

Outline of lecture

After this lecture you should:

- Know **the basics** about Life Cycle Thinking (LCT) and Life Cycle Sustainability Assessment (LCSA)
- Be able to **apply** (parts of) it on a case
- Know about the **main challenges** related to LCSA

Life Cycle Thinking (LCT)

- Life Cycle Thinking = Life Cycle Perspective
- LCT is an approach for more sustainable practices for the future
- Objective:
 - to incorporate sustainable development in decision-making processes by applying LCT to the environmental, social and economic impacts of a product over its entire life cycle and value chain⁷
- Method: Life Cycle Sustainability Assessment (LCSA)
 - “evaluation of all environmental, social and economic negative impacts and benefits in decision-making processes towards more sustainable products throughout their life cycle.”⁷

Development in the LCA field

- **The Past of LCA (1970-2000)⁶**

- *1970-1990: Decades of Conception:*

- environmental issues became a public concern;
 - conception of LCA: widely diverging approaches, terminologies, and results.
 - lack of international scientific discussion and exchange platforms for LCA.

- *1990-2000: Decade of Standardization:*

- coordination activities;
 - development and harmonization of methods (SETAC);
 - standardization of methods and procedures (ISO).

LCA and sustainability assessment

- Life cycle assessment is an elaborated methodology, but is it appropriate for sustainability assessment?

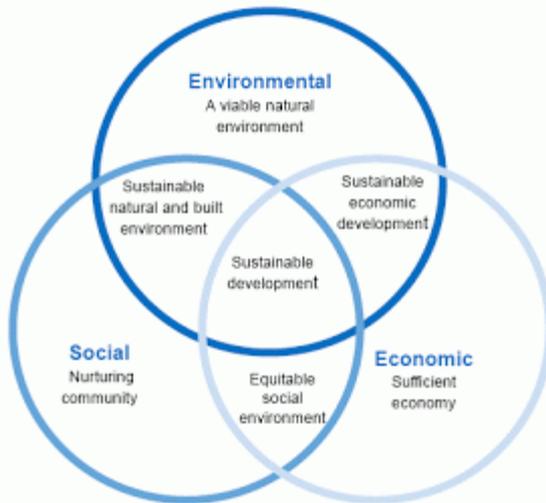
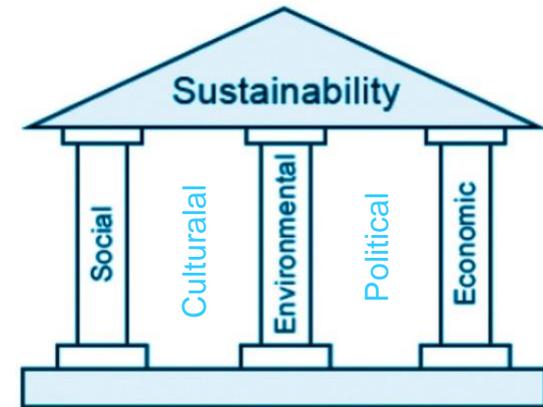


Sustainable Development and Sustainability

Definition in the Brundtland Report:

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs".

(Our Common Future, 1987)



Sustainability is considered to be:

- "the main political goal for the future development of humankind"²; and
- "the ultimate aim of product development"¹.

