TREES Training for Renovated Energy Efficient Social housing

Intelligent Energy Europe

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Section 2: Tools

2.6 Cost Calculation
Life Cycle Costing –
as a tool for decision-making

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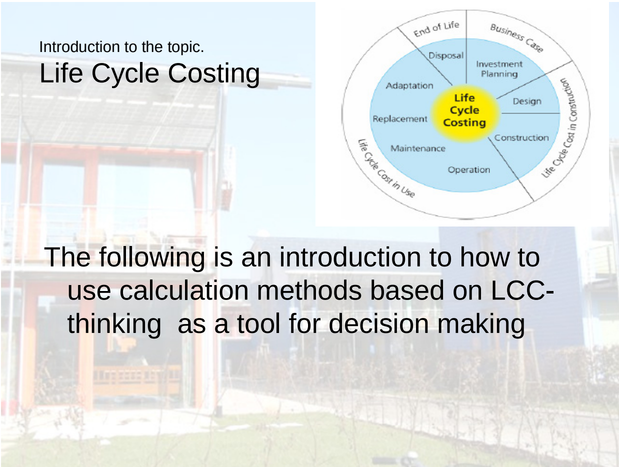
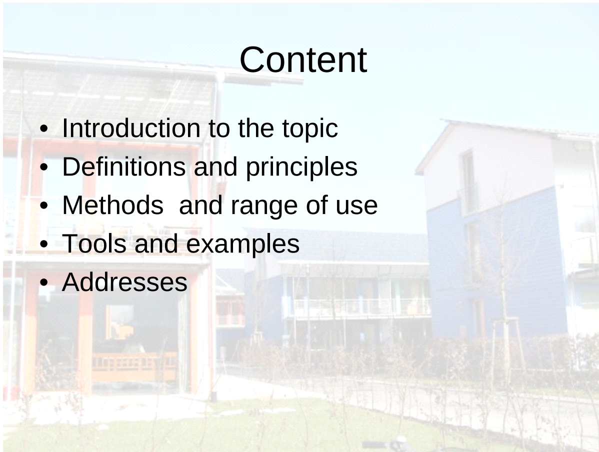
INTRODUCTION

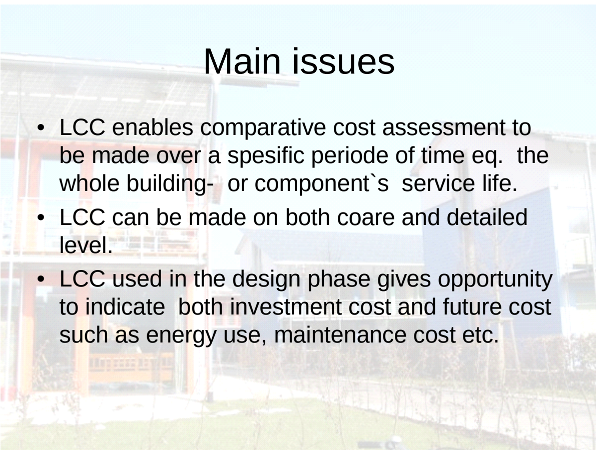
This paper gives additional comments to each slide to give the lecturer help with the issues that are presented. More detailed information can also be collected from papers or reports also included at the CD.

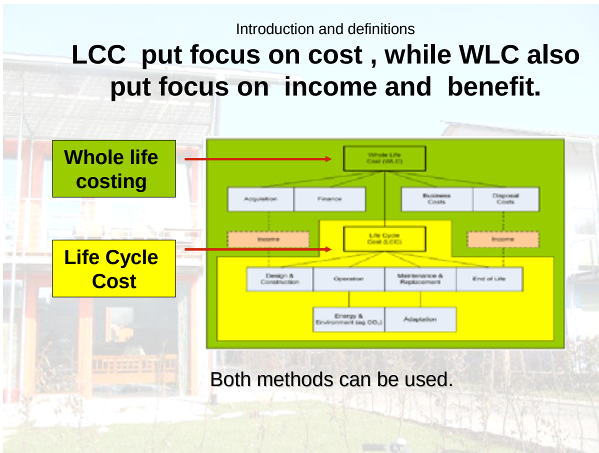
Slides 1-3 give a short introduction to the topic, just to tell the main content of the presentation.

