (2009): BFI-level 2
- Scopus rating (2009): SJR 1.201 SNIP 1.592
- Web of Science (2009): Indexed yes
- BFI (2008): BFI-level 2
- Scopus rating (2008): SJR 0.863 SNIP 1.33
- Web of Science (2008): Indexed yes
Identifying best existing practice for characterization modeling in life cycle impact assessment

Source: dtu
Source-ID: u::6861
Publication: Research - peer-review › Journal article – Annual report year: 2013

Life Cycle Risks and Impacts of Nanotechnologies

General information
State: Published
Organisations: Department of Management Engineering, Quantitative Sustainability Assessment
Authors: Jolliet, O. (Ekstern), Rosenbaum, R. K. (Intern), Laurent, A. (Intern)
Pages: 213-277
Publication date: 2013

Host publication information
Title of host publication: Nanotechnology and Human Health
Publisher: Taylor & Francis
Editors: Malsch, I., Edmond, C.
ISBN (Print): 978084938144
Main Research Area: Technical/natural sciences
Publication: Research - peer-review › Book chapter – Annual report year: 2013

Mapping and characterization of LCA networks
Purpose: The aims of this study were to provide an up-to-date overview of global, regional and local networks supporting life cycle thinking and to characterize them according to their structure and activities.
Methods: Following a tentative life cycle assessment (LCA) network definition, a mapping was performed based on (1) a literature search, (2) a web search and (3) an inquiry to stakeholders distributed via the two largest LCA fora. Networks were characterized based on responses from a survey.
Results and discussion: We identified 100 networks, of which 29 fulfilled all six criteria composing our tentative network definition (the remaining fulfilled four to five criteria). The networks are mainly located in Europe and the USA, whilst Africa, the Middle East and Central Asia are less covered regions. The survey results (from 25 network responses) indicate that LCA networks appear to be primarily small- to medium-sized (<100 members) and to include a large proportion of academia and industries, including small- and mediumsized enterprises, with much less involvement of authorities and non-governmental organisations. Their major activities relate to knowledge sharing and communication, support of case studies, and development of life cycle inventories and impact assessment methods. Networks in developing economies have different structures and activities than networks in developed economies and, for instance, more frequently have members from non-governmental organisations. Globally, an increasing trend in the formation of LCA networks over time is observed, which tends to correlate with the number of LCA scientific publications over the same time period. Continental distributions of networks also show a correlation with the number of LCA publications from the same region.
Conclusions: The provided list of LCA networks is currently the most comprehensive, publicly available mapping. We believe that the results of this mapping can serve as a basis for deciding where priorities should be set to increase the dissemination and development of LCA worldwide. In this aim, we also advocate the creation of an online, regularly updated database of LCA networks supplemented by an online platform that could facilitate network communication and knowledge sharing.

General information
State: Published
Organisations: Department of Management Engineering, Quantitative Sustainability Assessment
Authors: Bjørn, A. (Intern), Owsianiak, M. (Intern), Laurent, A. (Intern), Molin, C. (Intern), Westh, T. B. (Intern), Hauschild, M. Z. (Intern)
Pages: 812-827
Publication date: 2013
Main Research Area: Technical/natural sciences

Publication information
Journal: International Journal of Life Cycle Assessment
Volume: 18
ISSN (Print): 0948-3349
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.43 SJR 1.328 SNIP 1.423
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.504 SNIP 1.554 CiteScore 3.49
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.736 SNIP 1.738 CiteScore 3.65
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.666 SNIP 1.979 CiteScore 3.35
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.515 SNIP 1.701 CiteScore 2.89
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.581 SNIP 1.716 CiteScore 2.82
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.447 SNIP 1.861
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.201 SNIP 1.592
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 0.863 SNIP 1.33
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.8 SNIP 1.22
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.6 SNIP 1.387
Normalisation factors for ecotoxicity and human toxicity: Extrapolation strategies using GDP, CO₂ and Hg

Analysis of current research addressing complementary use of life-cycle assessment and risk assessment for engineered nanomaterials: have lessons been learned from previous experience with chemicals?