LCA cannot assess sustainability in a holistic perspective

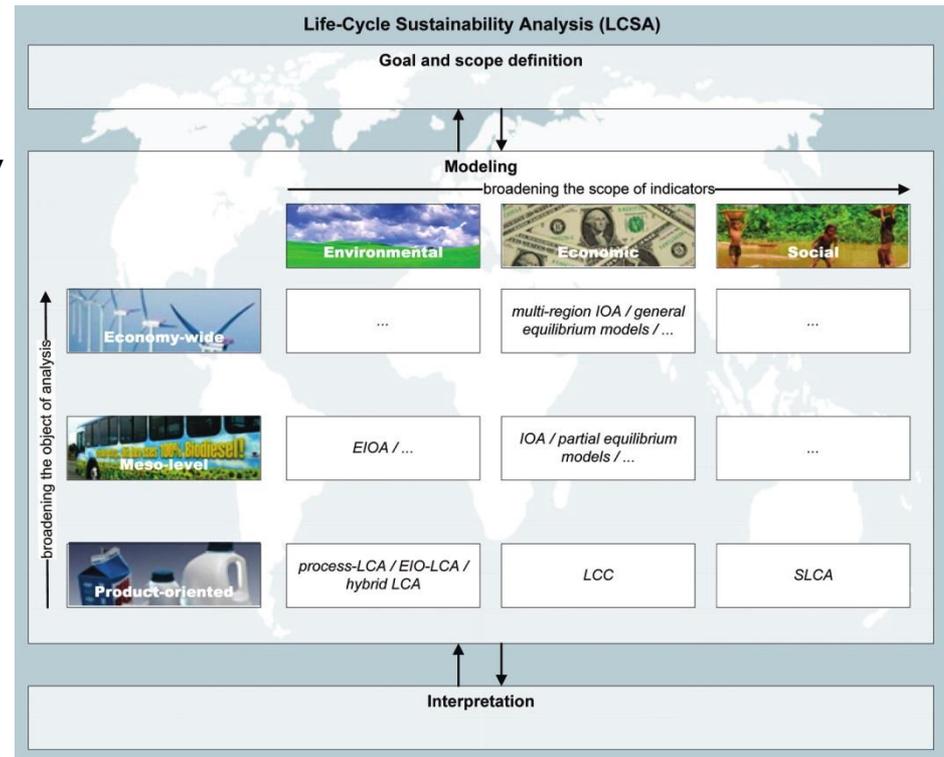
Further development of LCA

- **The Present of LCA (2000-2010): Decade of Elaboration⁶**
 - putting life cycle thinking into practice and improving the supporting tools through better data and indicators not only for environmental but also social assessment (UNEP-SETAC Life Cycle Initiative)^{6, 7}
 - emergence of other life cycle based methods (life cycle costing and social life cycle assessment), which are expected to have consistency problems with environmental LCA in terms of system boundaries, time perspectives and calculation procedures
- **The Future of LCA (2010-2020): Decade of Life Cycle Sustainability Analysis⁶**

Life Cycle Sustainability Analysis

Trans-disciplinary integration framework for models and methods from various disciplines, chosen for addressing a specific life cycle sustainability question⁶.

- Broadens the scope of indicators by including economic and social dimensions of sustainability in addition to the environmental;
- Broadens the object of analysis by including sector and economy levels in addition to the product level.⁶



How to assess sustainability in a life cycle perspective?

- Kloepffer's framework for life cycle sustainability assessment aiming at quantitative sustainability assessment of products (goods and services).

$$\text{LCSA} = \text{LCA} + \text{LCC} + \text{SLCA}^1$$

where

- LCSA is life cycle sustainability assessment
- LCA is environmental Life Cycle Assessment
- LCC is life cycle costing
- SLCA (S-LCA) is social life cycle assessment

