

Life Cycle Assessment: A Comprehensive Tool for Environmental Impact Evaluation and Sustainable Decision-Making

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Life Cycle Assessment (LCA) has emerged as a critical methodological framework for evaluating the environmental impacts of products, processes, and systems throughout their entire life cycle—from raw material extraction through production, use, and disposal. In this introductory lecture, we will explore the fundamental principles and applications of LCA, underscoring its importance in guiding sustainable decision-making across various sectors.

The presentation will begin with an overview of LCA's role in identifying and quantifying environmental burdens associated with different stages of a product's life cycle. We will delve into the four main phases of LCA as defined by ISO 14040: goal and scope definition, inventory analysis, impact assessment, and interpretation. Each phase will be examined in detail, highlighting the methodological choices and assumptions that can influence the outcomes of an LCA study.

A critical aspect of this discussion will be the examination of how our intuitive perceptions of sustainability often lead to misleading conclusions. Many products or processes that seem environmentally friendly at first glance may, in fact, have significant hidden impacts that are only revealed through a rigorous, quantitative analysis. For example, materials marketed as “green” or “eco-friendly” may have substantial environmental costs associated with their production or disposal, which are not immediately apparent without a thorough LCA. This underscores the importance of using robust tools like LCA to move beyond superficial assessments and make decisions based on comprehensive, scientifically grounded data.

We will also address the challenge of balancing comprehensiveness with practicality in LCA, discussing how the depth of analysis can be tailored to specific objectives, whether for eco-design, regulatory compliance, or corporate sustainability strategies. The lecture will further explore the integration of LCA with other assessment tools, such as Life Cycle Costing (LCC) and Social Life Cycle Assessment (S-LCA), to provide a more holistic view of sustainability.

In closing, the lecture will highlight current trends and future directions in LCA research, including the development of more sophisticated impact assessment methods and the increasing emphasis on data quality and transparency. Attendees will gain a solid understanding of LCA's potential to contribute to more informed and responsible decision-making, ultimately supporting the transition to a more sustainable and circular economy.

This session is designed to provide both newcomers and experienced practitioners with a comprehensive introduction to the principles, methodologies, and applications of LCA, equipping them with the knowledge necessary to apply LCA in their own professional contexts.