While it is generally agreed that successful strategies to address the health and environmental impacts of engineered nanomaterials (NM) should consider the well-established frameworks for conducting life-cycle assessment (LCA) and risk assessment (RA), scientific research, and specific guidance on how to practically apply these methods are still very much under development. This paper evaluates how research efforts have applied LCA and RA together for NM, particularly reflecting on previous experiences with applying these methods to chemicals. Through a literature review and a separate analysis of research focused on applying LCA and RA together for NM, it appears that current research efforts have taken into account some key “lessons learned” from previous experience with chemicals, while many key challenges remain for practically applying these methods to NM. We identified two main approaches for using these methods together for NM: “LC-based RA” (traditional RA applied in a life-cycle perspective) and “RA-complemented LCA” (conventional LCA supplemented by RA in specific life-cycle steps). Hence, the latter is the only identified approach which genuinely combines LC- and RA-based methods for NM-risk research efforts to date as the former is rather a continuation of normal RA according to standard assessment procedures (e.g., REACH). Both these approaches along with recommendations for using LCA and RA together for NM are similar to those made previously for chemicals, and thus, there does not appear to be much progress made specific for NM. We have identified one issue in particular that may be specific for NM when applying LCA and RA at this time: the need to establish proper dose metrics within both methods.
Can carbon footprint serve as a comprehensive tool for assessing and managing environmental sustainability?
Defining and mapping LCA networks: Initial results

General information
State: Published
Organisations: Quantitative Sustainability Assessment, Department of Management Engineering
Authors: Bjørn, A. (Intern), Owsianiak, M. (Intern), Laurent, A. (Intern), Molin, C. (Intern), Westh, T. B. (Intern), Hauschild, M. Z. (Intern)
Pages: 137-141
Publication date: 2012

Host publication information
Title of host publication: Proceedings
Main Research Area: Technical/natural sciences
Conference: 19th CIRP International Conference on Life Cycle Engineering, Berkeley, CA, United States, 23/05/2012 - 23/05/2012
Publication: Research - peer-review › Article in proceedings – Annual report year: 2012

LCA applied to nanotechnologies: A critical review

General information
State: Published
Organisations: Department of Management Engineering, Quantitative Sustainability Assessment, University of Michigan
Authors: Laurent, A. (Intern), Jolliet, O. (Ekstern)
Number of pages: 1
Pages: 97-97
Publication date: 2012

Host publication information
Title of host publication: Book of abstracts - SETAC 18th LCA Case Study Symposium and 4th NorLCA Symposium : Sustainability Assessment in the 21st century - Tools, Trends and Applications
Main Research Area: Technical/natural sciences
Conference: SETAC Europe 18th LCA Case Study Symposium and 4th NorLCA Symposium, Copenhagen, Denmark, 26/11/2012 - 26/11/2012
Electronic versions: programme_abstracts_book_31102012_v2.pdf
Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2012

LCA applied to solid waste management systems: A comprehensive review

General information
State: Published
Organisations: Department of Management Engineering, Quantitative Sustainability Assessment, Department of Environmental Engineering, Residual Resource Engineering, Lund University, University of Padua, Copenhagen Resource Institute
Authors: Bakas, I. (Intern), Clavreul, J. (Intern), Bernstad, A. (Ekstern), Niero, M. (Ekstern), Gentil, E. (Ekstern), Laurent, A. (Intern)
Number of pages: 1
Pages: 69-69
Publication date: 2012

Host publication information
Title of host publication: Book of abstracts - SETAC 18th LCA Case Study Symposium and 4th NorLCA Symposium : Sustainability Assessment in the 21st century - Tools, Trends and Applications
Learning by doing - bringing real-life case studies into the classroom

State: Published
Organisations: Department of Management Engineering, Quantitative Sustainability Assessment, Moelgaard ApS, Siemens
Authors: Hauschild, M. Z. (Intern), Laurent, A. (Intern), Mølgaard, C. (Ekstern), Walachowicz, F. (Ekstern)
Number of pages: 1
Pages: 148-149
Publication date: 2012