Slide 1 -4 :









Slide 5+6:

LCC is defined by the building and construction assets standard ISO15686- 5 as: "a technique which enables comparative cost assessments to be made over a specified period of time, taking into account all relevant economic factors both in terms of initial costs and future operational costs. LCC is used to optimise product performance and lifetime cost of ownership."

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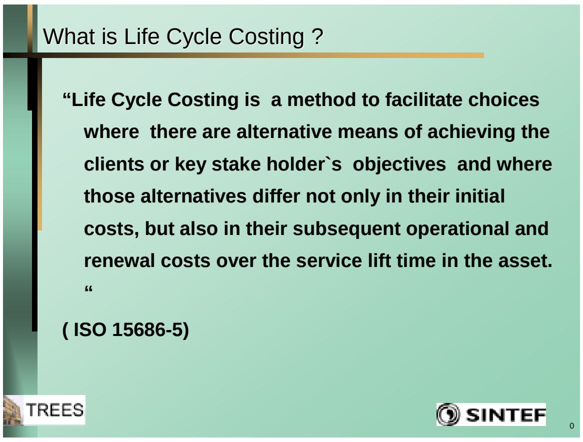
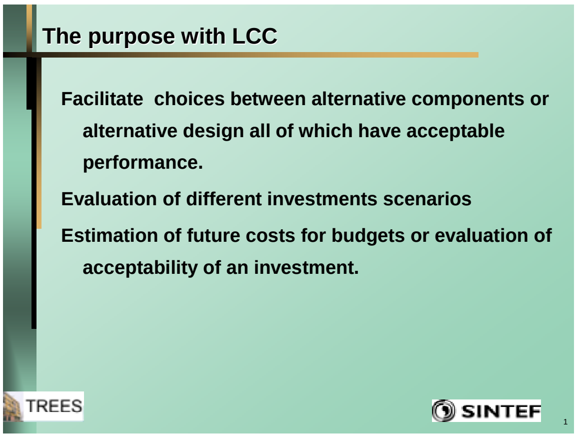




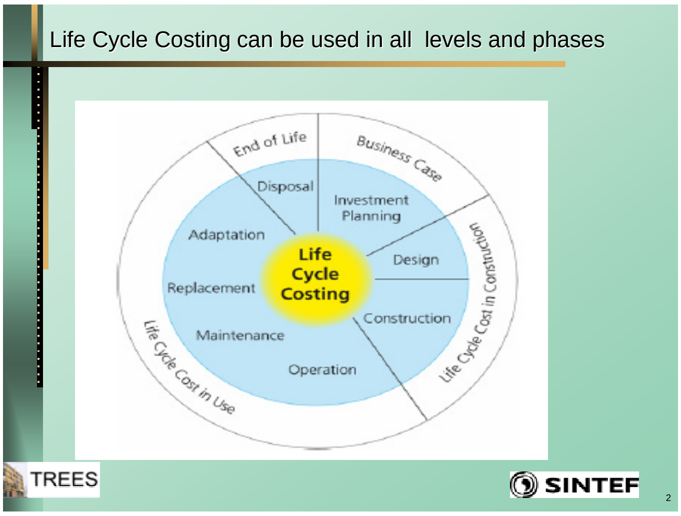
There are four key stages during the whole life cycle of any constructed asset where undertaking LCC is particularly relevant:

- Project investment planning. WLC/LCC strategic options appraisals (pre construction)
- During design and construction. LCC in Construction, at scheme, functional, system and detailed component levels
- During occupancy. Life Cycle Costing or Cost in use, (post construction)
- Disposal at end of life, or end of interest in the constructed asset.

Typically life cycle cost covers a defined list of costs over the physical, technical, economic or functional life of a constructed asset or over some other defined period.
Often (but not always) life cycle costs will include a single lump sum which represents all the acquisition costs (e.g. the purchase cost). Similarly, life cycle cost is more frequently used to describe a limited analysis of a few of the components within a constructed asset, rather than the whole building or structure. Practice also varies between users as to whether only costs borne by the customer for the analysis are taken into account, or whether customer/societal etc costs are also included.(ISO 15686-5)

