Life Cycle Cost: what does it really mean ?

Until recently BIM, Building Information Modelling, was the word of the town. Nowadays everyone seems to be talking about Life Cycle Cost and Net Present Value. But what do these terms exactly mean ? In this article we are going to try to shed some light on the subject.

A good introduction can be found on www.leonardo-energy.org. The ECI Publication No Cu0106 by David Chapman (published in August 2011) describes the application of LCC and NVP to an electrical installation.

Let's start with the definition: "Life Cycle Costing is a technique used to estimate the total costs of a project, installation or facility during the whole of its economic life, taking into account all costs and benefits." Something we definitely need since we are flooded with new techniques who all promise a great profit and seem to be outmost sustainable.

Usually the objective is to minimise the lifetime cost rather than determine it. Things which remain the same, are left out of the comparison to simplify the analysis.

And in order to keep some order into the different alternatives studied, it is necessary to work within the boundaries of a Standard.

With an example we are going to explain different aspects of LCC and attempt to set some rules.

The available Standards

In 2008 IWT invested in a KMO Innovation Project to "glue" all the different, existing Standards concerning costs in the construction industry in Belgium and Holland together. The result was 8 sets of rules. One of them was the Object Code for LCC. This Code "glues" following Standards:

- ❑ NBN B06-003 – costs related to investment
- ❑ NEN 2634 and the BB-SfB Plus – costs related to a design
- ❑ NBN B06-004 – costs related to run a facility

For our exemple we are going to take a look at the components of the Object Code concerning production of sanitary hot water together with the central heating system:

- ❑ Costs for the investor :
  - 3A.53.3 – initial construction of the installation
- ❑ Costs for the facilitator :
  - 9B.3.3A.53.3 – energy consumption of the installation in "sleep" modus
  - 9B.4A.3A.53.3 – preventional maintenance
  - 9B.4B.3A.53.3 – curative maintenance
  - 9B.4C.3A.53.3 – renewal

- 9B.4D.3A.53.3 – reparation of damage caused by the user

- Costs for the user :
  - 9C.3. 3A.53.3 – energy consumption when using the installation

Costs for the investor

In our example we invest in a 120 liter boiler with spiral for reheating, installed in a two bedroom apartment in Brussels.

The estimation of the investment cost is € 717,03 and consists of following items:

- Production cost for the contractor:
  - Purchase of the boiler: € 422,50 excl VAT
  - Purchase of additional material needed for installation: € 75,00 excl VAT
  - Labor cost: 3 hours à € 42,00/h excl VAT
- General non project related costs, profit and risk (GC+P/R) for the contractor: 15% on the production cost

Important to your comparison is to know the context of these costs !

First, do you work with one general contractor and several subcontractors or do you have different independant contractors working on site without subcontractors ? In our example we work with the latter. The costs for the coördination on site is dealt with in chapter 6 of the NEN 2634. Since this is not really relevant for our example it is further left out of the estimation.

Secondly, who is doing the study of the installation ? The contractor himself or a separate engineering office ? In either case, the costs related to the study are to be dealt with in chapter 8 of the NBN B06-003 and are not to be mixed up with the costs for purchase or installation on site. Since this is neither relevant for our example it is also further left out of the estimation.

Of course, when the alternatives studied mean another organisation on site or the cost for the study of the installation is different, it's clear that these costs can't be left out of the comparison !

Costs for the facilitator

It doesn't matter whether the facilitator is a seperate organisation or the owner himself. Technical installations need to be properly maintained if you want to have them up and running all the time.

In LCC these costs are minimized by the marketeers. Way to often only the investment cost is related to the profit by reduced energy consumption. One advice: get a realistic view on the costs for maintenance !