Host publication information
Title of host publication: Book of abstracts - SETAC 18th LCA Case Study Symposium and 4th NorLCA Symposium: Sustainability Assessment in the 21st century - Tools, Trends and Applications
Main Research Area: Technical/natural sciences
Conference: SETAC Europe 18th LCA Case Study Symposium and 4th NorLCA Symposium, Copenhagen, Denmark, 26/11/2012 - 26/11/2012
Electronic versions:
programme_abstracts_book_31102012_v2.pdf
Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2012

Limitations of Carbon Footprint as Indicator of Environmental Sustainability
Greenhouse gas accountings, commonly referred to with the popular term carbon footprints (CFP), are a widely used metric of climate change impacts and the main focus of many sustainability policies among companies and authorities. However, environmental sustainability concerns not just climate change but also other environmental problems, like chemical pollution or depletion of natural resources, and the focus on CFP brings the risk of problem shifting when reductions in CFP are obtained at the expense of increase in other environmental impacts. But how real is this risk? Here, we model and analyze the life cycle impacts from about 4000 different products, technologies, and services taken from several sectors, including energy generation, transportation, material production, infrastructure, and waste management. By investigating the correlations between the CFP and 13 other impact scores, we show that some environmental impacts, notably those related to emissions of toxic substances, often do not covary with climate change impacts. In such situations, carbon footprint is a poor representative of the environmental burden of products, and environmental management focused exclusively on CFP runs the risk of inadvertently shifting the problem to other environmental impacts when products are optimized to become more "green". These findings call for the use of more broadly encompassing tools to assess and manage environmental sustainability.

General information
State: Published
Organisations: Department of Management Engineering, Quantitative Sustainability Assessment
Authors: Laurent, A. (Intern), Olsen, S. I. (Intern), Hauschild, M. Z. (Intern)
Pages: 4100-4108
Publication date: 2012
Main Research Area: Technical/natural sciences

Publication information
Journal: Environmental Science & Technology (Washington)
Volume: 46
Issue number: 7
ISSN (Print): 0013-936X
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 6.26 SJR 2.538 SNIP 1.889
Mapping and characterization of LCA networks
Modelling health effects from inhalation of nano-objects

Importance of linkage between LCA methodology developments and their applications in practice

Normalization in EDIP97 and EDIP2003: updated European inventory for 2004 and guidance towards a consistent use in practice
encompass all potentially harmful chemicals released in Europe, e.g. omitting some toxic metals. Conclusions: The present study provides the most updated set of publicly available normalization references for the EDIP methodology and emission inventories for Europe that may also serve for the calculation of normalization references for other impact categories. It is believed to be the best estimate available for Europe and is thus recommended for use along with the guidance provided in this study.

General information
State: Published
Organisations: Quantitative Sustainability Assessment, Department of Management Engineering
Authors: Laurent, A. (Intern), Olsen, S. I. (Intern), Hauschild, M. Z. (Intern)
Pages: 401-409
Publication date: 2011
Main Research Area: Technical/natural sciences

