

STATE OF THE ART REPORT



Life Cycle Costing

Life Cycle Costing State of the art report

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About SPP Regions: SPP Regions promotes the creation and expansion of 7 European regional networks of municipalities working together on sustainable public procurement (SPP) and public procurement of innovation (PPI). The regional networks are collaborating directly on tendering for eco-innovative solutions, whilst building capacities and transferring skills and knowledge through their SPP and PPI activities. The 42 tenders within the project will achieve 54.3 GWh/year primary energy savings and trigger 45 GWh/year renewable energy. More information: www.sppregions.eu Email: info@sppregions.eu

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WHAT IS LIFE CYCLE COSTING (LCC)?

“Life cycle costing is a powerful technique that supports the analytical processes by which managers can make the most cost-effective decisions on options presented to them at differing life cycle stages and at different levels of the life cycle cost estimate”.

Code of Practice for Life Cycle Costing (NATO RTO, 2009).

Life Cycle Costing

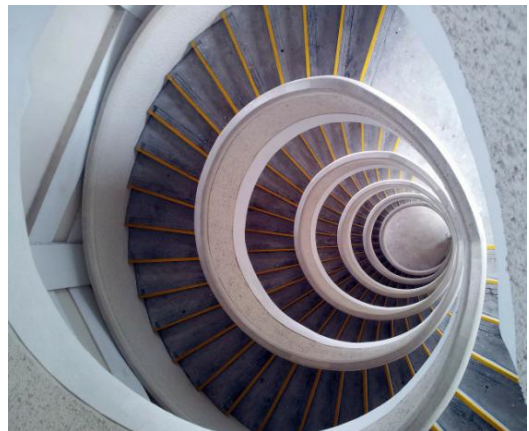
Life Cycle Costing (LCC hereafter) was first used in the United States by the Department of Defense (US DoD) in the mid-1960s (Epstein, 1996). The US DoD applied LCC in the procurement of military equipment, as they found that acquisition costs only accounted for a small part of the total cost for the weapons systems while operation and support costs comprised as much as 75% (Asiedu and Gu, 1998).

Since then, many different backgrounds and disciplines have been interested in calculating the optimal allocation of budget by estimating the costs that incur during the whole life cycle of a product, service, project, investment, etc. All the different fields, scopes and aims behind LCC have laid to a large number of different LCC definitions (see Hupples et al., 2004).

For Fabrycky and Blanchard (1998), LCC includes: *“All costs associated with the product, system or structure as applied over the defined life cycle”.*

The main cost categories that can be included in an LCC analysis are those related to the following five different life cycle stages (Hupples et al., 2004):

- Research, development and design
- Primary production
- Manufacturing
- Use
- Disposal



Procurement managers must consider the following cost elements for the calculation of the life cycle costs of a particular procurement item:

Acquisition costs: for example, the purchase price or lease costs.

Transport costs (if not already included in the cost of purchase).

Installation costs: for heating and lighting systems, for example.

Operating and maintenance costs: this includes, for example energy costs (e.g. electricity, gasoline, diesel), costs for drinking water supply and sanitation (e.g., for cleaning services), cost of paper and other consumable materials (e.g., toner cartridges, lubricants, cleaning agents), taxes, insurance costs, training costs, maintenance and maintenance costs, repair costs (spare parts, working hours), cost of necessary accessories

Disposal Costs: transport to the waste disposal company and cost of waste treatment and disposal

Residual value: revenue from the sale of the product after the end of the period of use and value of the object after the end of the useful life of the life cycle cost calculation, if this can still be used further

Umweltfreundliche Beschaffung: Schulungsskript 5. Einführung in die Berechnung von Lebenszykluskosten und deren Nutzung im Beschaffungsprozess (Öko-Institut e.V., 2012)

The details on the boundaries, cost categories and costs bearers that are included in the analysis, and how they are quantified and aggregated will determine the LCC method and approach to be applied, as well as the interpretation of the results and its integration and alignment with other analysis or results (see Huppel et al., 2004).

Total Cost of Ownership

Total Cost of Ownership (TCO) is a similar concept. It comes from the business sector, and determines the total costs (both direct and indirect) throughout the life cycle of a product or service, up till the preparation of the location of facilities for a next economic use (Huppel et al, 2004). Whether a cost is included in the TCO analysis generally depends on the relative importance or magnitude of those cost for the items purchased. Thus, TCO involves judgment on the part of the user (Ellram, 1994).

“The total cost of ownership examines the cost associated with purchased goods and services throughout the entire supply chain”.

Total Cost of Ownership: Elements and Implementation (Ellram, 1993).

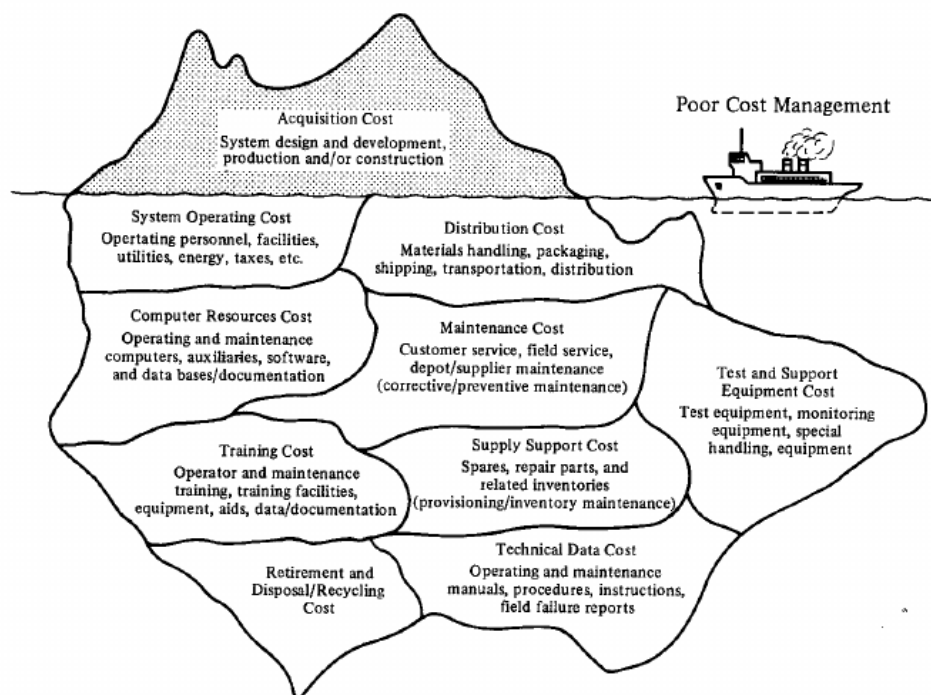
According to Geissdörfer *et al* (2009), life cycle costs, from the user perspective, can be defined as “the direct and indirect costs determined by the purchase decision, which occur over the entire life cycle of an investment, including acquisition and purchasing, operation and maintenance as well as final utilization”.

Life Cycle Analysis

These concepts should not be confused with Life Cycle Analysis (LCA), a scientific, structured and comprehensive method that is internationally standardised in ISO 14040 and 14044. It quantifies resources consumed and emissions as well as the environmental and health impacts and resource depletion issues that are associated with any specific goods or services (‘products’) (Wolf *et al*, 2012). The environmental LCA, thus, does not address the economic elements of the product life cycle, which indeed are the main focus of LCC.

LIFE CYCLE COSTING IN PROCUREMENT

The inclusion of all the costs in the procurement process is a way of visualizing hidden costs, which are by no means negligible (see its graphical representation in next figure), and bringing them into the procurement decision moment.



Source: Life-Cycle Costing (Fabrycky and Blanchard, 1998).

"Rather than simply buying based on price, the buyer should have a method for determining what a particular purchase really costs the organization - including more obvious issues such as transportation, duties and on time delivery, and more subtle issues such as supplier responsiveness and technical support "

Total Cost of Ownership (Ellram, 1999).

"The focus on the life cycle costs reveal that in most cases the operating costs have a significant share of the purchasing authorities total costs. It therefore is highly recommendable to take operating costs in account to the evaluating process of a tender."

Costs and Benefits of Green Public Procurement in Europe (Öko-Institut e.V. and ICLEI, 2007).



LCC in the EU Public Procurement Directive 2014/24/EU

The new EU public procurement Directives¹ clearly includes, defines and foresees the use of LCC within the public procurement process:

DIRECTIVE 2014/24/EU

Article 2. Definitions

Life cycle means “all consecutive and/or interlinked stages, including research and development to be carried out, production, trading and its conditions, transport, use and maintenance, throughout the existence of the product or the works or the provision of the service, from raw material acquisition or generation of resources to disposal, clearance and end of service or utilisation”.

The Directive encourages the use of LCC during the awarding phase, as a tool to get the “*most economically advantageous tender*”:

DIRECTIVE 2014/24/EU

Subsection 3. Award of the contract

Article 67. Contract award criteria

1. Without prejudice to national laws, regulations or administrative provisions concerning the price of certain supplies or the remuneration of certain services, contracting authorities shall base the award of public contracts on the most economically advantageous tender.
2. The most economically advantageous tender from the point of view of the contracting authority shall be identified on the basis of the price or cost, using a cost-effectiveness approach, such as life-cycle costing in accordance with Article 68, and may include the best price-quality ratio, which shall be assessed on the basis of criteria, including qualitative, environmental and/or social aspects, linked to the subject-matter of the public contract in question. [...].

The Directive 2014/24/EU devotes a whole article to life cycle costing to determine which are the relevant costs, how the data should be provided and which methods shall be used:

¹ Directive 2014/24/EU of the European Parliament and the Council of 26 February 2014 on public procurement and repealing Directive 2004/18/EC; and Directive 2014/25/EU on public procurement by entities operating in the water, energy, transport and postal services sector and repealing Directive 2004/17/EC.

DIRECTIVE 2014/24/EU

Subsection 3. Award of the contract

Article 68. Life-cycle costing

1. Life-cycle costing shall, to the extent relevant cover parts or all of the following costs over the life cycle of a product, service or works:

(a) costs, borne by the contracting authority or other users, such as:

- (i) costs relating to acquisition,
- (ii) costs of use, such as consumption of energy and other resources,
- (iii) maintenance costs,
- (iv) end of life costs, such as collection and recycling costs.