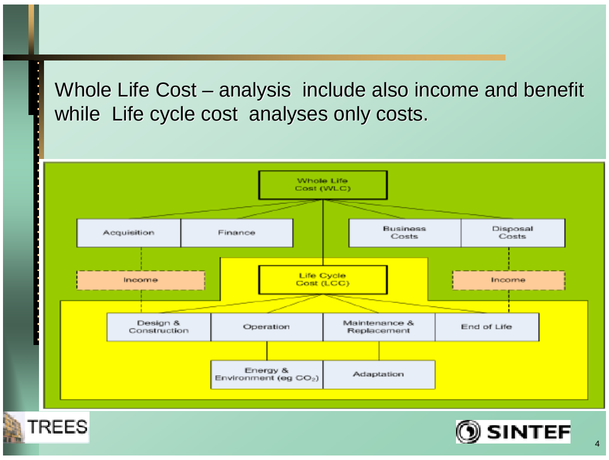
Slide 7:

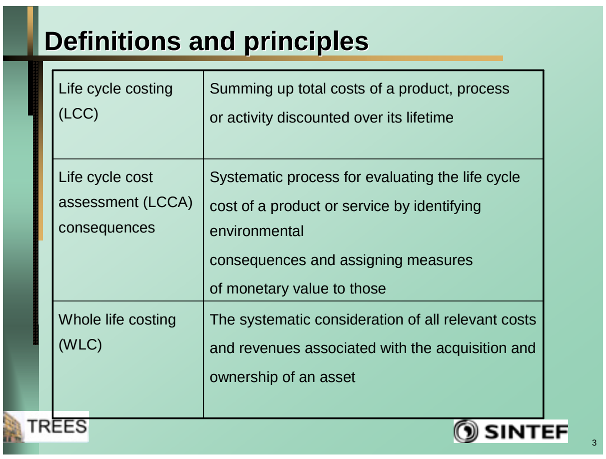
LCC is relevant at portfolio/estate management, constructed asset and facility management levels, primarily to inform decision making and comparing alternatives. Analysis may be at a strategic level (such as retain or rebuild, or acquire by alternative acquisition route such as purchase or lease and fit out); at a tactical level to evaluate alternative designs (such as between framed and load-bearing structures), or compare alternative specifications (such as between timber and metal windows or wood or brick facades) or for assessing alternative maintenance and asset renewal strategies.
LCC allows consistent comparisons to be performed between alternatives with different cash flows and different time frames. The analysis takes into account relevant factors from acquisition, through operation and maintenance, renewal and adaptation, disposal and decommissioning, with regard to the client's specified brief and the project specific service life performance requirements.



Slide 8 + 9
Life Cycle Costing (LCC) analysis should also make clear whether other costs like incomes / revenues and finance costs are included or excluded (i.e. if costs are reported net of incomes and funding). Slide 4 below indicates graphically the costs included in life cycle costs (LCC), and those normally dealt with as non construction costs - collectively termed whole life cost (WLC).

While all the life cycle elements described in the sections above will also be relevant to investment option appraisals, other issues which impact on the value for money assessment and/or the return on investment, are often taken into account. Such issues are additional to the defined elements of life cycle costs and are not mandatory. These may be relevant to some life cycle costing appraisals as well, where the client demands them (e.g. elements of the acquisition costs and the disposal costs). For certain forms of construction procurement these additional elements form an integral part of the investment option evaluation and appraisal process and they are sometimes known as Whole Life Cost (WLC) elements. Typically the difference to LCC is that the elements of WLC include a wider range of externalities or non construction costs, such as finance costs, business costs and income streams.
There also exist a number of different analysis techniques to measure and compare the return on investment.