Publication information
Journal: International Journal of Life Cycle Assessment
Volume: 16
Issue number: 5
ISSN (Print): 0948-3349
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.43 SJR 1.328 SNIP 1.423
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.504 SNIP 1.554 CiteScore 3.49
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.736 SNIP 1.738 CiteScore 3.65
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.666 SNIP 1.979 CiteScore 3.35
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.515 SNIP 1.701 CiteScore 2.89
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.581 SNIP 1.716 CiteScore 2.82
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.447 SNIP 1.861
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.201 SNIP 1.592
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 0.863 SNIP 1.33
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.8 SNIP 1.22
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.6 SNIP 1.387
Purpose: In life cycle impact assessment, normalization can be a very effective tool for the life cycle assessment practitioner to interpret results and put them into perspective. The paper presents normalization references for the recently developed USEtox™ model, which aims at calculating globally applicable characterization factors. Normalization references for Europe and North America are determined, and guidance for expansions to other geographical regions is provided. Materials and methods: The base years of the European and North American inventories are 2004 and 2002/2008, respectively. Emission data were extracted from two literature sources referring to each of the considered regions. The inventory for North America was adapted to avoid extrapolation of data from other regions and thus bring consistency with the emission inventory for Europe. In spite of different inventory assumptions, a similar coverage of substances was obtained for both regions with relatively high representation of metals and a number of organic compounds, mainly consisting of non-methane volatile organic compounds and pesticides. The two inventory sets were eventually characterized with the characterization factors (CFs) calculated with the version 1.0 of the USEtox™ model and substance database; both interim and recommended CFs were used. Results and discussion: Normalization references are provided for Europe and North America for the three USEtox™ toxic impact categories; ratios between the normalization references for the two regions in all cases lie below a factor of 3. Causes for the observed discrepancies are found to be different inventory assumptions as well as variations in the type and intensity of actual emissions between the two regions. Additional causes are inventories that only cover a limited number of substances, and the characterization model, which can only provide interim factors for certain substances like metal compounds. Based on these causes and on a review of recent studies on normalization references, a list of substances to be prioritized when collecting emission data was built, demonstrating the importance of metals. Conclusions: In the perspective of further refining the presented normalization references and of calculating new references for other regions, guidance is provided including a list of priority substances that should be considered when building emission inventories for normalization references.

**General information**

State: Published
Organisations: Quantitative Sustainability Assessment, Department of Management Engineering, Ecole Polytechnique de Montreal
Authors: Laurent, A. (Intern), Lautier, A. (Ekstern), Rosenbaum, R. K. (Intern), Olsen, S. I. (Intern), Hauschild, M. Z. (Intern)
Pages: 728-738
Publication date: 2011
Main Research Area: Technical/natural sciences

**Publication information**

Journal: International Journal of Life Cycle Assessment
Volume: 16
Issue number: 8
ISSN (Print): 0948-3349
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Normalization references for USEtox™-based toxic impact categories: North American and European economic systems

As an optional step of the life cycle impact assessment (LCIA) phase in the ISO standards, normalization aims to express the magnitude of the impacts by comparing the characterized results against a common reference situation - the normalization references. In this study, we used inventories of two economic regions, North America and Europe, to calculate normalization references for the three currently-modelled USEtox™-based impact categories, i.e. freshwater ecotoxicity, human toxicity, divided into cancer effects and non-cancer effects. Base years for the references are 2004 for Europe and 2006 for North America. The normalization references have been calculated using recommended factors as well as interim factors, as needed. It is found that, in spite of different inventory assumptions, the normalization references fall within the same order of magnitude for both North America and Europe. By analysing the most contributing substances, metals turn out to dominate the impacts in both regions. This may be explained by the interim status of the characterization factors (CFs) for metals, which might be overestimated in the current model. Part of the explanation may also lie in the incomplete coverage of organics in both the inventory and the CF databases. With respect to the intended global character of the USEtox™ model, different approaches to determine normalization references of other economic systems (e.g. Asia or world) are discussed in relation to these findings. Overall, we thus recommend the use of the provided set of normalization references for USEtox™, but we also advocate 1) to perform an update as soon as a more comprehensive inventory can be obtained and as soon as characterization factors for metals are revised; 2) to consider extension to other economic systems in order to allow normalization in USEtox™ to be used on a global scale.

General information
State: Published
Organisations: Quantitative Sustainability Assessment, Department of Management Engineering, Ecole Polytechnique de Montreal
Authors: Laurent, A. (Intern), Lautier, A. (Ekstern), Rosenbaum, R. K. (Intern), Olsen, S. I. (Intern), Hauschild, M. Z. (Intern)
Number of pages: 131
Publication date: 2011

Host publication information
Title of host publication: SETAC Europe 21st Annual Meeting Abstract Book
Main Research Area: Technical/natural sciences
Conference: 21st SETAC Europe Annual Meeting, Milan, Italy, 15/05/2011 - 15/05/2011
Electronic versions:
SETAC_USEtox_norm_03052011.pdf
AbstractBook.pdf
Source: orbit
Source-ID: 276861
Publication: Research › Conference abstract in proceedings – Annual report year: 2011