In our example we have to deal with following costs:

- 9B.3. 3A.53.3: € 0,00 since the boiler doesn't use any energy when not working
- 9B.4A.3A.53.3: preventionally, every 5 years the lime needs to be removed and the anodes need to be checked. Today, for the contractor this costs € 173,65.
  The estimation of this sum consists of:

- € 25,00 excl VAT budget for the purchase of material
- 3 hours labor à € 42,00/h excl VAT (the contractor needs to get to your place and back to his office)
- 15% GC+P/R

- 9B.4B.3A.53.3: all the parts last the whole lifetime of the boiler so there are no costs for curative maintenance involved
- 9B.4C.3A.53.3: a boiler with spiral for reheating lasts on average 15 years.
- 9B.4D.3A.53.3: in an apartment a boiler is usually put away in a corner. Damage by the user is not likely and therefor not considered in our exemple. Note that in DBFM projects it is of utmost importance that you describe which kind of damage is payed for and which isn't.

Period of the LCC

In a LCC estimation all costs are considered over a certain period - e.g. 30 years - but there are several ways to do so. In recent exercises we used the following set of rules:

- The year of investment is the year zero.
  Year 1 is the first year of use.
  In our exemple, the first 5-yearly maintenance is held in the beginning of year 6, after 5 years of use.
- The boiler can be used for 15 years and will therefore be replaced at the beginning of year 16. The second renewal is due in the beginning of year 31. But whether you do so or not is a decision to make in the **following** LCC period of 30 years. Hence, the second renewal is not considered in **this** LCC period.

Note that in DBFM projects you have to clearly state what you expect after the LCC period. According to the rules set above, you would end up with a boiler at the end of it's life cycle. Contractors and facilitators have in a DBFM project a responsibility for a certain period and will search for installations which last exactly that period.
Stating that you want to be left behind with a building which equals a brand new building, makes the comparison much more difficult. In this case you have to take into account principles like capital loss and depreciation. It's our opinion that this muddles a clear LCC estimation.

Net Present Value (NPV)

In the previous decades the world of investors on one hand and the world of facilitators and users on the other hand was completely seperated. Hence, estimators always based their work on the prices available on the market at that particular time. When we consider LCC we need to work differently.

Let's go back to the very basic principles of the financial world with a simple exemple.

In general terms we can define a **cashflow** as money put into or withdrawn from a banc account.

Suppose we put today € 100 on our banc account. At an anual rate of 10% we can, after a year, withdraw € 110. But if we decide to leave the money on the account, we could, after two years withdraw: € 100 x (1 + 0,1) x (1+ 0,1) = € 100 x $(1 + 0,1)^2$ = € 121.

In the example above the € 121 is a **future value** with the general formula C x $(1 + r)^t$ with

- C = cash, put into the banc account today
- r = rate, expressed in perunage (this is percentage / 100)
- t = period between the two cashflows (money put into the account and money withdrawn from the account)

The other way around: suppose we know that, two years from now, we will need € 121. We won't put this entire amount of money aside today. It is sufficient to put today € 100 at an account providing the banc offers us an anual rate of 10%.

In the example above the € 100 is a **present value** with the general formula C / $(1 + r)^t$ with

- C = cash, we need to withdraw from the banc after period t
- r = rate, expressed in perunage (this is percentage / 100)
- t = period between the two cashflows

Normally life gets more expensive when time goes by. Something which costs € 114 today will cost more in two years from now due to **inflation**. Suppose this is 3%. Within two years I will have to pay € 114 x (1 + 0,03) x (1 + 0,03) = € 121 euro

In the example above the € 121 is an **indexed value** with the general formula C x $(1 + s)^t$ with

- C = the price we pay today
- s = annual inflation, expressed in perunage (this is percentage / 100)
- t = period between the two cashflows

Rates on your account are a combination of two kinds of profit: prosponed consumption and inflation (or capital loss). When you take into account both aspects we speak of a **nominal rate**.

The **Net Present Value** is nothing else than the sum of present values of all the cashflows in and our your account.

Back to our boiler: today the preventional maintenance costs in year 0 of the investment € 173,65.

Assuming an annual inflation of 2%, the indexed value at the beginning of year 6 will be: € 173,65 x $(1 + 0,02)^6$ = € 195,56.

In other words, within 6 years I'll need € 195,56. How much money do I need to set aside today ?