(b) costs imputed to environmental externalities linked to the product, service or works during its life cycle, provided their monetary value can be determined and verified; such costs may include the cost of emissions of greenhouse gases and of other pollutant emissions and other climate change mitigation costs.

2. Where contracting authorities assess the costs using a life-cycle costing approach, they shall indicate in the procurement documents the data to be provided by the tenderers and the method which the contracting authority will use to determine the life-cycle costs on the basis of those data.

The method used for the assessment of costs imputed to environmental externalities shall fulfil all of the following conditions:

- (a) it is based on objectively verifiable and non-discriminatory criteria. In particular, where it has not been established for repeated or continuous application, it shall not unduly favour or disadvantage certain economic operators;
- (b) it is accessible to all interested parties;
- (c) the data required can be provided with reasonable effort by normally diligent economic operators, including economic operators from third countries party to the GPA or other international agreements by which the Union is bound.

3. Whenever a common method for the calculation of life-cycle costs has been made mandatory by a legislative act of the Union, that common method shall be applied for the assessment of life-cycle costs.

A list of such legislative acts, and where necessary the delegated acts supplementing them, is set out in Annex XIII. The Commission shall be empowered to adopt delegated acts in accordance with Article 87 concerning the update of that list, when an update of the list is necessary due to the adoption of new legislation making a common method mandatory or the repeal or modification of existing legal acts.”

It should be mentioned that currently, the only Union legal act listed in Annex XIII is the Clean Vehicles Directive². This directive defines the methodology for the calculation of operational lifetime costs, the operational lifetime energy and environmental impacts that all contracting authorities have to take into account when purchasing clean and energy-efficient road transport vehicles (see examples and tools sections for more detail).

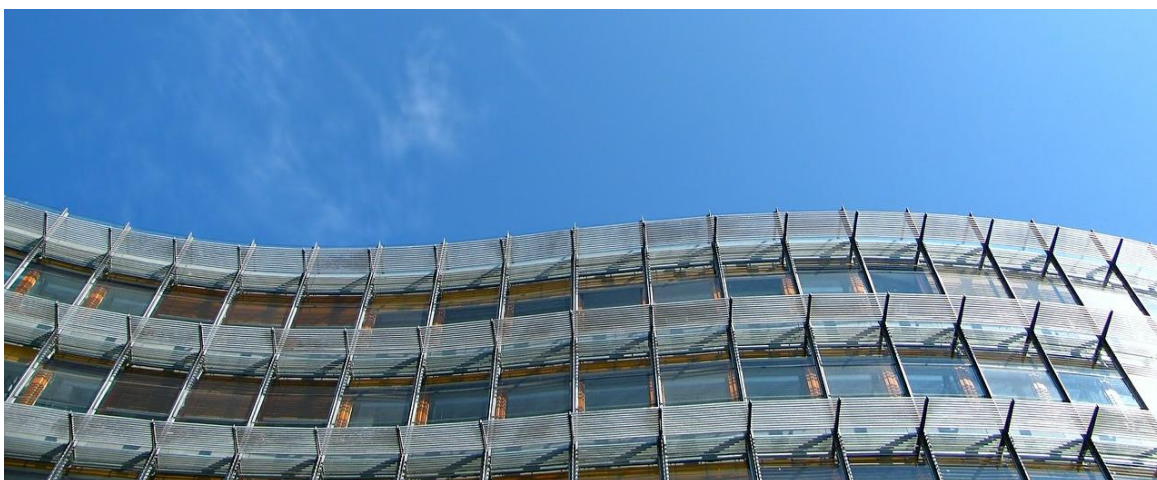
However, the awarding phase is not the only relevant moment for using LCC in the procurement. Analyzing the whole life-cycle costs of a product or service can be useful at different stages (Adell et al., 2011):

- At the preparatory stage: to assess the LCC of the current situation
- Before tendering: to roughly assess different proposals to help guide market engagement activities before tendering, or to narrow down the different technological solutions to be considered.
- During tendering: to compare the LCC and the anticipated CO2 emissions of different offers, during the evaluation phase.
- After tendering: to evaluate and communicate the improvements of the purchased product in comparison to the current situation and/or other products and to communicate results.

HOW TO INCORPORATE LCC IN THE BUILDING CONTRACTING PROCESS

The Austrian working group on construction (*IG Lebenszyklus Bau*) has published some guidelines on LCC. The last one (*Lebenszykluskostenrechnung in der Vergabe. Leitfaden für die Paketvergabe von Planungsleistungen*, 2016) describes the details regarding the integration of life cycle costs (LCCs) in the buildings procurement decisions, in the planning, awarding, construction and operating phases.

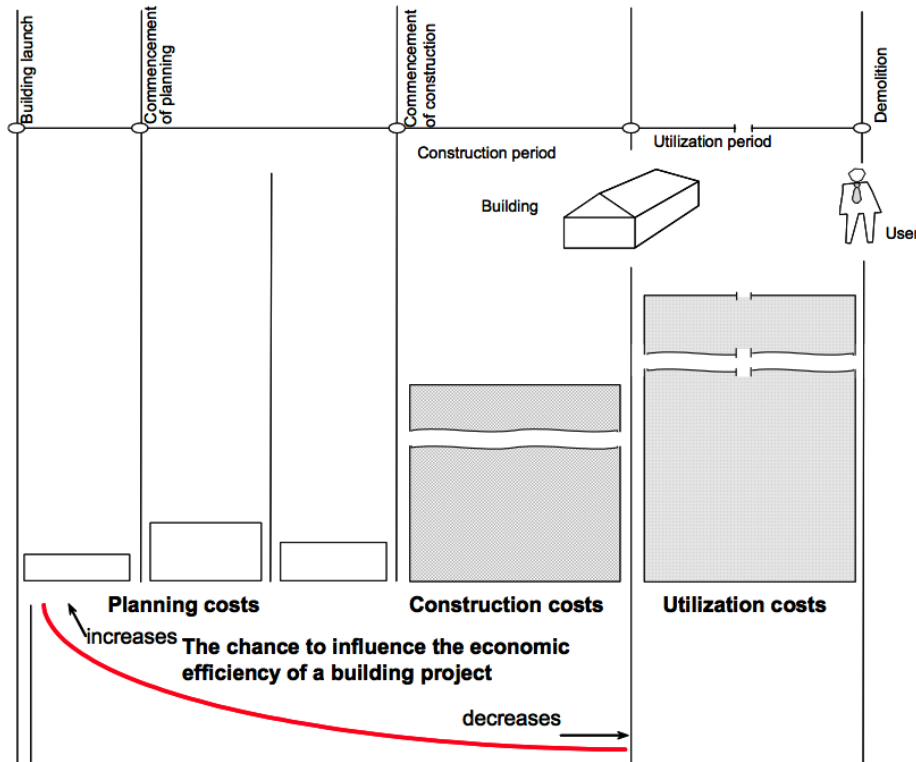
Source: *Lebenszykluskostenrechnung in der Vergabe. Leitfaden für die Paketvergabe von Planungsleistungen* (IG Lebenszyklus Bau, 2016)



² Directive 2009/33/EC of the European Parliament and of the Council on the promotion of clean and energy-efficient road transport vehicles

LCC IN CONSTRUCTION, EUROPEAN COMMISSION

One of the recommendations of the European Commission working group on Life Cycle Costs in Construction is to carry out LCC at early design stage, where the opportunities for modifying the costs of a project are greatest:



Source: FINAL REPORT. European Commission - Task Group 4: Life Cycle Costs in Construction (2003).

LCC AND THE ENVIRONMENT

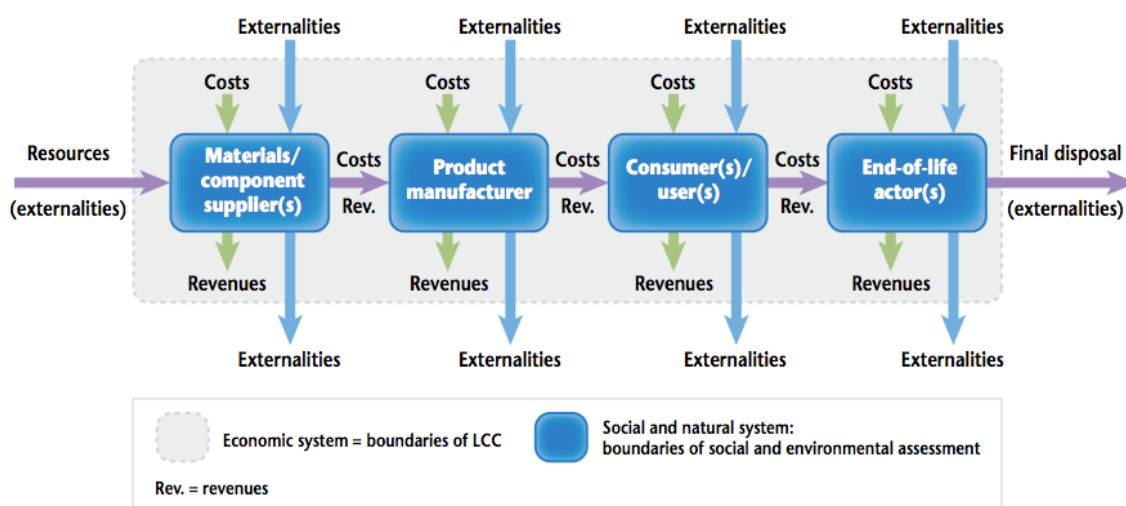
Initially, the LCC was only an economic tool, with the aim of analysing past, present and future costs in order to choose the most cost-effective option. As Glunch and Baumann (2004) rightly mention, traditional LCC does not become an environmental tool just because it contains the words "life cycle".

Rebitzer and Hunkeler (2003) already introduced the internalization of externalities within the LCC concept:

"Life Cycle Costing (LCC) is as an assessment of all costs associated with the life cycle of a product that are directly covered by any one or more of the actors in the product life cycle (supplier, producer, user/consumer, EOL-actor (End Of Life-actor), with complimentary inclusion of externalities that are anticipated to be internalized in the decision-relevant future".