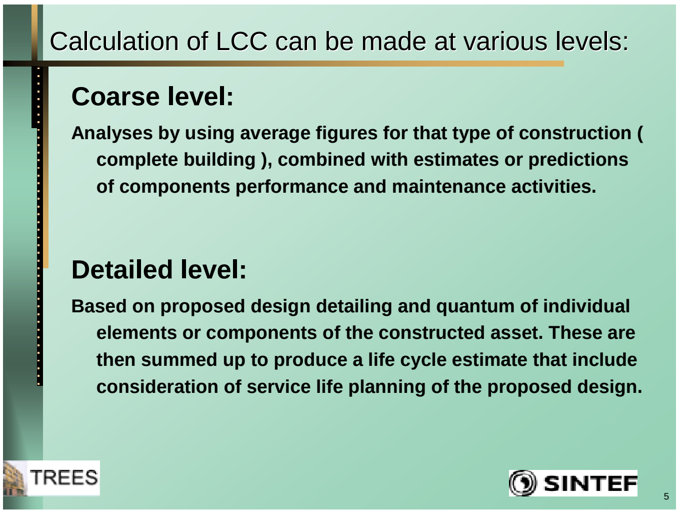




Slide 10:
Life Cycle Costing can be carried out at a coarse level using average (or benchmark) figures for that type of construction (sometimes termed parametric estimates) or at a detailed level on the basis of specific estimates or predictions of component performance and maintenance activities. Calculations of LCC can be made at various levels depending on which phase of the project process is involved. Similarly the degree of detail and information available will play a decisive role. The

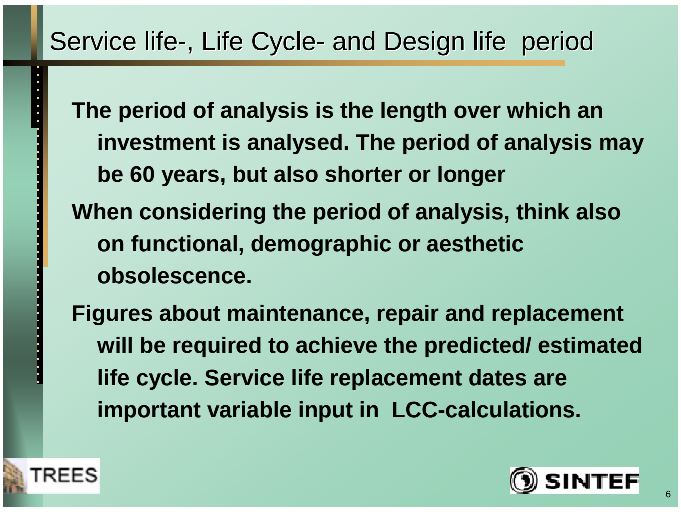
general principle that determines the level at which calculations of LCC are made is the corresponding level of detail employed to calculate the acquisition costs. Generally earlier analysis within the project life cycle is at benchmark level. Later analysis can be more detailed.

Detailed life cycle costing analysis will normally be based on the proposed design detailing and quantum of individual elements or components of the constructed asset. These are then summed up to produce a life cycle estimate based on first principles. As the design evolves the impact of specific options will be tested to assess the impact on the overall cost.



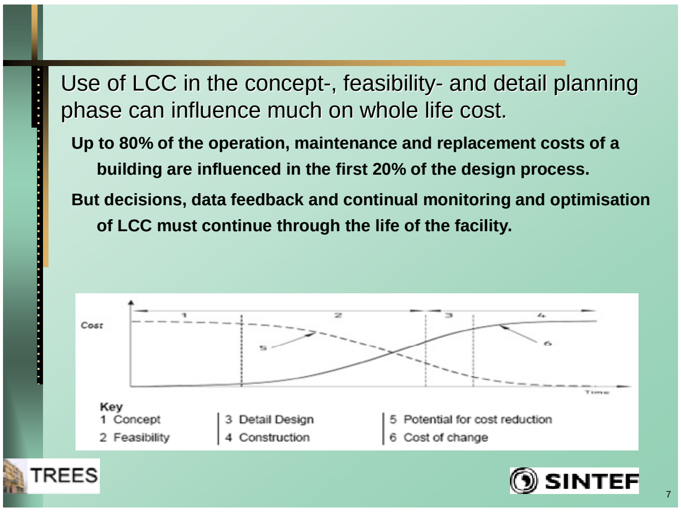
Slide 11:

The estimated service life of the asset should be at least as long as the design life (see ISO 15686-1). Maintenance, repair and replacement will be required for certain items to achieve the predicted/estimated life cycle. Service life replacement figures are an important variable in LCC. The life cycle takes account of the period during which the asset is intended to be used for its function or business purpose. Frequently this period will dictate the period of analysis of the LCC and may dictate the design life for major assets and components.
Service life may be extended by refurbishment and this decision may itself be the issue of an LCC analyses.



