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PILLAR 1

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**Life Cycle Sustainable Trade-offs:
Implications for material and product
development**

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Life Cycle Analysis and Its Applications

- LCA analyses through following European codes and standard intend to independently, transparently and accurately verify and communicate the environmental impact of different products in compliance with EN 15804 and ISO 14025.
- The main objective of LCA is to inform decision makers, whether consumers, industries and manufacturers or government policy makers, in taking actions that will minimise environmental impacts of processes and materials whilst also supporting strategic planning.



Image reference: Blonk Consultants

LCA/Target Stakeholder Groups/Technical and Methodological Challenges

1) End-users of LCA span a wide spectrum of interests:

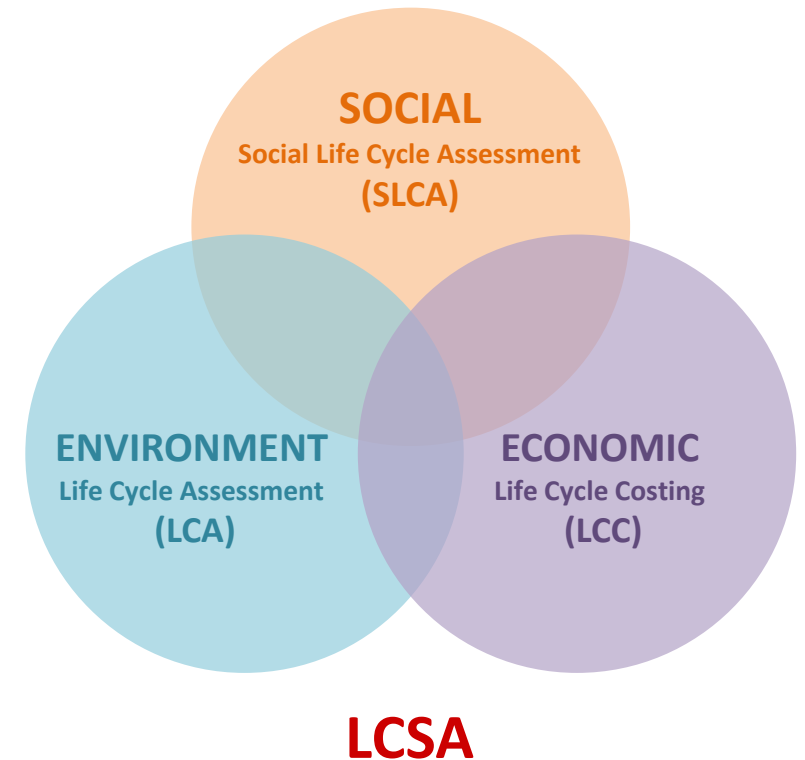
- **Process and Product developers:** Incorporate environmental considerations into their design process to avoid potential unforeseen risks.
- **Consumers:** Understanding the environmental impact of products and their alternatives in the market, while also bringing pressure to bear on producers and government legislators.
- **Regulators and policy makers:** Informing the development of environmental policies and mechanisms to enforce legislative objectives.

2) LCAs Technical and Methodological Challenges:

- **Availability of Data:** LCA is an intensively data-driven approach which relies on availability of adequate, high quality data.
- **Inconsistent parameters of assessment:** Sources of accurate and exhaustive data are based on different parameters of assessment including functional units, system, the LCI databases, the End-of-Life (EoL) scenarios.
- **Life Cycle Inventory techniques:** The discrepancies associated with data generated using different LCI techniques for the same case study are considerable. The available LCI techniques include process, input-output and hybrid methods.

Life Cycle Sustainable Analysis (LCSA)

- LCAs however are mainly concentrated on environmental issues and therefore not considering economic and social impacts and mechanisms.
- To extend the boundaries of current LCA, three mechanisms have been proposed:
 - 1) Including social and economic indicators,
 - 2) Broader assessment level: product-level to national and global levels,
 - 3) Including interrelations among the system elements, uncertainty analysis and stakeholder involvement.
- With these developments, LCA has been evolving into a new framework called Life Cycle Sustainability Assessment (LCSA).



Life Cycle Sustainability: Complexities and Trade-Offs

- LCSA is potentially a comprehensive multi-criteria quantitative sustainability assessment system, comprising a network of causal interdependent activities/indicators which allows tracking impacts over supply chains.