Rebitzer and Hunkeler (2003) define externalities or “external costs” as the costs that “*are envisioned to include the monetized effects of environmental and social impacts not directly billed to the firm, consumer, or government, etc. that is producing, using, or handling the product. [...] The so named “externalities” are outside the economic system, though inside the natural and social system*” as illustrated in next figure.

In that sense, LCC can be used to move the environment from an externality or indirect cost in the environment, health, and safety (EHS) units of the actors in the value chain to considerations as a direct, manufacturing, and liability issue, and, under appropriate conditions, an asset (Hunkeler and Rebitzer, 2003).



Source: UNEP-SETAC (2009) from Rebitzer and Hunkeler (2003)

However, the translation of environmental and social issues into monetary terms has never been an easy issue (Glunch and Baumann, 2004). The LCC calculation method proposed at the Clean Vehicles Directive³ and the recently launched LCC tool developed for the EC are two initiatives that include the externalities in public procurement oriented LCC tools:

³ Directive 2009/33/EC of the European Parliament and of the Council on the promotion of clean and energy-efficient road transport vehicles

CLEAN VEHICLES DIRECTIVE

The Directive 2009/33/EC of the European Parliament and of the Council on the promotion of clean and energy-efficient road transport vehicles obliges Member States to take into account, at least, the following operational lifetime energy and environmental impacts when purchasing road transport vehicles:

- a) Energy consumption
- b) Emissions of CO₂
- c) Emissions of NO_x, NMHC and particulate matter

This requirement can be fulfilled by two different options:

- setting technical specifications, or
- including them in the purchasing decision:
 - as award criteria, where a procurement procedure is applied
 - or with the methodology defined in the Article 6 of the directive, where these impacts are monetised

This directive is currently being reviewed, based in a previous evaluation of its effectiveness. The monetization methodology was identified as one of the most complex and incoherent elements. Thus, the Commission works now with the possibility of abandoning the monetization and introducing an absolute definition of clean vehicles in order to set consistent and coherent mandatory procurement targets.

Source: Brannigan, et al. Ex-post Evaluation of Directive 2009/33/EC on the promotion of clean and energy efficient road transport vehicles. Final Report. European Commission – Directorate-General for Mobility and Transport (2015).



NEW EUROPEAN COMMISSION LCC TOOL

The European Commission has launched a new LCC Tool, which includes direct costs (acquisition, use, maintenance and end-of-life costs) and indirect costs (environmental externalities as external costs). The tool initially assessed the four environmental impact categories: human health, ecosystem, resource availability and climate change.

The relevant items of products life cycle (e.g. electricity consumption) were firstly characterized by their resource/emission profile (using publicly available life cycle inventory data), and then converted into environmental impacts applying a life cycle impact assessment method (the method used in this tool is ReCiPe). Afterwards, the environmental impacts were converted into externalities applying monetization factors to the computed environmental impacts.

However, the final version of the tool mentions that there is still little consensus over the matter, especially for the impact categories “Human Health”, “Ecosystems” and “Resources availability”. And thus “after further discussions and evaluations between the Commission and the project team, it was decided to take, at least for the first version of the tool, a cautious approach and use a monetization only for the impact category Climate Change. The calculations for the externalities Human Health, Ecosystems and Resources Availability are disabled.”

Source: Studio Fieschi & soci Srl and Scuola Superiore Sant’Anna. LCC calculation tool. Technical Specifications (2016).

Specific challenges and experiences on the inclusion of externalities in LCC are outlined in the following chapters.

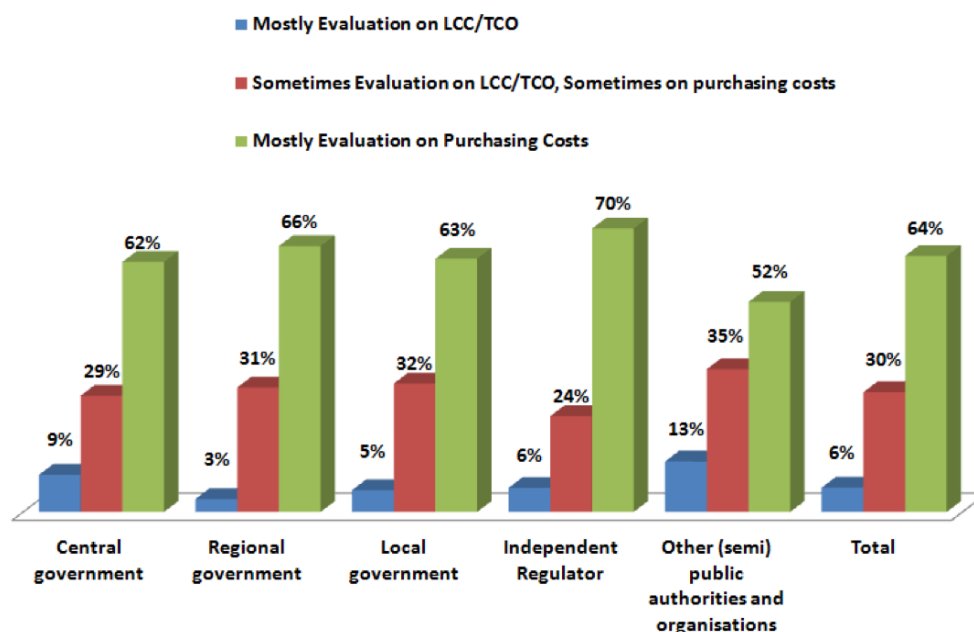
ACHIVEMENTS TO DATE

According to a study that monitored the level of GPP in the seven best performing Member States, LCC methods were not yet fully incorporated into the procurement process in 2009 (PricewaterhouseCoopers, Significant and Ecofys, 2009). Organisations evaluated proposals more often on purchasing costs rather than based on the outcome of LCC. The UK was an exception to this general rule, since evaluation on LCC occurred more frequently than on purchasing costs only.

Total	Mostly evaluation on LCC	Sometimes evaluation on LCC, sometimes evaluation on purchasing costs	Mostly evaluation on purchasing costs
Austria	9%	46%	45%
Denmark	12%	57%	31%
Finland	14%	38%	48%
Germany	14%	49%	37%
The Netherlands	11%	40%	49%
Sweden	7%	30%	62%
United Kingdom	26%	58%	16%
	13%	45%	41%

Source: Collection of statistical information on Green Public Procurement in the EU. Report on data collection results (PricewaterhouseCoopers, Significant and Ecofys, 2009).

In 2012, a similar study measured the level of uptake of EU core GPP criteria by procuring authorities in the EU27 (Centre for European Policy Studies and College of Europe, 2012) and showed similar results. Public authorities were still not frequently using Life Cycle Costing (LCC) and Total Cost of Ownership (TCO) methods. The most commonly used criterion was still the purchasing cost (64%), followed by a mix of the latter and LCC or TCO (30%); and finally, by the predominant use of LCC/TCO (6%). This order did not change when results were broken down per type of authority (central, regional and local governments, independent regulatory authorities or other).



Source: The uptake of green public procurement in the EU27 (Centre for European Policy Studies and College of Europe, 2012).

In the in-depth analysis per country, the study showed that in some of them, like Portugal and Romania, the use of LCC or TCO was still very limited while Ireland was the country where LCC/TCO was most widespread. However, even in that case only 25% of respondents reported that they mostly make use of this evaluation criterion (Centre for European Policy Studies and College of Europe, 2012).

Top 10 countries purchasing mainly according to			
Purchasing Cost		LCC/TCO	
PT	86%	IE	25%
RO	82%	NL	22%
PL	76%	UK	19%
GR	69%	SK	17%
MT	67%	SI	10%
CZ	65%	BG	10%
EE	63%	DK	9%
HU	62%	CY	9%
LV	61%	GR	8%
BE	59%	HU	8%

Source: The uptake of green public procurement in the EU27 (Centre for European Policy Studies and College of Europe, 2012).

When analyzing the LCC use in public procurement worldwide, the results are quite similar. For the majority of respondents, life cycle costing is being used “sometimes for some product categories”, or is being “used rarely”. A total of 17% of respondents state that it is not being used at all in their country, while only one a 2% of the respondents confirmed that they are using LCC in all cases.

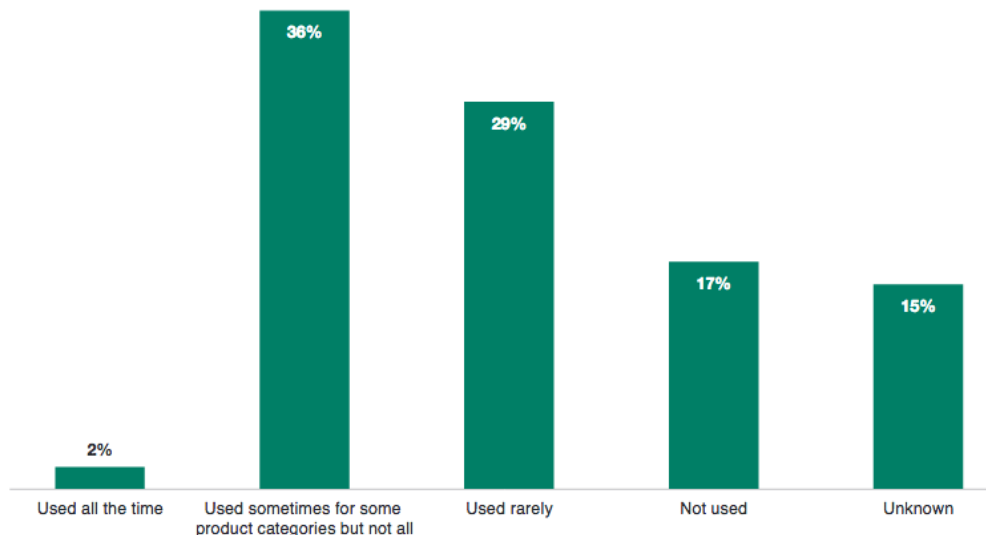


Figure 23: How well used is life cycle costing by national governments

Source: Sustainable public procurement - a global review (UNEP, 2013).

“Given recent economic conditions, we see more emphasis on life cycle costing. We also see more people asking fundamental questions about whether or not they really need to buy a product or service and if they can do without it. Simply not buying is sometimes (but not always) the greenest option.”

Niels Ramm, UNOPS

Source: Sustainable public procurement - a global review (UNEP, 2013).

