SCORELCA

STUDY N° 2016-03

Life Cycle Costing: methodological description and implementation

Executive Summary

April 2018

Scientific Coordinators :

José Rafael Dulbecco, Isabelle Descos, Tom Huppertz Bernard De Caevel
RDC Environment - Avenue Gustave Demey 57 - 1160 BRUSSELS
Belgium

In collaboration with **Andreas Ciroth**
GreenDelta GmbH, Müllerstrasse 135, 13349 Berlin
Germany

SCORELCA is an association that has been created to financially support collaborative research on LCA and related topics. It aims to promote and organize cooperation between companies, institutional and scientists in order to support the evolution of LCA methods and its practical implementation at European and international level.

✓ This work has been supported by ADEME (Agence de l'Environnement et de la Maîtrise de l'Energie) www.ademe.fr

✓ The views and recommendations expressed in this publication are those of the authors and do not necessarily reflect, unless otherwise stated, the views of all members of SCORELCA.

✓ The information and conclusions presented in this document were established on the basis of scientific and technical data and regulatory and normative framework in force at the date of the publication of documents.

Introduction - purpose of the study

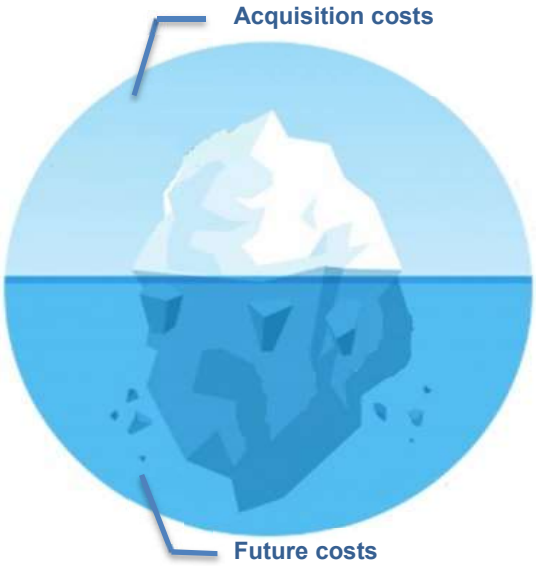
The *Life Cycle Costing* (LCC) is an economic tool which allows cost structure analysis of a specific object throughout its life cycle.

Through their convergent approach, certain complementarities between LCC and LCA have been identified: a combined application could help decision-makers find cost-effective solutions, while minimizing their environmental impact.

This study aims to provide the keys to understand LCC, its concepts, its scope of use as well as its theoretical and conceptual limits. It also presents operational elements such as: the current methods of application, the means available for its implementation and the possibilities of coupling it with LCA.

I. What is Life Cycle Costing?

The LCC is an economic tool that evaluates the costs of an object or system (usually a project or process) throughout its life cycle. This tool calculates, within a defined time scale, all the costs generated by the asset at each stage of its life cycle. The stages are, in the case of a product for example, development, production, use, maintenance and end-of-life.



The life cycle cost of an object, i.e. the result of the LCC, is therefore the sum of all the costs that will be generated by the object from its design to the end of its useful life, discounted to their present value.

The LCC can consider:

- Only internal costs

  Internal costs are those incurred directly by an individual or organization for the production, purchase or use of a product.