However, there are various challenges associated with applications of LCSA framework:

- Understanding a system's dynamic and causal nature, and predicting future impacts
- The selection of indicators to formalise connections between sub-systems remains as a challenging point of LCSA framework.
- Interpretation, weighting and aggregating multi-criteria results.
- Identifying/defining relationships among different sub-systems, its associated increased uncertainties
- Imbalanced development of the three legs of LCSA.

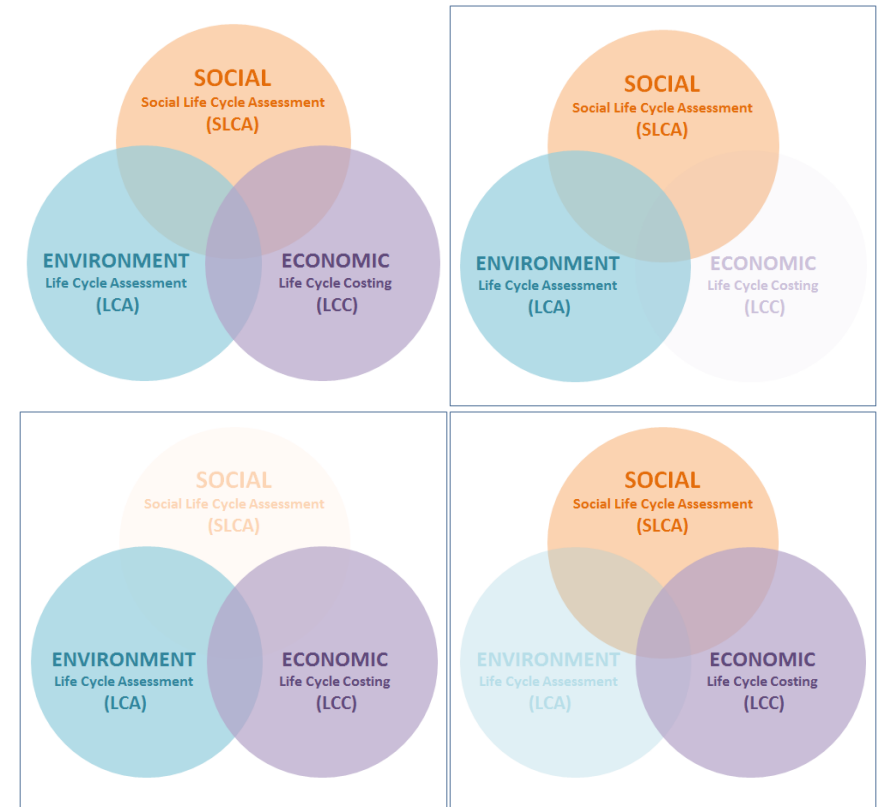
In a system, environmental trade-offs/burdens and socio-economic benefits may conflict fundamentally. To overcome issues associated with such multi-criteria trade-offs, developing/adopting effective methodologies seems necessary.

Avoiding Inappropriate Sustainability Trade-offs

Trade-offs occur everywhere in the practical world of environmental assessment throughout the process at various stages and scales:

- Decisions on how much resources are allocated to the assessment,
- Choices about what indicators to include, what alternatives to consider, what design features to incorporate, what enhancements and mitigations to consider adequate, time horizon to consider
- what activities to approve with what conditions and implementation controls, and many more.

Most significantly, trade-offs are about the anticipated effects resulting from these choices, including the predicted associated impacts and risks.



Unavoidable Sustainable Trade-offs and Their Implications

- Effective integration of various methods and tools with an interdisciplinary perspective to address the sustainability issues.
 - Avoiding trading off the short-term imperatives for longer term requirements of the system and vice versa.
 - Different needs and nature of the engaged stakeholders need to be acknowledged.
 - Development of a common and harmonised system is the most important challenge for advancement of LCSA to address complex issues.
 - Effective communication and dissemination strategies.
- *The industrial eco-systems similar to the natural ecosystems are extensive networks of interconnected activities. In such networks the size of a particular indicator is not necessarily a true representative of its effect. Care therefore must be taken where sustainable trade-offs are being considered so that the burden from one activity is not transferred to another part of the system with an even larger impact.*