Although their inherent deviation from reality, those studies (based on questionnaires, surveys, partial analysis...) show clearly the trend that LCC methods are still not incorporated as normal practice into procurement procedures. The German example mentioned below, where the law prescribes the use of LCC in the procurement of energy consuming products and services, is thus an exception.

GENERAL ADMINISTRATIVE REGULATION TO PROCURE ENERGY EFFICIENT PRODUCTS AND SERVICES (EEV-EnEff), GERMANY

Factoring life cycle costs into the bid assessment process is allowable under German contract-award law (Article 16(8) 8 VOL/A, Article 19(9) 9 VOL/A-EG) and in some cases is prescribed by law. For example, all federal agencies are required to take life cycle costs into consideration when evaluating bids concerning the procurement of products and services entailing energy consumption. (Article 2(4) of Allgemeine Verwaltungsvorschrift zur Beschaffung energieeffizienter Produkte und Dienstleistungen).

In the case of products involving calls for tenders exceeding the Community threshold, energy efficiency is to be appropriately included as a contract award criterion (Article 4 (6b) of the German contract-award law, known as VgV). This can be accomplished by factoring life cycle costs into the bid assessment process. In appropriate cases, bidders are in any case to be required to analyze minimized life cycle costs or the results obtained by using a comparable cost effectiveness evaluation method (Articles 4 and 6(2) of VgV).

Source: <http://www.umweltbundesamt.de>

EXAMPLES FROM THE SPP REGIONS PARTNERS EXPERIENCES

LCC IN VEHICLES PROCUREMENT - VILLE DE NIORT, FRANCE

The Ville de Niort has a car procurement strategy, which includes the use of LCC in the procurement process. The criteria used in the last procurement (7 vehicles) were:

- Guarantee and after sales service (25%)
- Car's technical value (15%)
- Car's safety (5%)
- Delivery time (5%)
- Financial and ecological cost (50%)

The cost criteria was calculated as: "total cost per kilometre", and included the following costs:

- Acquisition cost (including subsidies and taxes)
- Fuel cost (according to the assumption of 7.000 to 10.000 km/year, 10 years lifetime, 95% urban use)
- Maintenance costs (detailed information obtained from the Ville owned garage)
- Environmental cost (monetised according to the Clean Vehicles Directive)

IT TCO CALCULATIONS - CONSEIL GÉNÉRAL DU LOIRET, FRANCE

With the aim of reducing the global impact of its whole IT infrastructure, the Conseil Général du Loiret contracted an audit to calculate the Total Cost of Ownership (TCO) of its:

- 200 servers
- 1700 desktop and 800 mobile workstations
- 381 printers and 122 multifunction copiers

The 6 months audit (based on interviews, energy and technical data, etc.) revealed that the procurement costs (both of hardware and software) represented 17% of total costs, whilst 20% were operating costs, and up to 63% were indirect costs (maintenance, users and administrators, consumables, electricity costs, etc.).

Following the audit, proposed improvement measures include a one year increase of the computers durability or the mainstreaming of awareness and good practices among users, which could achieve more than 1 million € of savings.



COMPUTERS FRAMEWORK AGREEMENT - NATIONAL PROCUREMENT LTD., DENMARK

The National & Procurement Ltd. (SKI) established in 2012 a framework agreement on computers for 40 municipalities, where suppliers were not only evaluated on the computer's purchase price, but also on the products' total life cycle costs, TCO.

TCO calculations were an important part of the bid evaluation. Suppliers had to specify the energy consumption of the equipment in the different modes, according to the standard outlined in the Energy Star: on, stand by and off.

Model for beregning af TCO, stationær				
Tilstand	Procentvis andel af tiden	Effekt (Watt)	Totalpris pr. stk	Heraf strømforbrug
Tændt (for computere: i tomgang/idle)	40%			
Standby/slumre/sleep	5%			
Slukket	55%			
TCO = B14 + 8760/1000 * (B6 * C6 + B7 * C7 + B8 * C8) * B12 * B13			0,00	0,00
Antal				
El-pris:				
Levetid:				
Anskaffelsespris:				
Total				0,00

Through the use of this method, they could calculate the three-year power consumption of computers and added it to the procurement cost.

In addition, it was included as a minimum requirement that the products had to comply with the requirements of the Danish EPA's procurement guidelines. This ensured that the competition for having the lowest TCO price took place among the most energy efficient products in the market.

The 40 municipalities that are within the framework agreement have committed to buy about 340 million kr. over three years. According to the SKI calculations, the economic savings for each municipality are about 32,000 kr. for each 1 million. kr. spent. This corresponds to a total saving of almost kr. 11 million., 7,250 MWh and 3,625 tonnes of CO₂ over the three years.

Source: <http://www.ansvarligeindkob.dk/cases/miljoebesparelse-paa-ca-7-250-mwh-med-forpligtende-indkoebsaftale-paa-computere/>

PROCUREMENT OF LIGHTING - MUNICIPALITY OF SYDDJURS, DENMARK

Syddjurs Municipality used the Danish EPA Total Cost of Ownership (TCO) tool to calculate the costs of their lighting tender. The calculation showed that LED bulbs are six times less expensive than halogen bulbs, when looking at the total costs over a useful life of 15 years.

A specific challenge from Syddjurs' TCO calculation was how to compare different types of light sources, since the tender was not locked to a single type of bulb or technology. In order to compare them, it was necessary to change from watt to lumen when demanding the light sources offered.

Syddjurs Municipality used TCO price as an evaluation criteria. The tool showed that it was possible to save money on energy consumption, but also that there were savings to be made on working hours when the lamp is not to be changed as often.

The Municipality's procurement department was positively surprised that suppliers also welcomed the use of the tool. The current supplier believes that it is natural to take TCO calculations in a tender because it is an important parameter to calculate the payback period of their solutions. They send a clear recommendation for others to use TCO tools in the tender: "Use it! It is an eye-opener."

Source: <http://www.ansvarligeindkob.dk/cases/tco-beregninger-giver-store-besparelser-paa-belysning-syddjurs-kommune/>



STREET LIGHTING PROCUREMENT - ROTTERDAM, NETHERLANDS

Some 106,500 light sources illuminate the city of Rotterdam's roads, cycleways, pavements and shopping areas each night. Maintaining these light sources requires the replacement of some 4,000 fixtures at the end of their life cycle each year. In addition, a flexible procurement policy in the past has resulted in the purchase and use of well over 600 types of street light fixtures in the city - a situation that is far from efficient in terms of management and maintenance.

A special plan was developed to standardize the city's street lightning system, which includes special designs for both the lighting column and the fixtures. The columns were procured in 2012, by an open European call for tenders and an e-auction, resulting in a 4-year contract.

Since the e-auction process of procuring the columns was positively evaluated, the decision was to go about procuring the fixtures in the same way.

E-auction is an electronic marketplace process allowing suppliers who meet set minimum requirements to make a bid for various lots. By lowering their prices offered (and by scoring better on Social Return and TCO criteria) they compete for the lowest MEAT (Most Economically Advantageous Tender) score, which will see the winner awarded with the contract.

In a first stage, a number of minimum requirements were laid down (such as LED technology, colour temperature, etc.).

Secondly, an expert committee assessed the offers according to the award criteria defined, which included functionality, design, materials used and social return. These criteria determined the *Calculation Factor*.

Finally Total Cost of Ownership (TCO) was calculated by applying the technical specifications provided by the suppliers (previously tested in a laboratory) in a fictional street section of 1,200 metres in conformity with the Dutch street lighting guidelines. The factors included in the TCO calculation were:

- the required number of fixtures to properly illuminate the fictional street section
- the price of the fixture
- the LED light source and the driver
- the energy consumption and the maintenance costs over a period of 20 years

All these criteria determined the initial Most Economically Advantageous Tender (MEAT), according to this formula: $MEAT = TCO * Calculation\ factor$

During the e-auction, suppliers could lower the prices for the fixtures, light source or the driver in order to offer a new MEAT.

CHALLENGES AND SOLUTIONS

The different publications, guidelines, experiences, etc. highlight different key issues, challenges, difficulties, answers, solutions, suitable conditions, etc. regarding the use of LCC in public procurement.

This section compiles and addresses in detail some of the main challenges and solutions that public organizations should take into account when introducing LCC in a sustainable and innovative procurement context:

CHALLENGES	SOLUTIONS
<ul style="list-style-type: none"> ■ Availability of data ■ Complexity of environmental issues ■ Users knowledge ■ Environmental Vs. cost-effective alternative 	<ul style="list-style-type: none"> ■ Selection of suitable products and services ■ Clear policy framework ■ Monitoring and performance clauses ■ Combination of tools ■ Training and networking

Challenges

Availability of data

Any LCC analysis starts with a first stage of collecting and entering the data. This is needed in order to perform any calculation or comparison.

Typically, two kinds of data are needed. On the one hand, the **data that will determine the framework parameters of the calculation**, such as:

- The planning horizon, which will determine the period of time that will be taken into account
- The discount rate, or other economic metrics needed to compare costs in different moments of time

Additionally, all the **data aimed to describe the product or service life cycle**, is also needed. This includes:

- Lifespan
- Purchase price
- Initial costs: installation, investments
- Operation costs: consumption
- Maintenance costs: spare parts, fixed costs
- Taxes or fees
- End of life costs, remnant value



From the point of view of a public procurer, it is never easy to get all this data. Some of this information is clearly only held by the supplier (lifespan, future costs of operation, maintenance, etc.). But it is also difficult to get the data that theoretically should be available from the same contracting authority (such as previous consumptions, fixed costs, investments, etc.) as other departments normally hold them.

“There are two possible ways of assessing lifecycle costs in building planning services:

- 1. Calculation of the life cycle costs of the submitted architectural contests by independent experts appointed by the client. [...].*
- 2. Calculation of the life-cycle costs of the building design by the bidders themselves. For this purpose, the client must provide normative specifications for the calculation methodology as well as provide the predefined normatively determined data for the calculation to all bidders.*

The second approach is found to be unsuitable in practice for the following reasons:

- *The additional expenditure per participant for the calculation is disproportionate, apart from the often lacking know-how.*
- *The scope for interpretation when applying predefined data pools is too great for participants.*

Consequently, results can easily be falsified and the meaningfulness for the client is diminishing.”