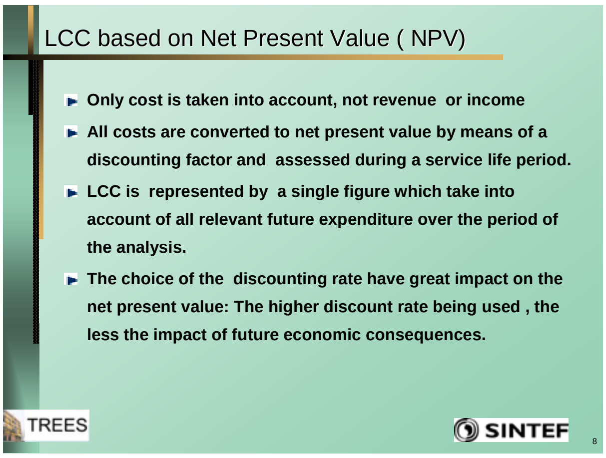
Slide 12:

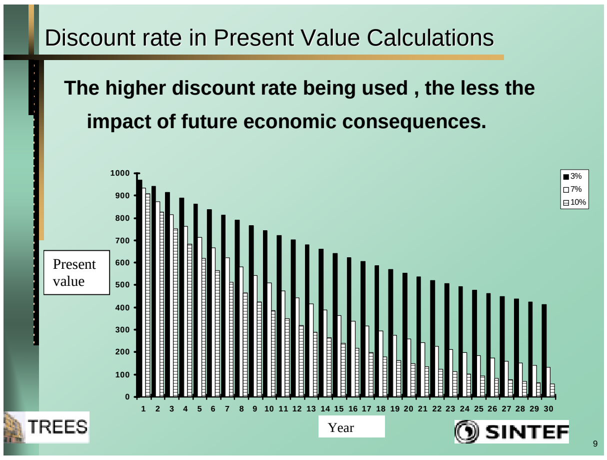
Use of LCC in design phase offers the greatest potential to influence the post construction life cycle cost in use, since the opportunity to influence the design and construction options becomes increasingly limited as the acquisition phase proceeds beyond the commitment to invest in purchase or construction of the asset.
The slide provides an indication of potential for cost reduction during the project life cycle phases.



Slide 13 +14:
The timing of costs and benefit incur is important, the investment calculation needs to reflect this. A common technique is the use of discounting. The time value of money, expressed as a discount rate, depends on inflation, cost of capital, investment opportunities and personal consumption preferences.
If the discount rate is set to 0% this means that the timing does not matter. The higher discount rate being used , the less the impact of future cost.
The most common technique of making incoming and outgoing payments from different times comparable and thus possible to add is discounting future payments to a net present value (NPV).

$$LCC = \sum_{t=0}^{T} P_n(1+i)^{-t},$$





Slide 15
Cost variables

<u>Investments cost</u>
Typically clients for the analysis will need to demonstrate lower in-use costs and/or enhanced performance if higher

Typical investment costs
a) site costs;
b) temporary works;
c) design/engineering costs;
d) regulatory/planning costs;
e) construction and earthworks;
f) commissioning costs/fees;
g) business use of in-house resources and administration.

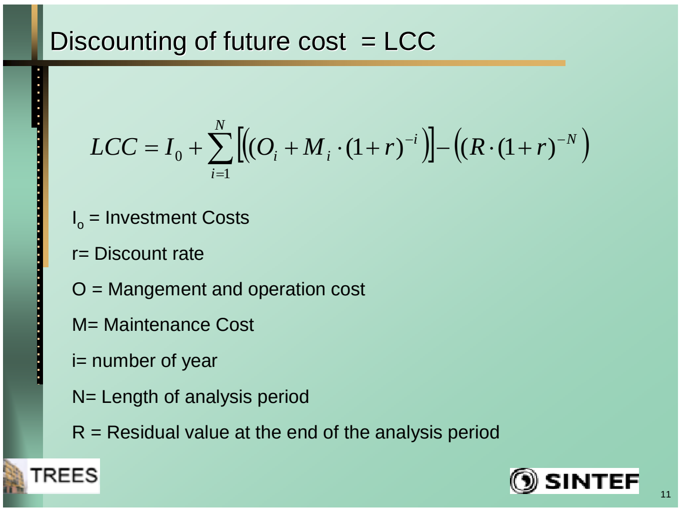
Typical Management, Operation and Maintenance Cost (MOM) :

The prime objective of planning the operation, maintenance and replacement costs is to ensure the service life is optimised to meet the specified design life. A wide range of operation and maintenance types and activities and frequencies are possible which have different costs and effects on the ongoing performance and future replacement cycle of a constructed asset. Operation and maintenance is therefore an integral part of any LCC exercise.