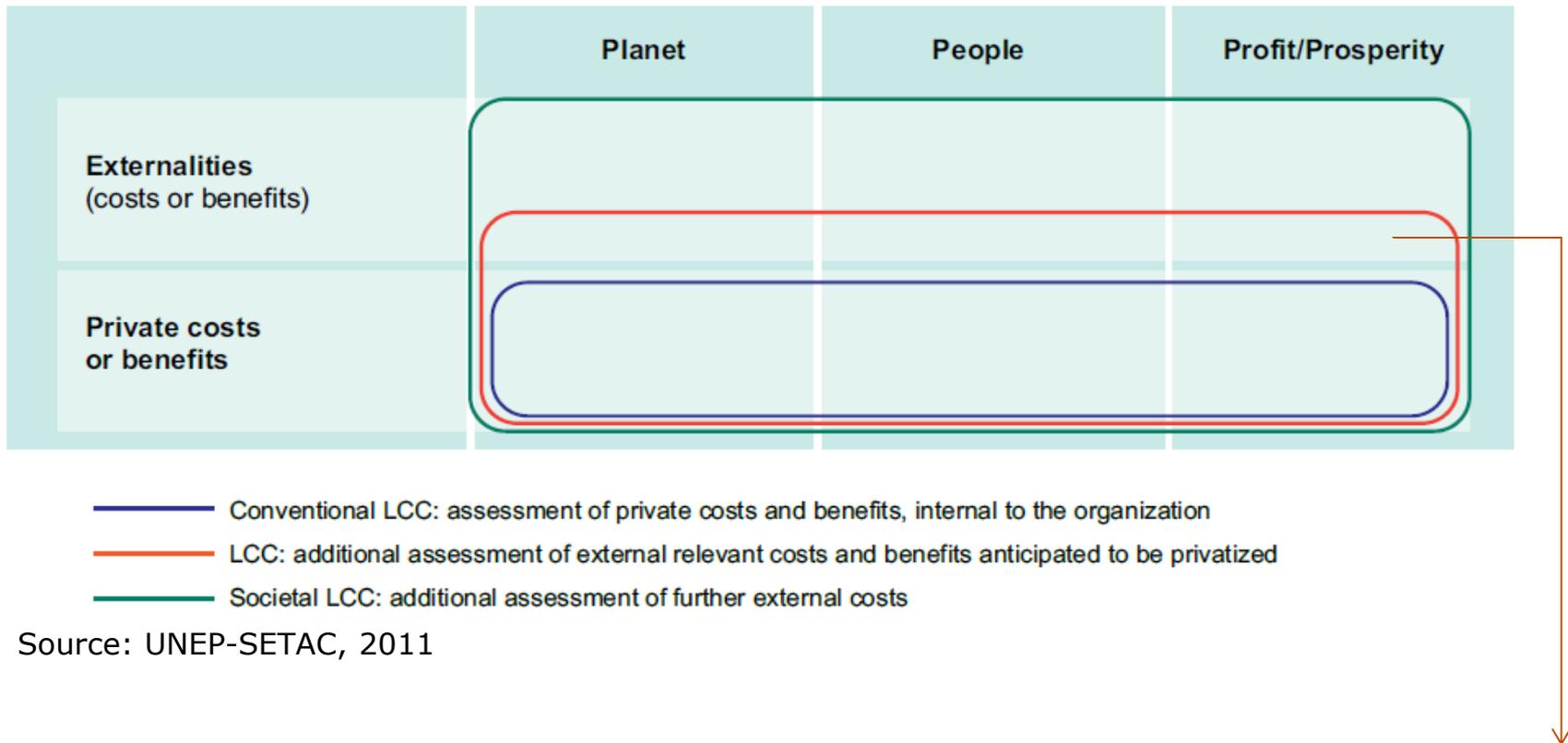
- The results of each assessment should be interpreted in combination with the results of the other two assessments
- Integrated decision-making based on life cycle thinking⁷

	LCA	LCC	SLCA
Goal	Assessment of environmental impacts	Assessment of economic impacts	Assessment of social impacts
Scope	Functional unit, system boundaries		
Inventory	Mass and energy	Cost and benefits	Working conditions Local community development
Impact assessment	Classification Characterization Normalization Weighting	Aggregation	Classification (built-in) Characterization Normalization Weighting
Unit of result	kg substance-eq, PE, wPE	Currency (e.g. EURO, USD, DKK)	hours (of work), number (e.g. accidents), description
Interpretation &
Integration of results	Decision-making		

Life Cycle Costing

- the oldest of the three assessments:
 - 1933: United States of America General Accounting Office (GAO) requested an assessment of the costs of tractors that considered a life cycle perspective in a Request for Tender⁷;
 - 1960s: U.S. Department of Defense for the acquisition of highcost military equipment⁶;
 - financial cost accounting approach.
- Assesses economic impacts in the life cycle of a product.
- Three types of LCC:
 - conventional LCC;
 - LCC;
 - Societal LCC.

Types of LCC



- a new tax on CO₂;
- a subsidy for engaging unskilled people

Environmental LCC

- Compatible with LCA and SLCA, but can also be performed as a stand-alone assessment;
- Covers all costs associated with the life cycle of a product (including use and end-of-life phases) that are directly covered by one or more of the actors in that life cycle;
- Costs must relate to real money flows in order to avoid overlap between environmental LCA and LCC;
- Steady-state nature;
- Monetization of future external costs is excluded to avoid double counting;
- Costs occurring in the future (e.g. due to climate change) are difficult (even impossible) to estimate;
- No impact assessment phase: aggregation of costs per cost category per functional unit (in currency terms).

Some LCC Application Areas

- Products with long life cycles and use phases (e.g. buildings, infrastructure, railways, trains and aviation projects);
- “Green” products:
 - should be profitable and not unreasonable expensive to be accepted by the market;
 - LCC information may lead to better decisions encompassing the needs of future generations.
- Public procurement;
- Monitoring of costs under different scenarios.