Lebenszykluskostenrechnung in der vergabe. Leitfaden für die Paketvergabe von Planungsleistungen (IG Lebenszyklus Bau, 2016)

The availability and reliability of all this information is one of the main challenges for the mainstreaming of the use of LCC (Lindholm and Suomala, 2005; Westminster Sustainable Business Forum, 2008; Adell et al, 2009; UNEP, 2011; Hochschorner and Noring, 2011, etc.). The lack of industrial standards to describe life cycle behaviour, the incomparability of data recorded in different accounting systems by different companies and the poor quality of existing data implies that the result from the LCC calculation is naturally beset with a high degree of uncertainty (Glunch and Baumann, 2004).

“The tasks of the contracting authority for life cycle cost accounting are:

- *To achieve the objective of being able to determine the most economically advantageous offer*
- *To ensure proportionality: the detail, assumptions, parameters and structure are just sufficient*
- *To provide the framework conditions and necessary bases to ensure the quality of the life cycle cost accounting*
- *To coordinate and consolidate the total life cycle cost calculation of all tenders”*

Lebenszykluskostenrechnung in der VERGABE. Allgemeine erläuterungen zum artikel 68 der eu-richtlinie 2014/24/eu vom 26. Februar 2014 über die öffentliche auftragsvergabe (IG Lebenszyklus Bau, 2014)

"It could be more reasonable to accept some inaccuracies in the life cycle cost calculations than not try to evaluate life cycle cost at all."

Present and future of life cycle costing: reflections from Finnish companies (Lindholm and Suomala, 2005)

In case of including externalities (such as social or environmental issues) in the analysis, these difficulties are even higher (see next point).

COST-BENEFIT ANALYSIS FOR EU GPP CRITERIA - JOINT RESEARCH CENTRE

The Institute for Prospective Technological Studies (IPTS) of the EU Joint Research Centre has initiated an exploratory work on the quantification of the impacts resulting from the adoption of EU GPP criteria. The objective is to assess the costs (the life cycle costs borne by the procurer in relation to the baseline) and benefits (the avoided externalities or decreased environmental impacts in relation to the baseline).

The procedure is currently in development, and is being tested on the product group "Office IT Equipment". Even though it was chosen because it is one of the product groups with better market data available, the main challenges faced are the lack of sufficient market data and the lack of adequate benchmarks.

Source: Cost-Benefit Analysis for EU GPP criteria (Joint Research Centre, 2015)

Complexity of environmental issues

The "traditional" LCC approach has evolved and tried to include other costs, not directly included in the system (called indirect costs). Externalities, such as environmental consequences, are then monetized and internalised in the analysis.

However, the complexity inherent to the environmental issues makes it difficult to achieve this challenge successfully. Glunch and Baumann (2004) provide a good summary of the deficiencies derived from including environmental considerations in the LCC analysis:

- It fails to handle decisions under uncertainty. Environmental decisions are characterized by considerable uncertainty at all stages of the decision-making process, such as the problem definition (issues not considered as a problem today may well be in the future an environmental problem) and possible outcomes (the effects of the climate change are nowadays still unpredictable).
- It over-simplifies environmental problems into a monetary dimension. LCC aims at translating environmental problems into one-dimensional monetary unit. But in the environmental field, it is not possible to translate all the items to price. Thus, the proposed solution is always an oversimplification of the reality.

- The poor availability and reliability of data, already found in general LCC, is even more pronounced in the case of environmental standards and data.
- Other elements such as the irreversible consequences of environmental conditions, the underrating future environmental costs, or the difficulties of dealing with items without owner, such as air or water, are added to these difficulties.



Users knowledge

As reported in many previous studies (see examples below), the lack of knowledge among procurers and other LCC users on specific and complex LCC aspects is one of the main barriers for mainstreaming the use of LCC.

- Perera et al (2009) focus on the “skills gap” related to the financial evaluation, present value and internal rate of return. Even when expertise exists, considerable debate and uncertainty surround the selection and use of appropriate discount rates.
- Glunch and Baumann (2004) highlight the conceptual confusions given the great diversity of confusing similar concepts such as LCC, TCO, LCA, different lifetimes, etc.
- Hochschorner and Noring (2011) stress a general perception that using LCC is too difficult and complicated, too time-consuming and too expensive.

“As a result of inconsistencies in the understanding and application of whole-life costing, procurers have been left in a position of ‘trying to compare apples with pears’.”

Kathryn Bourke from Costing the future: Securing value for money through sustainable procurement (Westminster Sustainable Business Forum, 2008)

Environmental Vs. cost-effective alternative

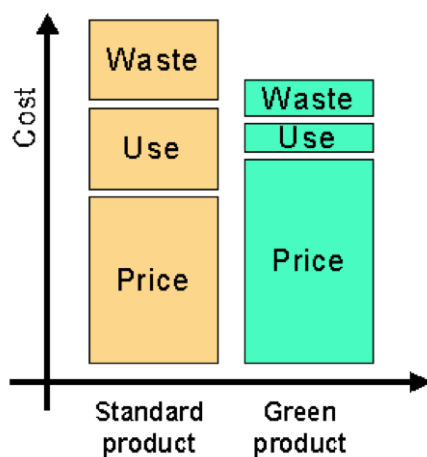
One of the main dilemma when using LCC in a context of sustainable public procurement is related to the question as to whether the LCC results (without including the environmental impacts as externalities) point to an alternative that is not the more sustainable one, from an environmental point of view?

“Life cycle costing is primarily an economic tool and, while it may have positive implications for sustainable procurement, it is not a panacea. As such the application of whole-life costing methodology is necessary but not sufficient to guarantee sustainable procurement.”

Costing the future: Securing value for money through sustainable procurement (Westminster Sustainable Business Forum, 2008)

Initially, LCC can help to overcome one of the main barriers for the implementation of sustainable procurement highlighted in several surveys across Europe which suggest that greener products are perceived to be more expensive than non-green, conventional products (Adell et al, 2009). Hence, LCC can be a useful tool to support sustainable procurement as far as the costs savings that occur during the product/service lifetime compensate the price premiums linked to the sustainable alternatives (Perera and Morton, 2009). LCC can also help to unveil “hidden” costs to the contracting department in order to make procurement decisions more cost-effective not only for the area but for the whole public administration (Adell et al., 2009).

In an ideal case, the higher initial price of the greener product is more than compensated by the much lower usage and disposal costs:



Source: Life-cycle costing (LCC) Fact sheet (European Commission - DG Environment, 2008)

However, experiences show that LCC-efficient alternatives are not always the most environmentally and socially sustainable ones (Perera and Morton, 2009). Rebitzer and Hunkeler (2003) already warned that life cycle costing, without additional assessments, could not serve as a sole indicator for good (sustainable) practice, unless there is a validated correlation of low life cycle costs to low environmental and social impacts for specific products or product groups.

LOW TEMPERATURE GAS FUEL VS. CONDENSING GAS FUEL BOILERS

The *Costs and Benefits of Green Public Procurement in Europe* study analyzed the cost differences between green and non green alternatives for 11 procurement categories. The example of boilers showed that condensing boilers for gas fuel are about twice as expensive as the less efficient low temperature boilers. However, due to the much lower costs for gas fuel consumption, which account for 40 to 60% of the total LCC, the overall cost difference is reduced to only 16%. However, the green version is still more expensive than the non-green version; despite this, the difference is significantly reduced.

Source: Costs and Benefits of Green Public Procurement in Europe (Öko-Institut e.V. and ICLEI, 2007)

"The UK Regional Centres of Excellence website defines efficiency as:

*'More for the same
Much more for a little more
More for less
The same for less
A service cut is NOT an efficiency gain'*

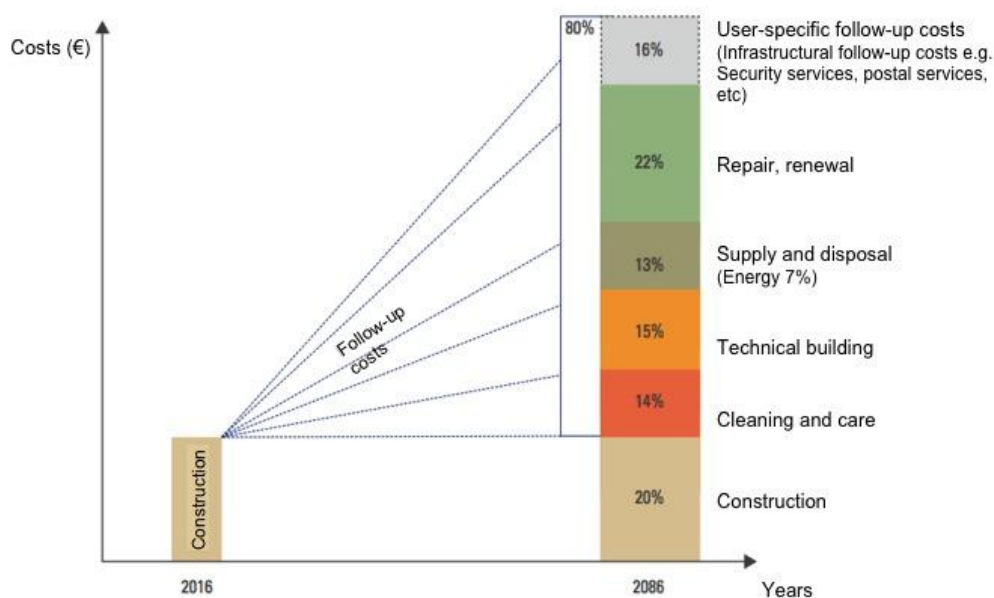
Costing the future: Securing value for money through sustainable procurement (Westminster Sustainable Business Forum, 2008)

Solutions

Selection of suitable products and services

A good decision on when to use LCC is probably one of the solutions in order to align the economical analysis of an LCC with sustainable procurement. Initially, it would make sense to calculate LCC in the procurement of products and services that will generate significant costs in the post-acquisition phases (use, maintenance, disposal...).