Ability of carbon footprint to reflect the environmental burden of a product or service – an empirical study

In the context of a global awareness of the climate change, carbon footprint (CFP) has recently become extensively used as a simple way to sensitize not only consumers in their purchasing behaviours but also public opinion in general. However, limitations in its environmental representativeness arise if one decides to expand the outlook to include other environmental impacts, which are commonly evaluated in Life Cycle Assessments (LCA). In that perspective, over 500 products/services and two concrete cases are investigated, using the EDIP-methodology and the USEtox™-based toxicity-related impacts, each one updated with the latest set of characterization factors and with normalization references for the emission year 2004. Outcome of the study shows that carbon footprinting coincides well with the LCA-based global warming assessment, though divergences rise whenever NMVOC show a significant contribution in the inventory. Among other impact categories, especially the toxicity-related impacts do not correlate and show significant differences to carbon footprint results. Despite the fact that carbon footprint is a first step towards a more “environmental friendly” policy, its implications shall therefore be nuanced as they might overlook other environmentally-relevant impacts and lead to possible misinterpretations, if for instance a product presenting low CO2 emissions is qualified as “green”, even though its true environmental burden is high due to the contribution of other impacts (e.g. human toxicity).

General information
State: Published
Organisations: Quantitative Sustainability Assessment, Department of Management Engineering
Authors: Laurent, A. (Intern), Olsen, S. I. (Intern), Hauschild, M. Z. (Intern)
Publication date: 2010
Event: Poster session presented at 20th SETAC Europe Annual Meeting, Sevilla, Spain.
Main Research Area: Technical/natural sciences
environmental burden, USEtox, representativeness, Carbon footprint
Electronic versions:
SETAC_2010_CFP.pdf
Source: orbit
Source-ID: 262454
Carbon footprint as environmental performance indicator for the manufacturing industry

With the current focus on our climate change impacts, the embodied CO2 emission or "Carbon footprint" is often used as an environmental performance indicator for our products or production activities. The ability of carbon footprint to represent other types of impact like human toxicity, and hence the overall environmental impact is investigated based on life cycle assessments of several materials of major relevance to manufacturing industries. The dependence of the carbon footprint on the assumed scenarios for generation of thermal and electrical energy in the life cycle of the materials is analyzed, and the appropriateness of carbon footprint as an overall indicator of the environmental performance is discussed.
Eco-efficiency indicators for development of nano-composites

The EU FP7 funded project “NanCore” aims to develop foam nano composites. One WP addresses the environmental aspects using Life Cycle Assessments. A preliminary assessment, based on literature sources, aims to provide inputs for the further technology development in terms of eco-indicators. Four nanocomposites (5 wt%-nanofiller) were investigated; PU/CNT (in-situ polymerization), PP/CNT (in-situ polymerization), PU/clay (bulk polymerization), and PP/clay nanocomposites (bulk polymerization). Due to of lack of information, only the material stages (extraction of materials) and the production of the nanocomposites were evaluated, i.e. so-called “cradle to gate” assessment. Overall, the study emphasizes the CNT production as a main cause of impact. Variations occur depending on the type of technology considered (HiPco, FBCVD). However, acid production (for purification process), electricity production, and production of catalysts are identified as main contributors to the impacts. Regarding nano clay the main contributors to impacts on environment are the foaming process as well as the production of the reactants and the catalysts (e.g. polyol, propylene). Nano clay does not contribute significantly. Eco-indicators thus high-light the CNT production, but also foaming processes etc. as focus areas for further technology development. Potential release of nano particles during the life cycle is also a particular issue to devote consideration.