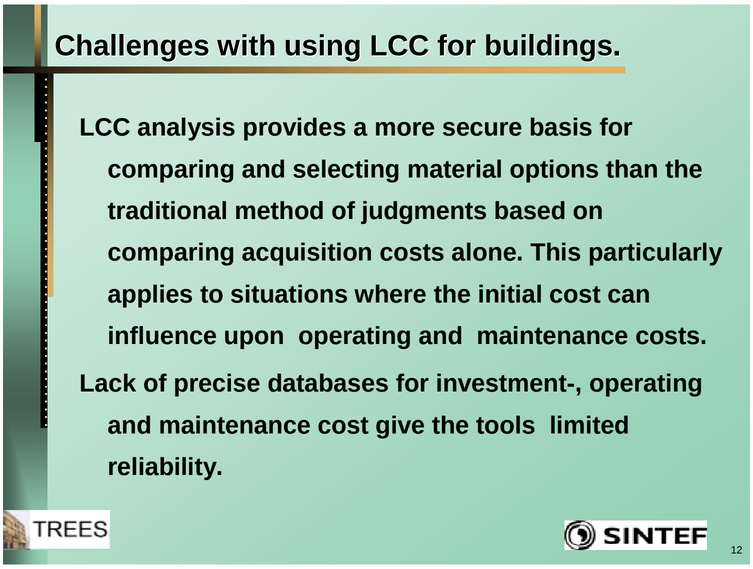
Management and operation cost:
1) rates and rent(if applicable);
2) insurance; local taxation and land charges
3) facilities management costs (including health& safety);
4) water and sewerage costs
5) energy costs; environmental costs
6) cleaning and waste management;
7) security;

Maintenance and replacement cost:
8) annual regulatory costs (e.g. fire, access inspections) and regulatory maintenance costs;
9) maintenance (including major repairs, replacement, refurbishment);
10) revenue from ownership or use of the asset (e.g. rent, service charges etc)

Other costs may also be considered including:
i) demolition;
ii) cost of disposal;
iii) residual value (R) of the construction at the end of the analysis period (year N)



Slide 16:
LCC is afflicted with practical problems, foremost concerning poor availability and reliability of input data. Lack of data implies that the investment decision is carried out under uncertainty which means that the decision-maker must make many estimates. When decision makers are faced with uncertainty they generally make estimations that are biased towards their own values and motives rather than being objective.



Slide 17:

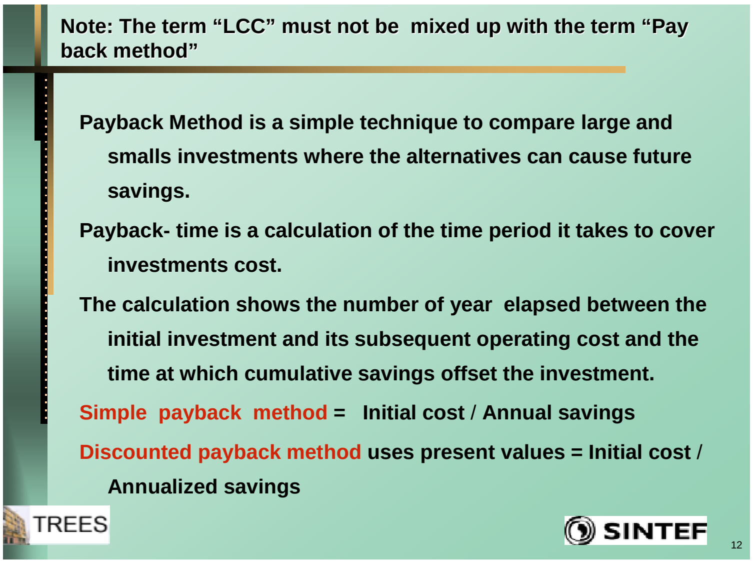
To avoid confusion about terms:

A common used analysis method for decision makers is to calculate *pay-back time*. This method must not be mixed up with LCC. *Pay back calculation* is quite different from *life cycle cost calculation*. This slide briefly show the difference.