Buildings are a clear example. The figure shows the LCC of an office building during the 70 years after its construction:



Source: Lebenszykluskostenrechnung in der Vergabe. Leitfaden für die Paketvergabe von Planungsleistungen (IG Lebenszyklus Bau, 2016)

According to (Perera et al. 2009) LCC can be most feasibly applied to certain categories of products and services:

Frequently purchased items	Level of applicability of life cycle costing		
	Very applicable	Moderately applicable	Not applicable
Products			
Office and server ICT equipment			
Vehicles			
Indoor lighting			
Outdoor lighting			
Paper			
Office supplies			
Fuel			
Furniture			
Apparel made with modern fibres and polymers			
Services			
Software			
Electricity			
Transport			
Couriers and postal services			
Waste handling			
Catering: food			
Catering: beverages			
Works			
New buildings			
Refurbishment of existing buildings			
Landscaping			
Railways			
Roads			

Source: Life Cycle Costing in Sustainable Public Procurement: A Question of Value (Perera et al., 2003)

Apparently, energy consuming products and services are one of the procuring categories where a LCC analysis could better help to highlight the future benefits of buying a more efficient alternative, provided that external conditions (see point above) are favourable.

The study Costs and Benefits of Green Public Procurement in Europe (Öko-Institut e.V. and ICLEI, 2007) compared the costs and benefits of green public purchasing versus non green purchasing. The life cycle costs of green product versions were compared to those of non green product versions for these 11 product groups: construction work; transport: buses and bus services; transport: passenger cars; cleaning products and services; clothing; electricity; IT devices: computers and monitors; IT devices: printers and copiers; food, paper and furniture.

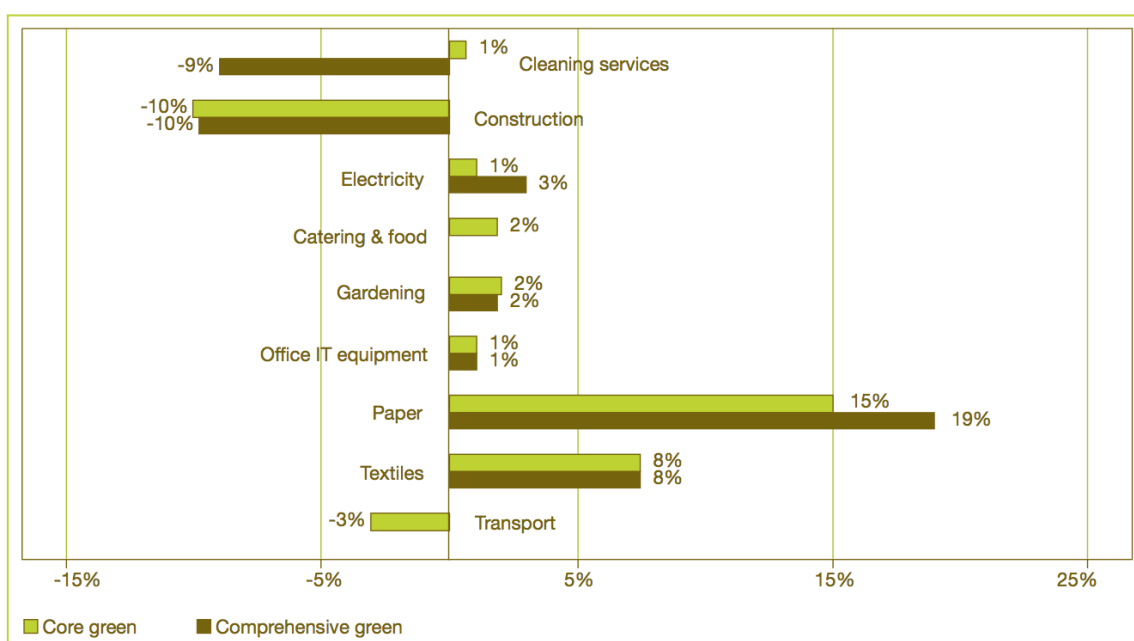
It concludes that:

- In most cases, the operating costs (for energy, paper, or other operating media) cause a significant share of the total life cycle costs. Therefore, in these cases the sole focus on the purchase price during the tender process is not justified.

- In some cases (clothing, electricity, food, or paper products) the purchase price is the only relevant cost element in the life cycle of a product.
- Where costs are highly dominated by labour costs like ‘painting’ and ‘cleaning products and services’, the cost share of the “greenable ingredient” only contributes to a minor degree to the overall costs of the end product or service.

In 2009, the Collection of statistical information on Green Public Procurement in the EU (PricewaterhouseCoopers, et al 2009) also tried to determine the financial impact of Green Public Procurement, calculated by the differences in costs between a green product and a non-green product. Those costs were calculated with a LCC perspective⁴, including not only purchasing costs, but also operational costs or costs for disposal.

The results of these cost ratios (called “financial impact per functional unit”) are shown in the figure below, both for the core and comprehensive levels of GPP. The graph shows how a product group can positively or negatively determine the overall financial impact of GPP, and also to what extent. If a figure is negative, this means that cost reductions can be achieved for that product group by purchasing green. On the other hand, positive numbers indicate increases in costs from GPP.



Source: Collection of statistical information on Green Public Procurement in the EU. Report on data collection results (PricewaterhouseCoopers et al., 2009)

⁴ The study only focused on those life cycle elements that were most relevant to the user of a product, as far as relevant data was available. Furniture is not included in this analysis, since it was found that no reliable financial data was available concerning the criteria asked in the questionnaire.

The study concluded that:

- Procurement of green construction, transport or cleaning services with green comprehensive criteria can result in a negative financial impact (i.e. cost reduction),
- While procurement of green textiles, green paper or 100% electricity supplied from renewable energy sources can lead to non-negligible increases in costs.

Finally, in a study made by the Öko-Institut e.V. on behalf of the Senate Administration for Urban Development and the Environment of the Berlin Region (Öko-Institut e.V., 2015) examined the environmental and cost relief of an environmentally sound procurement against conventional procurement of 15 product groups and services. For each of these 15 categories, costs were calculated



for annual life cycle costs (purchase and consumption-related energy or material costs, and, where relevant, the disposal costs). The environmental pollution potential is only shown for the greenhouse gas emissions associated with the use of the products. In exceptional cases, the water conservation and the reduction of particle emissions are carried out.

When evaluating the costs, they found that the environmentally compatible procurement variants were more favourable in 10 of the 15 analyzed product groups in their lifecycle costs:

- The product groups that lead to a LCC reduction were: cars, office lighting, street lighting, flooring, buildings, multifunctional appliances, computers, refrigerators, freezers, copying paper and cleaning agents. Despite their higher purchase prices, the use of the products lead to a net saving due to lower consumption costs.
- For the remaining 5 product groups and services (disposal of commercial waste, procurement of electrical energy, construction machinery, dishwashers and textiles), the life cycle costs of the environmentally acceptable procurement variants were above the cost of the conventional variant.

Clear policy framework

There are many external factors that can affect enormously the outcomes of an LCC analysis:

- Market price variability of products and services
- Electricity, water and gas prices
- Taxes, subsidies and incentives
- Inflation, discount rate and other economic elements
- Waste disposal regulations

Thus, the final result of an LCC can be highly dependent on these external factors, which usually are not related at all with the environmental quality of the product or service analyzed. The establishment of a clear environmental policy can help to overcome this variability as well as other possible changes in the external conditions.

The approval of laws that makes the introduction of certain environmental criteria compulsory, for example, ensures that the result of the procurement process will fulfill a minimum environmental level, independently from the LCC results.



The environmental regulation of taxes, fees or subsidies is another way of fostering the environmental alternatives from an economic point of view. The study on Costs and Benefits of Green Public Procurement in Europe (Öko-Institut e.V. and ICLEI, 2007) compared, among others, the costs of green and non green vehicles. The conclusions highlighted that the final costs (and thus the LCC results) depends highly on the tax policy of the different Member States.

VEHICLES REGISTRATION TAX, DENMARK

Denmark has a clear policy goal on promoting sustainable mobility. Danish vehicles registration tax is probably one of the highest in Europe. It is based on the vehicle's purchase price, and is set at 105% if the vehicle price is up to DKK 82,800 (around EUR 11,000) and 150% if the price is above DKK 82,800. That means, for example, that if you buy a 15,000 Euros car, you would pay approximately a 17,550 Euros registration tax.

From 2008 to 2016, electric vehicles weighing less than 2,000 kg were exempt from the registration tax (from 2016 to 2020 the government is gradually bringing back the registration tax for electric cars in a way that electric vehicles will pay full registration tax by 2020).

This discount element affected directly to the LCC costs, and gave no room for uncertainties. Buying a green car in Denmark was clearly also the most cost effective decision. The monetary internalization of environmental preference (by means of taxes in that case) is one of the best ways of ensuring that green alternatives are also good from an economic point of view.

Source: <http://www.skat.dk>

Monitoring and performance clauses

According to Lindholm and Suomala (2005) During the life cycle of a product, the focus of LCC should shift to cost monitoring and management. Ideally, at the end of a life cycle, the complete cost history of a product would have been tracked, compared with original estimations, reviewed and understood. This process would reduce the uncertainty of future analysis. However, in most of the cases, incurred costs and performance are not monitored adequately, the collected cost information

is not analyzed systematically and comparison of actual costs with estimations are made only occasionally (Lindholm and Suomala, 2005).

“(I) Lifecycle costs arise during the entire life cycle of a building from concept to demolition and include the installation and follow-up costs, including repairs, renovation and demolition.

“(II) They are dependent on the use, use changes and user behaviour [...]”

Lebenszykluskostenrechnung in der Vergabe. Leitfaden für die Paketvergabe von Planungsleistungen (IG Lebenszyklus Bau, 2016)

Linking the LCC results with the contract performance clauses could be a possibility of reducing the risks associated to uncertainty. It could be stated that the supplier agrees to not exceed the lifecycle costs estimations during the contract. Penalties could also be applied if there are considerable deviations between the predicted LCC and the monitored one (Adell et al, 2009).

