Nanotechnology and Life Cycle Assessment. A systems approach to Nanotechnology and the environment - DTU Orbit (04/03/2019)


This report summarizes the results of “Nanotechnology and Life Cycle Assessment,” a twoday workshop jointly convened by the Woodrow Wilson Center Project on Emerging Nanotechnologies; the United States Environmental Protection Agency Office of Research and Development; and the European Commission, RTD.64 “Nano S&T: Converging Science and Technology” Held in October 2006, the workshop involved international experts from the fields of Life Cycle Assessment (LCA) and nanotechnology. The main program of the workshop consisted of introductory lectures, group discussions and a final plenary session. A writing group prepared the initial draft of this report based on workshop discussions, and the final report was reviewed by all workshop participants and outside experts. The contents are based on the results of the group discussions. The structure of this report follows the main topics identified and discussed by the groups. The purpose of the workshop was to determine whether existing LCA tools and methods are adequate to use on a new technology. This document provides an overview of LCA and nanotechnology, discusses the current state of the art, identifies current knowledge gaps that may prevent the proper application of LCA in this field and makes recommendations on the application of LCA for assessing the potential environmental impacts of nanotechnology, nanomaterials, and nanoproducts. For the purposes of this report, “nanoproducts” are defined as products containing nanomaterials. A short version of this report will be published in an appropriate LCA and/or a technical nanotechnology journal. The following presents a summary of the main conclusions and recommendations identified by the workshop participants and presented in this report. Main Conclusions: · There is no generic LCA of nanomaterials, just as there is no generic LCA of chemicals. · The ISO-framework for LCA (ISO 14040:2006) is fully suitable to nanomaterials and nanoproducts, even if data regarding the elementary flows and impacts might be uncertain and scarce. Since environmental impacts of nanoproducts can occur in any life cycle stage, all stages of the life cycle of nanoproducts should be assessed in an LCA study. · While the ISO 14040 framework is appropriate, a number of operational issues need to be addressed in more detail in the case of nanomaterials and nanoproducts. The main problem with LCA of nanomaterials and nanoproducts is the lack of data and understanding in certain areas. While LCA brings major benefits and useful information, there are certain limits to its application and use, in particular with respect to the assessment of toxicity impacts and of large-scale impacts. Within future research, major efforts are needed to fully assess potential risks and environmental impacts of nanoproducts and materials (not just those related to LCA). There is a need for protocols and practical methodologies for toxicology studies, fate and transport studies and scaling approaches. · International cooperation between Europe and the United States, together with other partners, is needed in order to address these concerns. · Further research is needed to gather missing relevant data and to develop user-friendly eco-design screening tools, especially ones suitable for use by small and medium sized enterprises. Key Recommendations 1. Case-studies/prioritizing efforts With limited resources, a case-study research approach could be adopted to significantly enhance knowledge on environmental impacts of nanomaterials and nanoproducts. 2. LCA studies and presentations of results Any LCA study on nanoproducts and nanomaterials most likely suffers from high uncertainty issues. Therefore, the report recommends: · Do not wait to have near-perfect data. · Be modest about uncertainties; clearly state relevant uncertainty aspects and assumptions. · Draw conclusions in the case of major or significant improvements; otherwise, state that the nanoproducts and the conventional product are equivalent. · At this early stage, studies should focus on protecting humans and the environment. · Separate the category indicators, grouping them by relevance/uncertainty. · Avoid overselling the benefits of the new nanoproduct, since assessment methodologies will improve and might show “problems” in the future. · Work with toxicologists and other scientists (geographical and socio-economic impacts) to review data and bound the issue. · Make disaggregated data available for future LCA comparisons. 3. Approaches · Critical review should always be done to ensure credibility of LCA studies. · An independent review should be made by an expert panel with balanced representation and wide range of expertise. · Data for the critical review or other supporting data should be published. · Panels of interested parties should be formed to establish rules for LCA of nanomaterials and nanoproducts. 4. Actions from stakeholders Different stakeholders/authorities can potentially support the application and use of LCA for nanoproducts and nanomaterials through a large set of actions. Government actions could include: · Setting up research frameworks and programs for the methodology development of LCA in the field of nanotechnology and with nanoproducts. · R&D activities, with special emphasis on multinational cooperation in fields related to health and environmental safety. · Use of LCA results to design adapted economic instruments. · Using LCA to help develop green purchasing and integrate nanotechnology criteria in green purchasing. · Allocating a portion of current nano research funding to nano/LCA research to make it more attractive to the private sector for further R&D. · Providing independent, standardized and reviewed LCA information that might be used by industry and other stakeholders. · Covering different nanotechnologies’ flows of substances (air emissions, water releases etc.) into the European Commission’s “European Reference Life Cycle Data System” (ELCD), and the US Life Cycle Impact database. · Working toward an international LCI database for nanomaterials. · Improving data coordination among different government agencies, e.g., agencies responsible for product consumer safety evaluations, workplace safety evaluations and environmental issues. Academia can potentially support the application and use of LCA to nanoproducts and nanomaterials through a large set of actions, including: · Setting up databases for LCA case studies on nanotechnology and nanoproducts. · Providing scholarships to the universities to hire Ph.D. students specifically for nano/LCA research. · Carrying out research in LCA methods and applied to nanotechnology and nanoproducts. Industry can potentially support the application and use of LCA to nanoproducts and nanomaterials through a large set of actions, including: · Undertake R&D activities. · Use of LCA results to design improved products. · Co-funding research on developing LCA methods, impact characterization metrics specific to nanotechnologies. · Co-funding research on toxic effects of specific nanomaterials. · Co-funding social science research on public concerns about nanotechnology and on developing effective risk-communication strategies using LCA data. · Actively creating mechanisms for sharing confidential data without compromising competitiveness. The report also notes...
that the insurance industry should play a leading role in assessing life cycle risk assessments of nanoproducts. NGO and Consumer Associations can potentially support the application and use of LCA to nanoproducts and nanomaterials through a large set of actions, including: · Communicating LCA study results to the public to inform consumers. · Educating themselves and promoting LCA as a tool to assess nanotechnology.

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