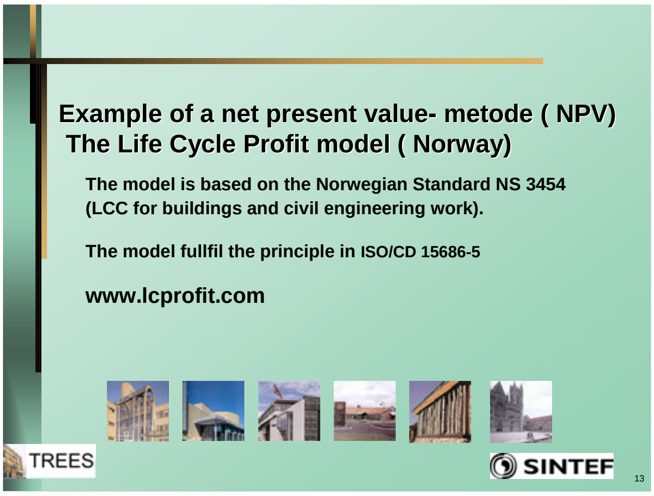
Payback Method is a simple technique to compare large and smalls investments where some alternatives may cause future savings. Payback- time is calculation of the time period it takes to cover the investments cost. The calculation shows the number of year elapsed between the initial investment time and its subsequent operating cost and the time at which cumulative savings offset the investment.

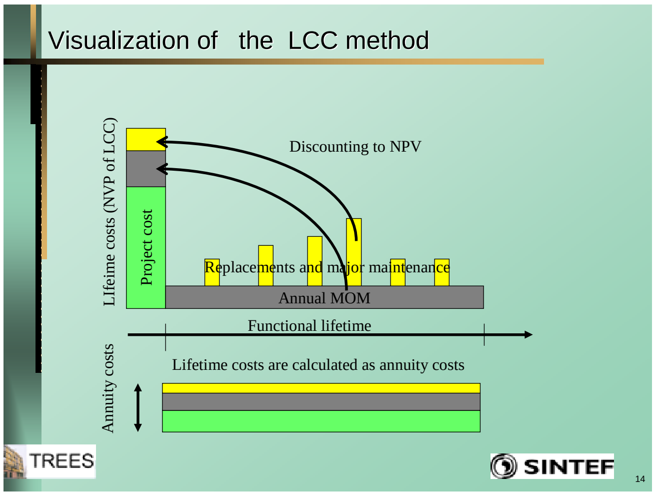
Simple payback method = Initial cost / Annual savings

Discounted payback method uses *present values = Initial cost / Annualized savings*



Slide 18 +19:
LCC- tools (The slide animation show the principle)





Slide 20:
Example of using LC-Profit to evaluate two alternative of façade cladding.
(The load bearing construction and insulation are not included in the figures.)
The comparison has been made at a analyse period of 60 years.

Alt A: Painted wood panel facade. This cladding has a estimated predicted life of 30 years before replacement. The façade intend to be cleaned and painted each 10. years.
The construction cost is 75 €/ m^2, the replacement cost will also be 75 € /m^2. The maintenance cost (cleaning and painting) is 0,9 €/ m^2 each 10. year.

Alt B: Cladding in clay brick. This cladding has a estimated predicted life of 60 years, the same as the analysis period. The mortar joint intend to be cleaned and renewed after 30 years.
The construction cost is 150 €/ m^2.(Twice as much as the wood alternative. The maintenance cost is 0,6 €/ m^2 in year.
Calculation has been made with discount rate of respectively 3 and 7 %.
Life time cost   is construction cost + discounted future cost:
The LCCs presented as NPV

Painted wood panel: 3% : 124 €   Net present value (LCC) :   4 €
Painted wood panel: 7% :   93 €   Net present value (LCC) : 6,5 €
Clay brick   : 3% :   153 €   Net present value (LCC) : 5,5 €
Clay brick   : 7 % : 151 €   Net present value (LCC) : 11 €

Note:
The net present value shows that calculation with low discount rate (3 %) gives during the period of 60 years a annualized total cost of about at the same level for the two alternatives (

6,5 and 5,5 €.) You can double the construction cost and due to future savings achieved by less maintenance and replacement cost the brick alternative is almost competitive to the cheaper wood alternative.