Assuming a real annual rate of 5%, the nominal rate becomes in this case 5% - 2% = 3%
The present value is: € 195,56 / $(1 + 0{,}03)^6$ = € 163,78

At the beginning of year 11 we have the second preventional maintenance.
At the beginning of year 16 we buy a new boiler but at the beginning of the years 21 and 26 we have again preventional maintenance.

Each time we apply the same formula.

To cover the preventional maintenance for a LCC period of 30 years we therefore need today:
€ 163,78 + € 155,98 + € 141,48 + € 134,74 = € 595,98
To cover the renewal for a LCC period of 30 years we therefore need today:
€ 717,03 x $(1 + 0{,}02)^{16}$ / $(1 + 0{,}03)^{16}$ = € 613,40

Doing the same exercise with a nominal rate of 8% instead of 3%, we get following NPV:
preventional maintenance: € 307,41 or minus 48%
renewal: € 287,31 or minus 53%

Doing the same exercise with an inflation of 5% (so that the nominal rate becomes 0%), we get following NPV:
preventional maintenance: € 1630,93 or plus 174%
renewal: € 1565,18 or plus 155%

As you can see, with the assumption of the rate and inflation, you can prove everything !
The rates we applied for running a facility seem to be rather common: 5% real rate and 2% inflation

Costs for the user

So far we had following figures for our 120 liter boiler with spiral for reheating for a LCC period of 30 years, 5% real rate and 2% inflation:

- 3A.53.3 – initial construction of the installation € 717,03
- 9B.3.3A.53.3 – energy consumption when keeping the installation running € 0,00
- 9B.4A.3A.53.3 – preventional maintenance € 595,98
- 9B.4B.3A.53.3 – curative maintenance € 0,00
- 9B.4C.3A.53.3 – renewal € 613,40
- 9B.4D.3A.53.3 – repairing damage € 0,00
- 9C.3. 3A.53.3 – energy consumption when using the installation ???

Leaves us only to solve the cost for energy consumption while using the boiler.

Determining the price of energy and the inflation involved is the most difficult item of the whole LCC. We retrieved our figures from Enerdata: € 0,058 all in for gas and an average annual inflation in Belgium over the last 5 years of 2,85%.
In our energy model we found that the primary energy needed was 1837 kWh / year.
We used the conversion factor towards gas of 1 kWh natural gasenergy = 1,1 kWh primary energy.
Combined with a real rate of 5%, the NPV for 30 years of gas = € 3783,28

In a more worse case, the inflation of energy could be higher e.g. 10%. The nominal rate becomes negative and the NPV for 30 years of gas = € 4670,82 or plus 23%

Let's put some things together in a summary for three scenario's:

- Optimistic situation: 10% real rate and 2% / 2,85% inflation
- The situation we considered: 5% real rate and 2% / 2,85% inflation
- Pessimistic situation: 5% real rate and 2% / 10% inflation

	10% + 2% / 2,85%	**5% + 2% / 2,85%**	**5% + 2% / 10%**
3A.53.3	€ 717,03	€ 717,03	€ 717,03
% LCC for invest.	15,0%	12,5%	10,9%
9B.3.3A.53.3	€ 0,00	€ 0,00	€ 0,00
9B.4A.3A.53.3	€ 307,41	€ 595,98	€ 595,98
9B.4B.3A.53.3	€ 0,00	€ 0,00	€ 0,00
9B.4C.3A.53.3	€ 287,31	€ 613,40	€ 613,40
9B.4D.3A.53.3	€ 0,00	€ 0,00	€ 0,00
% LCC for running	12,5%	21,2%	18,3%
9C.3. 3A.53.3	€ 3438,42	€ 3783,28	€ 4670,82
% LCC for use	72,5%	66,3%	70,8%
Total LCC, 30 years	**€ 4750,17**	**€ 5709,69**	**€ 6597,23**
	83%	**100%**	**116%**

Conclusion on LCC: good agreements are absolutely necessary to make an objective comparison !

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