LCC MANAGEMENT, NATO

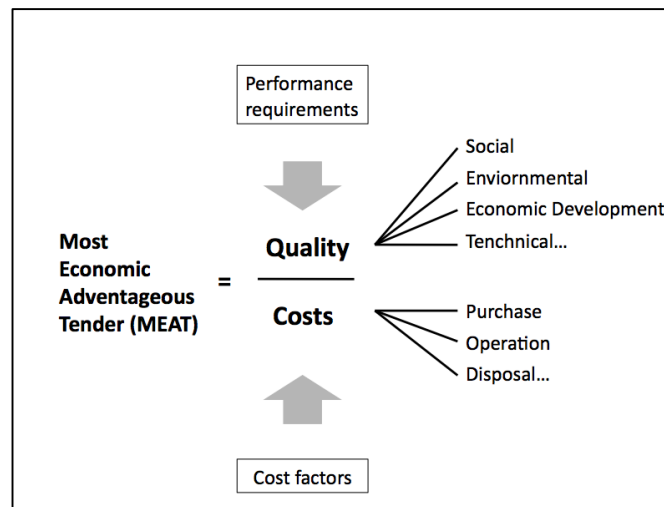
The North Atlantic Treaty Organisation (NATO) foresees the different uses and responsibilities during the use of LCC in the different phases of the acquisition process. The in-service stage includes the designation of an “LCC manager”, who should continuously monitor the system’s effectiveness by comparing the previously estimated values of LCC with the actual values incurred to identify trends and possible problem areas, and to determine causes and interrelated aspects.

Source: Cost Structure and Life Cycle Cost (LCC) for military systems (NATO, 2001)

Combination of tools

Given the difficulties and challenges mentioned above, a combination of tools could be one of the best solutions. LCC analysis would be then just one piece of a wider number of elements to take into account when preparing and evaluating a public procurement process. Environmental impacts, as well as social conditions or innovation could be other additional issues to take into account in the procurement process.

This approach is closer to the “cost-effectiveness” and the “price-quality ratio” concepts of the Directive, as summarized in next figure:



Source: Own adaptation from Universität der Bundeswehr München (2016)

MULTIPLE PROCUREMENT TOOLS, RIJKSWATERSTAAT (THE NETHERLANDS)

Rijkswaterstaat, a part of the Dutch Ministry of Infrastructure and the Environment, is responsible for the design, construction, management and maintenance of the main infrastructure facilities in the Netherlands. They apply different tools in order to include all relevant procurement elements into the decision making process:

- Total costs - by LCC or TCO
- Sustainability: In order to quantify the sustainability of material used, RWS (Rijkswaterstaat) has developed a software tool that calculates the environmental impact of the material. This calculation is based on a life cycle analysis (LCA) of the material. This software is called the Sustainable Building Calculator, or "DuboCalc".
- CO2: The CO2 performance ladder is a certification system, by which a contractor can demonstrate that in his business and projects takes measures that lead to reductions of CO2 emissions within the company or elsewhere in the chain.

<http://www.rijkswaterstaat.nl/zakelijk/zakendoen-met-rijkswaterstaat/inkoopbeleid/duurzaam-inkopen/index.aspx>

THE UNEP-SETAC LIFE CYCLE INITIATIVE

The UNEP-SETAC Life Cycle Initiative conceives LCC as one tool within a broader concept called Life Cycle Management: a framework to analyse and manage the sustainability performance of goods and services. It is a business approach that goes beyond short-term success and aims at long-term value creation (UNEP-SETAC, 2009).

	Social dimension	Environmental dimension	Economical dimension
Objective	SUSTAINABILITY		
Concept	LIFE CYCLE THINKING		
Strategies	LIFE CYCLE MANAGEMENT		
	Corporate social responsibility	Pollution Prevention	Product- and supply chain management
Systems	OHSAS 18001	ISO 14001 & POEMS	ISO 9001, TQM, EFQM
Tools	Work place assessment	Cleaner Production, LCA, EcoDesign,	EMA & LCC

Explanations: OHSAS = Occupational Health And Safety, POEMS = Product Oriented Environmental Management System, TQM = Total Quality Management, EFQM = European Foundation for Quality Management, LCA = Life Cycle Assessment, EMA = Environmental Management Accounting, LCC = Life Cycle Cost Analysis.

Source: Life Cycle Initiative. Life Cycle Management - A bridge to More Sustainable Products Training Toolkit (UNEP-SETAC, 2005)



LCC IN BUILDING PLANNING, CONSTRUCTION AND OPERATION, (AUSTRIA)

A guide developed by IG Lebenszyklus Bau on the use of LCC in the public procurement of supplies, services and construction contracts for the planning, financing, construction, refurbishment, and operation of buildings, building parts and building elements mentions three components that define the most economically advantageous tender:

- The price component and / or
- Life cycle costs and / or
- Quality criteria

It highlights the need of introducing quality criteria in order to ensure the quality of the submitted projects. These can be, for example:

- Functionality
- Usability and operability
- ~~Technical~~ Infrastructural integration /Urban /Architectural approach:
- Construction period:
- Energetic economy
- Ecology: Recyclable or renewable resources, waste management, life cycle assessment, etc.

Source: Lebenszykluskostenrechnung in der VERGABE. Allgemeine erläuterungen zum artikel 68 der eu-richtlinie 2014/24/eu vom 26. Februar 2014 über die öffentliche auftragsvergabe (IG Lebenszyklus Bau, 2014)

Training and networking

From one side, capacity building is strictly needed to overcome the initial difficulties and complexities of applying LCC. More over, permanent training and networking is needed in order to stay aware of the last achievements and changes regarding for example available tools, data standardization, technical information, new results, etc.

Sharing experiences both within one organization and with other authorities is a perfect way of learning and exchanging knowledge, barriers, solutions, points of view, practical information, etc.

WORKING GROUP ON TCO - FORUM ON SUSTAINABLE PROCUREMENT, DENMARK

The Forum on Sustainable Procurement, an initiative of the Danish Ministry of Environment and Food with the aim of promoting environmentally conscious and sustainable procurement by professional buyers of goods and services – both in public and private organisations, established a working group on Total Cost of Ownership. The group developed some guidance on the topic in order to help procurers through the methods, ways of working with TCO, how to integrate TCO in different phases of the procurement, answer some of the typical questions when working with TCO and share best practices.

<http://www.ansvarligeindkob.dk/total-cost-of-ownership/>

EXISTING LCC TOOLS

NAME OF THE TOOL	PRODUCT / SERVICE CATEGORIES	LINK
European Commission LCC tool	<ul style="list-style-type: none"> Office IT equipment Office & street lighting White goods Vending machines Electrical medical equipment 	http://ec.europa.eu/environment/gpp
SMART-SPP EU project LCC and CO2 tool and users guide.	<ul style="list-style-type: none"> General tool 	http://www.smart-spp.eu html-version: http://www.lcc-tool.eu
Danish Environmental Protection Agency TCO calculators and guidance documents.	<ul style="list-style-type: none"> Self-serving machines Bulbs and lighting systems Office IT equipment Refrigerators and freezers Bidet toilet seats 	http://mst.dk/virksomhed-myndighed/groen-strategi/groenne-indkoeb/totalomkostninger/
Swedish Environmental Management Council (SEMCO), currently The National Agency for Public Procurement, excel tools.	<ul style="list-style-type: none"> General tool Professional kitchens (fridges and freezers) Household appliances Indoor and outdoor lighting Vehicles Vending machines 	http://www.upphandlingsmyndigheten.se/en
German Federal Environment Agency (UBA) Excel tool.	<ul style="list-style-type: none"> General tool 	http://www.umweltbundesamt.de/sites/default/files/medien/515/dokument/lcc_tool.xls
The Berliner Energy Agency "Buy Smart" EU-Project costing tools.	<ul style="list-style-type: none"> Lighting Motor vehicles Household appliances Green electricity IT 	http://www.buy-smart.info/media/file/983.BuySmart_LCC_calculation_tool.xls
The ZVEI (German Zentralverband Elektrotechnik- und Elektronikindustrie e.V.) tool	<ul style="list-style-type: none"> Large scale projects 	http://www.zvei.org/en/subjects/energy/Pages/Considering-life-cycle-costs-energy-efficiency-pays.aspx

NAME OF THE TOOL	PRODUCT / SERVICE CATEGORIES	LINK
Clean Fleets EU Project LCC Tool	■ Vehicles	http://www.clean-fleets.eu/fileadmin/files/documents/Publications/Clean_Fleets_LCC_tool_-_EN.xlsm
US National Institute of Standards and Technology (NIST) Building Life Cycle Cost Programs	■ Buildings	http://energy.gov/eere/femp/building-life-cycle-cost-programs
US National Institute of Standards and Technology (NIST) BEES (Building for Environmental and Economic Sustainability) software	■ Building products	http://www.nist.gov/el/economics/BEESSoftware.cfm
ISO 15686-5:2008 Buildings and Constructed Assets. Service Life Planning. Lifecycle Costing.	■ Buildings	http://www.iso.org/iso/catalogue_detail?csnumber=39843
BDM (Bâtiments Durables Méditerranéens) Collaborative tool	■ Buildings	http://www.enviroboite.net/outil-collaboratif-bdm-de-benefices-durables

Additionally, the Munich University of the Federal Armed Forces and the Hessian Ministry of Finance and the Centre of Competence and Innovative Procurement have developed a **“LCC tool picker”**, in order to help in the selection of the 54 identified and analyzed existing LCC tools (<http://de.koinno-bmwi.de/aktuelles/lebenszyklus-tool-picker-ist-online>).