Conducting LCC (1)

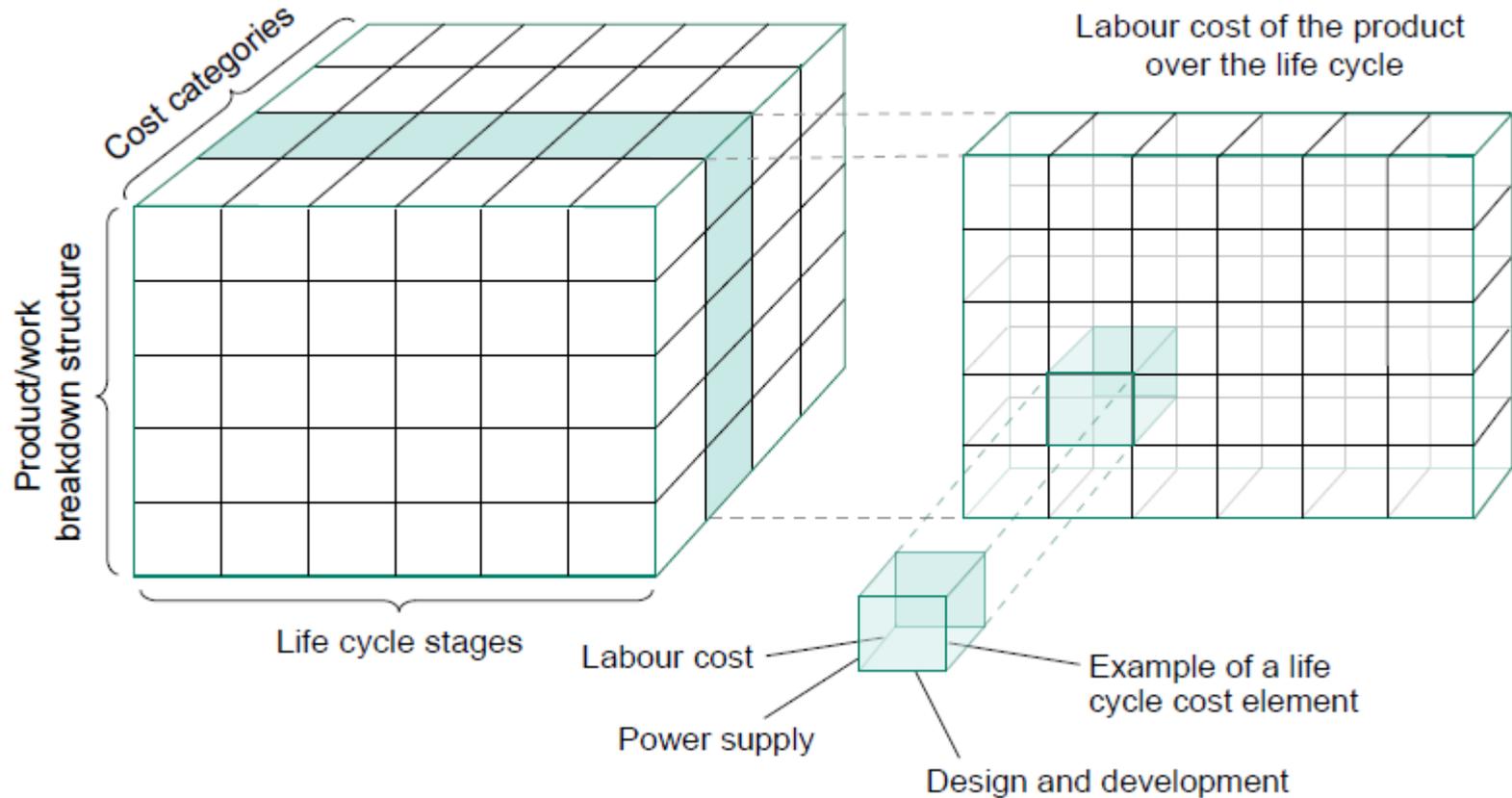
- **Goal, scope and functional unit definition:**

- *apply allocation procedures,*
- *choose discount rates:*
 - converting future costs into a present value for current decision-making;
 - *in cases of* durable goods with cost flows in the future;
 - no consensus on which discount rate should be applied for an LCC, therefore a sensitivity analysis is recommended.
- *state viewpoint of the life cycle actor* (e.g. supplier, manufacturer, user or consumer);
- develop cost breakdown structure to facilitate data collection and aggregation.