General information

State: Published
Organisations: Quantitative Sustainability Assessment, Department of Management Engineering
Authors: Olsen, S. I. (Intern), Laurent, A. (Intern)
Publication date: 2010
Event: Poster session presented at 20th SETAC Europe Annual Meeting, Sevilla, Spain.
Main Research Area: Technical/natural sciences
Electronic versions:
SETAC 2010 Nancore reduced.pdf
Source: orbit
Source-ID: 265559
Publication: Research › Poster – Annual report year: 2010

Deliverable 4.2: Methodology for including specific biological effects and pathogen aspects into LCA

As described in deliverable 4.1 (Larsen et al. 2007) NEPTUNE is using two main types of life cycle impact assessment (LCIA) methodologies when doing LCA studies on the waste water treatment technologies included. The basic methodology is the well known existing EDIP97 methodology (Wenzel et al. 1997, Hauschild and Wenzel 1998) for which the impact assessment on toxicity is PNEC based. However, in order to include the newest development on especially best available practice as regards ecotoxicity a new revised and updated EDIP 200X LCIA methodology has been
developed. A first draft of this methodology is presented here. Furthermore, special issues related to waste water have been addressed by including novel development on LCIA methodology for possible impact from pathogens and whole effluent toxicity. Special focus is also allocated to micropollutants with specific toxic mode of action (i.e. endocrine disruptors) and the possibilities and relevance of including impact categories on land use and site-specific assessments have been addressed. Further, the special problems on how to deal with land fill and how to do normalization and weighting of impact potentials are also dealt with. The problem with possible bias in normalization references is especially addressed.

**General information**

State: Published
Organisations: Quantitative Sustainability Assessment, Department of Management Engineering
Authors: Larsen, H. F. (Intern), Olsen, S. I. (Intern), Hauschild, M. Z. (Intern), Laurent, A. (Intern)
Number of pages: 111
Publication date: 2009

**Publication information**

Original language: English
Series: EU FP6 project, deliverable
Number: 4.2
Main Research Area: Technical/natural sciences
Whole Effluent Toxicity, EDIP 200X, Endocrine disrupters, Normalisation, Pathogens, LCIA methodology, Land fill

**Projects:**

**Environmental sustainability assessment of the aquaculture sector at global and national scales**

Department of Management Engineering
Period: 15/12/2016 → 14/12/2019
Number of participants: 4
Phd Student:
Bohnes, Florence Alexia (Intern)
Supervisor:
Hauschild, Michael Zwicky (Intern)
Schlundt, Jørgen (Intern)
Main Supervisor:
Laurent, Alexis (Intern)

**Financing sources**

Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU)
Project: PhD

**Development of environmental footprints for large-scale systems**

Department of Management Engineering
Period: 15/09/2016 → 14/09/2019
Number of participants: 4
Phd Student:
Leclerc, Alexandra Segolene Corinne (Intern)
Supervisor:
Hauschild, Michael Zwicky (Intern)
Wood, Richard (Ekstern)
Main Supervisor:
Laurent, Alexis (Intern)

**Financing sources**
**ECOdesign of urban buildings by integration of organic photovoltaics microgrids (ECLIPS microgrids)**

Department of Energy Conversion and Storage  
Period: 15/12/2014 → 28/02/2018  
Number of participants: 7  
PhD Student:  
Chatzisideris, Marios Dimos (Intern)  
Supervisor:  
Gevorgyan, Suren (Intern)  
Main Supervisor:  
Laurent, Alexis (Intern)  
Examiner:  
Owsianiak, Mikolaj (Intern)  
Nelson, Jenny (Ekstern)  
Nelson, Jenny (Ekstern)

**Financing sources**

Source: Internal funding (public)  
Name of research programme: Samfinansieret - Andet  
Project: PhD

**Product/Service-System Design from a Life Cycle Costing Perspective**

Department of Mechanical Engineering  
Period: 01/02/2014 → 21/09/2017  
Number of participants: 6  
PhD Student:  
Pagoropoulos, Aris (Intern)  
Supervisor:  
Maier, Anja (Intern)  
Main Supervisor:  
McAloone, Tim C. (Intern)  
Examiner:  
Laurent, Alexis (Intern)  
Andersen, Ingrid Marie Vincent (Intern)  
Isaksson, Karl Ola (Ekstern)

**Financing sources**

Source: Internal funding (public)  
Name of research programme: Samfinansieret - Andet  
Project: PhD