But with a discount rate of 7 %, a higher construction cost, as in the brick alternative will not be profitable. The higher discount rate being used, the less will future cost have impact of economic consequences calculated in net present value method.

Example: Calculation of NPV of two façade claddings (wood and brick)

Facade cladding	Predicted replace-ment life (years)	Predicted refurbishment intervals (years)	Main-tenance cost (€)	Con-struction cost (€)	Discount rate %	Dis-counted future cost (€) (Lifetime Cost)	Net present value (€) (Annuity Cost)
Painted wood panel	30	10	0,9	75	3 %	49	4
					7 %	18	6,5
Brick cladding	60	30	0,6	150	3 %	3	5,5
					7 %	1	11

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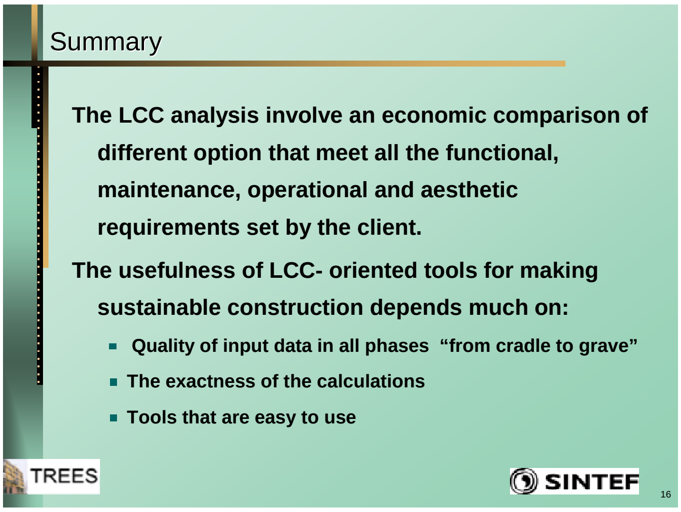
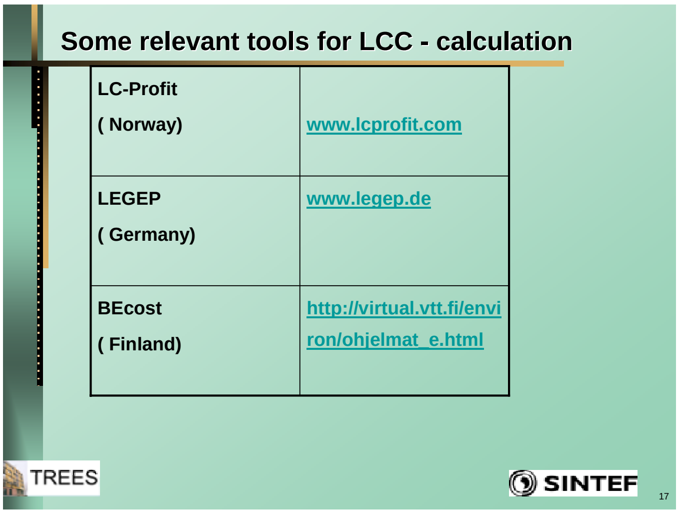
Slide 21:
Summary
Life Cycle Costing (LCC) is a valuable technique which is used for predicting and assessing the cost performance of constructed assets. The objective with LCC is to facilitate choices where there are alternative means of achieving the client's, or key stake holder's objectives and where those alternatives differ not only in their initial costs, but also in their subsequent operational and renewal costs over the service life time. Still there are some conceptual confusions about different terms and definitions. LCC is one approach but the users shall be aware of the diversity of different concepts. From a user perspective it seems to be a good idea to link environmental issues with financial consequences when implementing environmental issues. However, LCC-oriented tools are grounded in classical economic theory, developed for pure financial analysis and the focus is therefore different from that of environmental analysis.



Slide22: Available tools

There are not many commercial tools available. On the list we have put some useful www-pages.



Acknowledgements:

Thank you to ISO TC 59/SC 14 for letting us use the revised DIS draft of ongoing standard for LCC. (DIS15686-5)

Especially to Kathryn Bourke, Faithful + Gould Consult, UK that have produced the ISO DIS papers with theory connected to this presentation.

Also thank you to Statsbygg - The Directorate of Public Construction and Property for letting us use LCProfit as an example of NPV- theory.

http://www.lcprofit.com/default_en.asp