- **Inventory costs:**

- costs are *inventoried on a unit process level*;
- *allocation of costs to each product (revenue, working hours)*;
- *3 dimensions of costs*

3 Cost Dimensions



Source: UNEP-SETAC, 2011

Conducting LCC (2)

- ***Aggregation of costs by cost categories:***

- costs are aggregated by cost categories;
- LCC for supply chains more difficult due to different costing systems in different countries.

- ***Interpretation of results***

- ***Future research needed for:***

- definition of cost categories,
- data availability and data quality assessment and assurance.

Social Life Cycle Assessment

- 1980s: First discussions on how to deal with social and socio-economic aspects in the life cycle of products;
- 1980s-1990s: Initiatives on combining social and environmental aspects:
 - 1987: German *Projektgruppe oekologische Wirtschaft* (Project Group on Ecological Economics within Öko- Institut);
 - 1993: SETAC workshop report on a conceptual framework for LCIA (Fava et al., 1993).⁷
- 2010s: Recognized need for integration of social criteria into LCA:
 - UNEP/ SETAC Life Cycle Initiative:
 - *2009: Guidelines for Social Life Cycle Assessment of Products*
 - key experts in the field of social responsibility, sustainability and life cycle assessment were involved;
 - based on the consensus that LCA does not engage in important issues in developing countries⁷.
 - Research groups: DTU, Montpellier, etc.
 - Case studies: notebook computer, roses, etc.

Exercise: Life Cycle Sustainability Assessment

- Choose a product
- Define functional unit and system boundaries
- Identify and discuss challenges at:
 - LCI: e.g. data collection;
 - LCIA
 - Interpretation
 - Decision-making

Industry & Sustainability

- Interpretation of sustainability in industry:

Triple Bottom Line (TBL): People, Planet, Profit

- Purpose of TBL: to measure the social and environmental impacts of an organization's activities and relate them to its economic performance in order to demonstrate improvement or to make an evaluation.⁷
- Thus, TBL encourages an integrated approach of sustainability assessment on the basis of the three pillars of sustainability.
- Life cycle assessments can contribute to TBL accounting by providing reliable, robust and comprehensive sustainability assessment results⁷

LCSA and CSR

- LCT and LCSA can provide “information for managing ‘social responsibility’ of an organization and its value chain – from the ‘cradle to the grave’ – taking into account all dimensions of sustainable development.”⁷
- CSR Initiatives:
 - UN Global Compact,
 - OECD Guidelines for Multinational Enterprises,
 - ISO 26000 (Guidance on Social Responsibility),
 - Global Reporting Initiative (GRI).

Potential Benefits of LCSA⁷

- Providing a framework for structuring of complex environmental, economic and social information and data.
- Clarifying trade-offs between the three sustainability pillars, life cycle stages and impacts, products and generations.
- Facilitating industries in becoming more socially responsible by considering all impacts from their products and services.
- Promoting awareness in value chain actors on sustainability issues.
- Identifying weaknesses and enabling improvements of a product life cycle (product design).
- Facilitating decision-making related to sustainability of products.

Outline of lecture - *revisited*

After this presentation you should know:

- ✓ • What Life Cycle Sustainability Assessment (LCSA) is
- ✓ • Be able to apply (parts of) it on a case

- ✓ • Know about the main problems related to LCSA
 - Challenges in data collection
 - Integration of assessments

If you want to learn more?: Brief intro to LCSA - Life Cycle Sustainability Assessment

LCSA = SLCA + LCA + LCC

(corresponding to "People + Planet + Prosperity")

- A very young discipline! – no mature methodology
- Assessment and *visualisation* of results:
"The Dashbord Project" by the EU Commission's JRC:
<http://esl.jrc.ec.europa.eu/>



- UNEP Guide (2011)

DTU Management Engineering
Department of Management Engineering



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 - 5) Sustainability 3 picture: <http://www.thegreenmarketoracle.com/2013/09/understanding-sustainability-enduring.html>
 - 6) Life Cycle Assessment: Past, Present, and Future. J E R O E N B . G U I N E E , R E I N O U T H E I J U N G S , A N D G J A L T H U P P E S , A L E S S A N D R A Z A M A G N I , P A O L O M A S O N I , A N D R O B E R T O B U O N A M I C I , T O M A S E K V A L L A N D T O M A S R Y D B E R G , Environ. Sci. Technol. 2011, 45, 90–96
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Thank you for your attention!