**Development of a Life Cycle Impact Assessment methodology for Brazil**

Department of Management Engineering  
Period: 15/12/2013 → 14/12/2017  
Number of participants: 6  
PhD Student:  
Crespo Mendes, Natalia (Intern)  
Supervisor:  
Laurent, Alexis (Intern)  
Main Supervisor:  
Hauschild, Michael Zwicky (Intern)  
Examiner:  
Olsen, Stig Irving (Intern)
Bruun, Sander (Ekstern)
Ugaya, Cassia Marie Lie (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Science Without Borders, Brasi
Project: PhD

Impacts of waterbone nitrogen emissions to hypoxia-driven marine eutrophication: modelling of damage to ecosystems in
life cycle impact assessment (LC IA)

Department of Management Engineering
Period: 15/12/2012 → 01/09/2016
Number of participants: 7
Phd Student:
Cosme, Nuno Miguel Dias (Intern)
Supervisor:
Birkved, Morten (Intern)
Rosenbaum, Ralph K. (Intern)
Main Supervisor:
Hauschild, Michael Zwicky (Intern)
Examiner:
Laurent, Alexis (Intern)
Henderson, Andrew D. (Ekstern)
Verones, Francesca (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU)
Project: PhD

Life cycle assessment applied to nanomaterials in solid waste management - Focus on human health impact assessment

Department of Management Engineering
Period: 01/05/2010 → 24/03/2014
Number of participants: 6
Phd Student:
Laurent, Alexis (Intern)
Supervisor:
Hellweg, Stefanie (Ekstern)
Main Supervisor:
Hauschild, Michael Zwicky (Intern)
Examiner:
Birkved, Morten (Intern)
Hansen, Steffen Foss (Intern)
Walser, Tobias (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: 1/3 DTU-stip, 2/3 FUR/andet
Project: PhD

Activities:

Energy Modelling Platform for Europe (EMP-E) 2017
Period: 18 May 2017
Alexis Laurent (Participant)
Department of Management Engineering
Quantitative Sustainability Assessment

**Description**
Assessing environmental impacts of future energy systems: A holistic LCA model for Europe in 2015-2050

**Related event**

Energy Modelling Platform for Europe (EMP-E) 2017
17/05/2017 → 18/05/2017
Brussels, Belgium
Activity: Attending an event › Participating in or organising a conference

**SETAC Europe: 27th Annual Meeting – Environmental Quality Through Transdisciplinary Collaboration**
Period: 9 May 2017
Alexis Laurent (Participant)

Department of Management Engineering
Quantitative Sustainability Assessment

**Description**
Estimating soil emissions and toxicity impacts from the application of livestock manure: application to heavy metals at national scale

**Related event**

SETAC Europe: 27th Annual Meeting – Environmental Quality Through Transdisciplinary Collaboration
07/05/2017 → 13/07/2017
Brussels, Belgium
Activity: Attending an event › Participating in or organising a conference

**Globally-differentiated land use flow inventories for life cycle impact assessment**
Period: 8 May 2017
Alexis Laurent (Speaker)
Maria Faragò (Other)
Lorenzo Benini (Other)
Michela Secchi (Other)
Serenella Sala (Other)

Department of Management Engineering
Quantitative Sustainability Assessment

**Related event**

SETAC Europe: 27th Annual Meeting – Environmental Quality Through Transdisciplinary Collaboration
07/05/2017 → 13/07/2017
Brussels, Belgium
Activity: Talks and presentations › Conference presentations

**Position of existing footprints in the environmental sustainability landscape**
Period: 8 May 2017
Alexis Laurent (Speaker)

Department of Management Engineering
Quantitative Sustainability Assessment
Degree of recognition: International

**Related event**

SETAC Europe: 27th Annual Meeting – Environmental Quality Through Transdisciplinary Collaboration
07/05/2017 → 13/07/2017
Brussels, Belgium
Life cycle assessment of electric vehicle deployment in Copenhagen with a systemic perspective
Period: 1 Feb 2016 → 15 Jun 2016
Jay Sterling Gregg (Supervisor)
Alexis Laurent (Main supervisor)
Department of Management Engineering
Systems Analysis
Quantitative Sustainability Assessment

Description
Master's Thesis
Florence Alexia Bohnes
s141069