EXISTING LCC BEST PRACTICES

LCC AVAILABLE CASE STUDIES

- SMART SPP EU Project
http://www.smart-spp.eu/fileadmin/template/projects/smart_spp/files/Case_studies/SMART_SPP_Case_Studies_ENG-www.pdf
- Clean Fleets EU Project
<http://www.clean-fleets.eu/case-studies/>
- SCI Network EU Project
<http://www.sci-network.eu/snapshots/>
- Danish Forum on Sustainable Procurement
<http://www.ansvarligeindkob.dk/cases/>
- EU GPP in practice
 - http://ec.europa.eu/environment/gpp/case_group_en.htm
 - http://ec.europa.eu/environment/gpp/pdf/news_alert/Issue9_Case_Study24_Kolding_Lights.pdf
 - http://ec.europa.eu/environment/gpp/pdf/news_alert/Issue10_Case_Study25_Stockholm_IT.pdf
 - http://ec.europa.eu/environment/gpp/pdf/news_alert/Issue17_Case_Study40_Slovenia_vehicles.pdf
 - http://ec.europa.eu/environment/gpp/pdf/news_alert/Issue49_Case_Study103_Frankfurt.pdf
 - http://ec.europa.eu/environment/gpp/pdf/news_alert/Issue36_Case_Study78_Rijkswaterstaat.pdf
 - http://ec.europa.eu/environment/gpp/pdf/news_alert/Issue44_Case_Study93_Vantaa_Finland.pdf
 - http://ec.europa.eu/environment/gpp/pdf/news_alert/Issue46_Case_Study96_Basque_Country.pdf
 - http://ec.europa.eu/environment/gpp/pdf/news_alert/Issue47_Case_Study97_Copenhagen.pdf
 - http://ec.europa.eu/environment/gpp/pdf/news_alert/Issue64_Case_Study_128_London.pdf
- GPP 2020 EU Project
 - <http://www.gpp2020.eu/low-carbon-tenders/>
 - http://www.gpp2020.eu/fileadmin/files/Tender_Models/GPP2020_Tender_Model_Print_and_Copy_Management_Italy_April_2015.pdf
 - http://www.gpp2020.eu/fileadmin/files/Tender_Models/GPP_2020_Tender_Model_MFDs_LIPOR_April_2016.pdf
 - http://www.gpp2020.eu/fileadmin/files/Tender_Models/GPP_2020_Fallstudie_Sp%C3%BClautomat_BeschA_April_2016.pdf
 - http://www.gpp2020.eu/fileadmin/files/Tender_Models/GPP_2020_Tender_Model_Printers_BeschA_2015_-_ENG-Final_01.pdf

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FURTHER LITERATURE AND RESOURCES

FURTHER LITERATURE AND RESOURCES

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LCC WORKSHOP RESULTS

Time and date:	Thursday 13 October, 11:30 - 12:30 and Friday 14 October, 12:00 – 16:30
Location:	Salone delle Fontane, Via Ciro il Grande 10/12, Rome

Workshop overview

The SPP Regions Life Cycle Costing expert workshop and user clinic that included presentations and opportunities to work with experts was held on October 13th and 14th at Salone delle Fontane, Roma, in the framework of the Italian event CompraVerde - BuyGreen Forum and the Procura+ European Sustainable Procurement Network Seminar.

The first part of the workshop (Thursday 13 October, 11:30 - 12:30) was included as part of the GPP Academy initiative of the CompraVerde - BuyGreen Forum, while the second part of the workshop (Friday 14 October, 12:00 – 16:30) was included as one of the Capacity Building sessions offered during the Procura+ Seminar.

In addition to giving practical advice to the participants, the discussion also provided themes and topics to be highlighted in the state of art report.

GPP Academy: Life cycle costing and environmental criteria: complimentary of competing tools?

This first session was shared between Helena Estevan (Ecoinstitut) and Lidia Capparelli (CONSIP SA).

Helena Estevan introduced some of the main LCC concepts:

- LCC definitions,
- cost elements,
- the role of LCC in the new procurement Directives,
- and the achievements to date

Afterwards, different “classical challenges” that appear when applying LCC tools were mentioned (such as the availability of data, uncertainties, users knowledge, etc.), while some “extra challenges” related to the use of LCC in the context of sustainable public procurement were highlighted (such as the complexity of environmental externalities or the possible dilemma between the most environmental friendly or the most cost-effective alternative. Finally, a clear environmental policy framework and a combination of economic and environmental tools were mentioned as some of the possible solutions.

Lidia Capparelli presented the new Italian legal framework, which reflects the LCC concepts included in the EU Directives. She highlighted the opportunity that LCC represents to purchasers, which may lead to skip the offers’ technical assessment, with its consequent savings of time and public resources. By reviewing the LCC experiences and tools existing so far, it can be said that performing a

“classic LCC” (which would include “only” direct costs) is more or less possible, while a common and accepted methodology to monetize externalities is missing. Wider and public Life Cycle Analysis (LCA) databases, the further development of the Product Environmental Footprint at EU level or a greater collaboration among universities, ministries, procurers, etc. could accelerate the transition of full LCC (including also indirect costs) in public tenders.

Capacity building session: Life cycle costing in action.

The capacity building session was divided in two parts, lasting one hour and a half each of them. For this session, 3 experts were invited in order to share with the participants their specific experiences on the use of LCC in the procurement of different procurement product categories.

The first part, started with a short presentation of each participant and their expectations (see annex I) and a brief introduction of the topic made by Helena Estevan.

Afterwards, Benoit Tarois, Purchasing Service Manager of the Ville de Niort (France), shared his experience in the use of LCC in the procurement of vehicles. They calculated and compared the cost per kilometre of each alternative, which included:

- acquisition and registration costs,
- fuel costs,
- maintenance cost (from the detailed data obtained by their own garage),
- and pollutant emissions costs (based on the Clean Vehicles Directive tool)



Karin Sonne, Procurement Consultant of the Syddjurs Kommune (Denmark), exposed the results and conclusions of applying the Danish EPA LCC tool in their procurement of bulbs. Their calculations included the:

- purchase price
- energy consumption
- products lifetime

The results showed very clearly that the LEDs longer lifetime (which reduces significantly the total high costs of replacing units) and its much lower energy consumption make them the best solution in the long run.



Ildikó Czeglédi, coordinator of the Working Group on Water Economics from the European Water Association, explained the difficulties found in applying the LCC methodology in the water infrastructure sector, because of:

- the specific market conditions of a first need natural supply,
- and the complexity of infrastructures projects (with big investments, long lifetimes, with many phases: planning, building



She also briefly introduced the Dynamic Cost Comparison (DCC), a tool for applying the life cycle approach during the planning phase.

During the second part of the capacity building session, two discussion tables were settled with the experts, where the participants had the opportunity to raise challenges, questions and share their experiences relating to this topic.

The main topics and conclusions of the discussions were summarized during the final part of the capacity building session. They are compiled in the next tables:

- Table conclusions: challenges and solutions
- Next steps in the framework of the Procura+ Network

TABLE CONCLUSIONS

CHALLENGES	SOLUTIONS
■ Short procurement budget periods	■ Leasing, third party financing, shared cost among years, etc.
■ Departmental division	■ High level political support
■ Risk and uncertainty on price change, new technologies, guarantees, lifetimes, etc.	■ Sensitivity analysis?
■ Extra difficulties with long life products	■ LCC performance clauses: ensure annual savings, LCC auditing
	■ Include maintenance in the contracts (ex. ESCOs)
	■ Product service-systems
■ LCC still not commonly used, because of the perceived complexity	■ Training
■ Difficulties in the concepts definitions of methodologies, cost elements, ...	■ Sharing examples, tools, data, etc.
■ Lack of tools, data, ...	
■ Extra difficulties for using LCC in the	■ Usefulness of performing feasibility studies

awarding phase	(including LCC) prior to tender
<ul style="list-style-type: none"> Externalities How to translate environment, health, etc. into money? 	<ul style="list-style-type: none"> Keep on using environmental labels, criteria, etc. in order to set minimum environmental standards, besides the use of LCC (as an economic tool).
<ul style="list-style-type: none"> Few experience in the application of LCC for other than the energy cost during the use phase. 	<ul style="list-style-type: none"> Taking into account the cost differences in applying environmental good practices in gardening services would be an interesting exercise.

HOW COULD THE PROCURA+ NETWORK TAKE THIS DISCUSSION FORWARD AND WORK TOGETHER ON SOLUTIONS?

<ul style="list-style-type: none"> Continue the topic. For example creating an LCC interest group, in order to help in finding future solutions Strengthen training and capacity building Distribute existing tools Share examples, including the data details Lobbying in order to get more support from the EU on that topic

LCC capacity building participants' expectations

LCC CAPACITY BUILDING PARTICIPANTS' LIST

- Iben Sohn, Danish Environmental Protection Agency
- Maria Fray, City of Copenhagen
- Kristiina Bailey, Helsinki Region Environmental Services Authority
- Maximilian Müngersdorff, German Development Institute
- Desislava Koleva, Gabrovo Municipality
- Beat von Felten, City of Zurich
- Yolanda Morcillo Ripoll, Catalan Waste Agency
- Maria José Sarrias, Catalan Government
- Ditte Vesterager, Region Hovedstaden
- Hidemi Tomita, Lloyd's Register LRQA
- Roberta Centonze, University of Bologna
- Lidia Capparelli, CONSIP
- Benoit Taris, Mairie de Niort
- Karin Sonne, The municipality of Syddjurs
- Ildikó Czeglédi, European Water Association
- Simon Clement, ICLEI
- Bettina Schaefer, Ecoinstitut
- Helena Estevan, Ecoinstitut

LCC CAPACITY BUILDING PARTICIPANTS' EXPECTATIONS

- Learning about practical experiences and methodology implementations.
- Understand practical examples of LCC.
- Interested in LCC approach in order to promote recycled materials, since sometimes they are not the cheapest.
- Learning by examples to include in the LCC tool other dimensions than CO2 and Ozone Depletion.
- Are there documented results of savings achieved by applying LCC?
- Understand what should be done in practice, in tenders, in relation to LCC requirements from the new Directive.
- LCC methodology.
- Different models of procurement depending on the results of LCA. Specifications of products.
- Existing databases.
- LCA - who makes them at which stage? Are SMEs participating in LCA?
- Share my experience in order to inspire other to use the TCO considerations.
- Tools.
- Ideas to how implement LCC in procurement.

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- Ideas for pilot projects.
 - Carbon pricing.
 - Good examples of concrete use of LCC / TCO.
 - Method improvement.
 - Share specialties of water infrastructure LCC and learn practice from other products than water.
 - How to move on with LCC in practice?
 - Learn from good examples.
 - Looking for tools.
 - Learn more about LCC.
 - Arguments in favor.
 - Receive great inputs, examples, etc. for the “LCC - State of the Art - Report”.
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About SPP Regions

SPP Regions is promoting the creation and expansion of 7 European regional networks of municipalities working together on sustainable public procurement (SPP) and public procurement of innovation (PPI).

The regional networks are collaborating directly on tendering for eco-innovative solutions, whilst building capacities and transferring skills and knowledge through their SPP and PPI activities. The 42 tenders within the project will achieve 54.3 GWH/year primary energy savings and trigger 45 GWH/year renewable energy.

SPP REGIONS PARTNERS



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