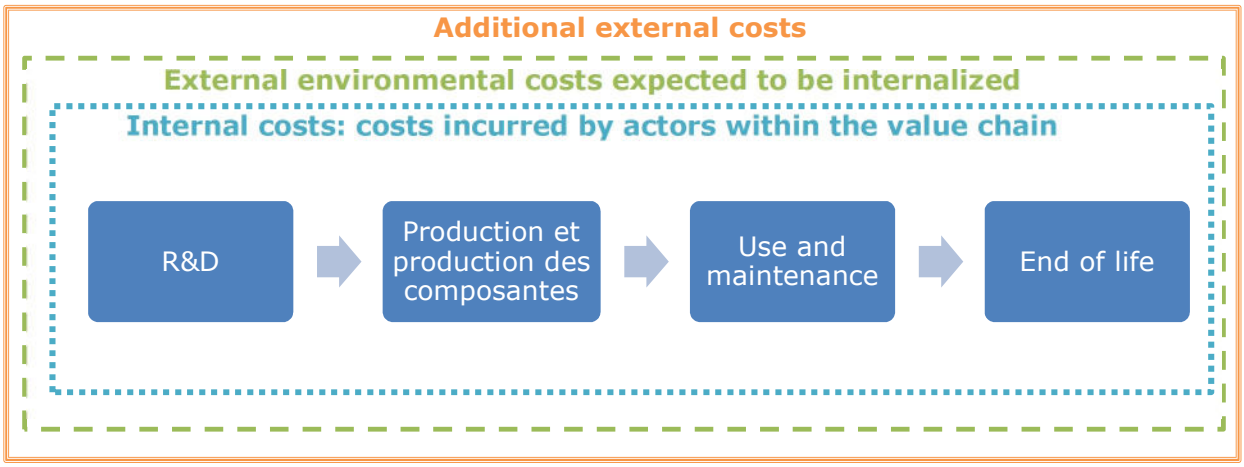
- Internal + external costs

  External costs are those that are not necessarily included in the transaction costs between the supplier and the buyer and are referred to as externalities.

II. Types of LCC

Three categories of LCC application are identified in the literature:

- ***Conventional LCC***: internal cost evaluation; the life cycle evaluation can be restricted to a single actor; no parallel LCA application.
- ***Environmental LCC:*** additional assessment of external environmental costs (externalities) expected to be internalized in the future decision-making process; parallel LCA to be carried out.
- ***Societal LCC:*** evaluation of all additional external costs (externalities)



II.1.1. CONVENTIONNEL LCC

This is the traditional application of the LCC. This approach is based on a purely economic evaluation. It generally includes the costs associated with an object that are **directly incurred by an actor involved in the life cycle chain** (usually the buyer/user). Costs associated to externalities (non-internalized impacts), such as pollution, are excluded.

II.1.2. ENVIRONMENTAL LCC

The LCC may also **include environmental externalities generated by the object**, such as greenhouse gas emissions or other pollutants. This heard version of the LCC is referred to as Environmental Life Cycle Costing (E-LCC). In practice, internal costs are the same costs as those considered in a conventional LCC to which are added **the environmental externalities related to the product life cycle (external costs) that are likely to be internalized in the future**.

II.1.3. SOCIETAL LCC

Societal Life Cycle Costing's (S-LCC) objective is to include in the LCC calculation -in addition to internal costs- all environmental and social impacts of the object under study, i.e. all external costs associated with environmental and social externalities. Since the S-LCC considers a broader macroeconomic system, costs related to internal transfers within the system, such as subsidies and redistributive taxes, should not be included.

II.1.4. UTILITÉS DES DIFFÉRENTS TYPES DE LCC

Table 2: Example of LCC inputs by type of actor and scope of study

Use		Buyer	Producer
Internal	Conventional	• Choose the investment/purchase option that minimizes the acquisition, opportunity, use and end-of-life cost of an object • Know the cost factors to assess future financial resource requirements	• Choose the production strategy that minimizes life cycle costs and thus improves its competitiveness • Know the cost factors to make strategic choices regarding resource allocation and identify risks • Assess the economic viability of projects or products
	E-LCC (additional objectives to those of the conventional).	• Choose the environmentally responsible investment/purchase option that considers both environmental impact and life cycle costs	• Choose an eco-efficient production strategy that minimizes environmental impact and life cycle costs.
	S-LCC (idem)	• Choose the sustainable investment/purchase option that considers environmental and social impact as well as life cycle costs	• Choose a sustainable production strategy that minimizes environmental and social impact and life cycle costs
External	Conventional	• Communicate responsible budgeting practices that consider future costs, not just present ones	• Communicate on the product's competitiveness, considering use and end-of-life costs
	E-LCC (additional objectives to those of the conventional).	• Communicate environmentally responsible investment/purchasing practices	• Communicate on eco-responsible production practices • Highlighting ecological products
	S-LCC (idem)	• Communicate sustainable investment/purchase practices	• Communicate sustainable production practices • Promote sustainable products

III. LCC implementation

III.1. Methodology

Several industry guidelines and references on LCC implementation have been published. Kawauchi and Rausand (1999) synthesized these different methodologies and proposed a six-step structure:

	1	2	3	4	5	6
Step	Clearly define the objective	List cost items	Establish the model	Collect data	Take into account the time horizon	Calculate results and perform sensitivity analyses
What am I supposed to do?	The questions to be answered: • What objective? • What perspective? (buyer, buyer and producer) • Are external costs taken into account? • What scope? (internal or external use)	Identify costs : • internal - associated with the life cycle • external - (environmental and social) and then monetize them	• Establish the equations	• Identify data sources • Estimate not available data	• Discount costs for periods of more than 2 years • Take price trends into account (deduct discount rate by inflation rate)	
Practical advice		• Allocate indirect costs via: Activity Based Costing or direct cost allocation • Approaching costs through prices if "financial" approach	Avoid double counting: • of incoming costs • environmental and social impacts	• Using available data (public database or supplier data) • Characterize their quality	• Discount rate value: 0-15% generally • Private sector: internal rate of return (IRR) or weighted average cost of capital (WACC) • Public sector: sovereign rates • Private consumer: commercial interest rate • If "sustainable" approach, lower discount (0.01 to 2%)	Conduct sensitivity analyses on: • discount rate • inflation rate • influential and/or uncertain data

Figure 4: LCC milestones and key issues/recommendations to remember

III.2. Available tools

III.2.1. DATABASES

There is no specific database for LCC, as is the case for the practice of LCA (Ecoinvent databases, GaBi...).

- For economic data on prices, LCC practitioners should refer to national or regional databases (e.g. Eurostat for European energy price data or the London Metal Exchange for metal prices in European markets).
- For the technical data needed to estimate the costs (fuel consumption of a car to drive one kilometer) the LCC practitioners could refer to
  - LCA databases or directly to suppliers;
  - experts, who may also be part of the company/institution that wishes to carry out the LCC (i.e. internal expertise)

III.2.2. LCC PROCUREMENT TOOLS: PRESENTATION

The LCC IT tools help to compare different purchase/investment options. They propose a cost structure and a system model adapted to predefined objects (cars, computers, etc.).

We particularly recommend the use of the following tools:

- European Commission's LCC tool for the evaluation of capital goods [1]. Main features:
  - Cost categorization adapted to each type of asset
  - Country and currency (European) adaptation
  - Presentation of results (internal costs, externalities and total) in monetary units (the environmental impact of GHG emissions being monetarized)
- Clean Fleets tool for vehicle evaluation [2]
  - Cost categorization fully adapted to vehicles
  - Inclusion of fuel price forecasts (diesel, ethanol, electricity, etc.)
  - Accounting for emissions in addition to CO2, namely NOx, PM, and NMHC
- ZVEI tool for the evaluation of investment projects [3]
  - Ability to perform sensitivity analysis of cost parameters and discount rate
  - Adaptation to any investment project

[1] http://ec.europa.eu/environment/gpp/pdf/SF_SSSUP_ELCC.xlsm

[2] http://www.clean-fleets.eu/fileadmin/files/documents/Publications/LCC_tool_Aug_2015/Clean_Fleets_LCC_tool_-_EN.xlsm

[3] https://www.zvei.org/fileadmin/user_upload/Themen/Energie/Lifecycle_Cost_Evaluation__LCE_/excel/calculation_tool_LCE_blank.xls

IV. Combining LCC - LCA

IV.1. Interest

Although there are practical differences between the two (the role of the temporal dimension, the asymmetry of economic and environmental hotspots...), these do not constitute any barrier to the combination of both methods and they are compensated by their synergies.

The main point of convergence is that the two approaches stem from the same Life Cycle Thinking principle and seek to answer the same two questions: what is the impact (cost) of each stage of the life cycle and what is the total impact (cost)?

It should be noted, however, that the use of these two methods is not enough assess sustainability; a third method -social impact assessment- is needed to encompass the three dimensions of sustainable development

The ultimate objective of combining both methods is to study the viability of a product or system. By integrating external costs related to the environment, an LCC study completed with an environmental assessment also seeks to determine eco-efficient processes as well as eco-responsible purchasing practices

Figure 10 : Sustainable development

IV.2. Principles guiding the combination

There are very few concrete elements in the literature concerning the implementation of the LCC with LCA. Two main options are considered:

- **The combined application of LCC and LCA with the same computational structure** (Moreau & Weidema, 2015; Heijungs, 2013; Norris, 2001; Shapiro, 2001).

  In this application, the processes established in an LCA model are not only associated with the physical flows but also with their respective costs, in other words, the processes of a given LCA model are defined in physical terms (kg, kWh...) and in monetary terms.

- The realization of a LCC in parallel with the LCA with their independent computational structures (Swarr et al.,2011; Hunkeler et al., 2008; Kloepffer, 2008).

  This application corresponds to the E-LCC as described in the literature by Swarr et al (2011) and Hunkeler et al (2008). In this case, the two methods are implemented in parallel but independently: The E-LCC covers the internal and external environmental costs associated with the environmental externalities expected to be internalized; the LCA covers all other environmental impacts that are not internalized.

Both assessments should use the same functional unit and system boundaries of the object under study (Swarr et al., 2011).

IV.3. Tools for LCC-LCA combination

LCC-LCA combination can be done using software. This section in the study presents the different tools that allow this combination. Each tool is described according to the cost indicators used (market price or added value), the work plan, available databases, proposed results and analysis possibilities.

The analysis covers the following software:

- CCaLC2
- GaBi
- OpenLCA
- SimaPro
- Umberto NXT

The transversal analysis of these tools leads to the following conclusions:

- Overall, the approach is always the same, namely
  - Modeling in an LCA tree structure;
  - Integration of costs from a pre-existing category or to be created (only for SimaPro);
  - Restitution of results by life cycle stage.
- The results can generally be decomposed by step / process, in the form of tables or diagrams
- The main problem is the lack of data

All these tools also offer the possibility to run a LCC alone. The software are compared from a simple case study from a Moreau and Weidema (2015) publication on the life cycle of a wooden chair, with a lifespan of 2 years.

IV.4. Key points to consider

- The asymmetry of economic and environmental hotspots

  LCA focuses only on elements that generate environmental impacts. The approach therefore includes certain elements which, in terms of impact, could be very significant from an environmental point of view but negligible from an economic perspective.

  Consequently, the relevant phases of the life cycle may not be the same. **It is therefore appropriate, if the model is common, not to carry out too many simplifications a priori** and to have a critical look at the model of the economic expert if the LCC practitioner is rather a LCA practitioner.

- The difference in the concept of "life cycle" between the two methods

  In LCA, the concept of life cycle includes all stages from cradle to grave; all stages are generally considered. In the case of LCC, the scope of the cycle varies according to the objective and the actor executing it. For example, in a consumer LCC, all upstream production costs are included in the purchase price, so the R&D and design steps may not be separately identified in the calculation.

Thus, the system boundaries for studying the same object may differ between the LCC and the LCA. It is therefore necessary to have clearly defined these two perimeters from the beginning to be able to interpret the results correctly.

- The different role of the time dimension in LCA and LCC

  The LCC considers the time dimension to express the decrease in value of money and the increase in prices over time.

  For the integrated application of LCA and LCC, it is necessary to adapt the often timeless LCA model to include the variation of costs over time. This is currently done by multiplying future process costs by discount factors that reduce future costs.

V. Prospects for work to improve practice

1. Standardize the practice of the LCC

To homogenize the practice and increase the transparency of methodological approaches, an ISO standard could be generalized. Standardization could help to:

- Establish consensus on definitions (internal costs, external costs, internalization...);
- Establish clear rules to define the scope of the study (example: if internal and external costs are less than a given amount, the life cycle stage can be excluded);
- Establish a common methodological framework.

2. Include cost data in LCA databases

To facilitate the combination of LCA and LCC, especially when it is done in the same computational structure based on an LCA model, dedicated LCA databases should continue to be supplemented with economic data (costs) associated with different material flows and processes.

3. Develop standardized techniques for monetarizing environmental and social externalities

Currently, monetarization techniques are widely debated and there is no general standard technique.

In this perspective, ISO is currently preparing a standard (ISO 14008) on monetary assessment of environmental impacts and related environmental aspects, which is expected to be published at the end of 2018. This is an important step towards the standardization of techniques for monetarizing environmental impacts; the standardization of social impacts has yet to be developed.

4. Develop social impact assessments of the Societal LCA type (societal LCA)

Economic and environmental valuation methods are not sufficient to answer sustainability questions. The social pillar must also be covered (see Figure 10). It is therefore necessary to encourage the development of methods compatible with the Life Cycle Thinking principle and which allow the evaluation of social impacts. A relatively new method that goes in this direction is societal LCA (cf. ScoreLCA study entitled "Social LCA, Sustainable development, CSR: state of research? What are the methodological needs?").