Life Cycle Costing

Dermot Kehily
Lecturer School of Surveying and Construction
Dublin Institute of Technology
What is a Green Building?
What is a Green Building?

How Do You Define Green?

Builder A
- Energy Efficient
- Healthy & Safe

Builder B
- Energy Efficient
- Healthy & Safe
- Durable
- Water Efficient

Builder C
- Energy Efficient
- Healthy & Safe
- Durable
- Water Efficient
- Environmentally Responsive
- Sustainable Community
GREEN BUILDING RATINGS

- LEED (US)
- BREEAM (UK)
- Green Star (Australia & NZ)
- DBNB (Germany)
- CASBEE (Japan)
- CBAS (China)
- BEAM (Hong Kong)
- Certevia (France)
- ?? (Ireland)
Categories of LEED (Credits and Points)

What Is Green Building?

Documented – Cost Benefits of Sustainable Construction

- Higher future capital value
- Less need for refurbishment
- Lower operating costs
- Lower maintenance costs
- Reduced Carbon Tax exposure
- Higher lease rates
- Improved Productivity
- Better IRR – Quicker Payback
Sustainability and Costs

What’s the additional Costs?

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Hypothetical Sustainable Construction Cost

<table>
<thead>
<tr>
<th>Option</th>
<th>Total Costs</th>
<th>PV Operational Costs</th>
<th>PV Investment Costs</th>
<th>Cost Reduction</th>
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<tr>
<td>Conventional Design</td>
<td>€2000</td>
<td>1,000 €</td>
<td>850 €</td>
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<td>Traditional Options</td>
<td>€1900 -5%</td>
<td>1,050 €</td>
<td>800 €</td>
<td>12.5%</td>
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<tr>
<td>Green/Sustainable Option</td>
<td>€1750 -12.5%</td>
<td>950 €</td>
<td>800 €</td>
<td></td>
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</table>
Reality (Study 1) – Additional Cost

Cost of Building Green

Additional cost to build green:
Evidence from 146 green buildings

Median in the data set: < 2% added cost
Public misperception: 17% added cost*

*2007 opinion survey by World Business Council for Sustainable Development

Range of reported premiums
Be Careful! What is the Basis of Additional Costs

• How Much More Does Sustainable Building Costs?

• DEPENDS ON COMPARISON!
  – Buildings Original Budget
  – Project itself With Out the Green Elements
  – Similar Benchmarked Projects
Just Pricing the Added Elements

• Some Green Attributes have No Cost
  – Building orientation (Energy); Passive ventilation/heating; Locating near train/bus line
  – Using some sustainable building materials (May even save money)

• Some elements are embedded in the scope and thus should not be seen as additional costs
  – Location (Brownfield site), Waste Management
  – Complying with Statutory Requirements (Regs & Certification)

• Some elements have identifiable additional costs over traditional baseline cost
  – Additional Insulation, Airtightness, Building Controls (BMS & Smart Technology)
  – Renewable Technology, Water Conservation Measurers
  – Using Recycled Building Materials
  – More Durable Building Components and Materials

• Average Additional Baseline Costs of 3-6%
Comparison to sample population of same building type (Benchmarked)

• In the US. No statistical significant difference between LEED – and non LEED **average costs** for similar building types

• Certified Sustainable Buildings can be built within the same established cost parameters (Benchmarks) as non green

• Higher green classifications such as LEED Gold & Platinum will have an added premium.

• The cost of a building depends more on good traditional cost management rather than additional green features
How do we account for sustainability

LCC as a means of financial evaluation of sustainability option:

- How to put a price on environmental impact?
- How many years to pay back the initial investment?
- What is the total cost over the life of the asset?
- What cost savings are generated by sustainable options?
- What is the impact of different energy prices or inflation rates?
Accounting for Sustainable Construction?

Measuring Sustainability

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Measuring Sustainability – QS (LIFE)

- **FOCUS IS ON LIFE of Building**
- Life Cycle Costing (Accounting in Cost)
- Life Cycle Analysis (Accounting in Carbon)
A method of economic evaluation that sums all relevant owning, operating, and maintenance costs of buildings or building systems, over a given study period, in present value euro (PV€ - to-day’s euro).
Is traditional QS services enough?

LCCA: Colaiste Bhride (60 years)
“Whole Life Costs should be integrated at each stage in cost plan development”.

No Information in CWMF to carry out LCCA other than a sample summary page.
So Is it being Implemented?

– Practice Based Research (incl DIT Research)
– NO!

• Confusion with terminology (LCA, LCC, WLCC, LCCA, WLCCE)
• Confusing and long winded calculations
• Access to Life Cycle Cost Databases
• Presentation of the LC Cost Plan
• No useful rules of measurement or guidance notes
• What software do I use?
• Training

– Research addresses these issues leveraging BIM
Life or Whole Life!

Terms used Interchangeably

BS ISO 15686 – 5 for LIFE CYCLE COSTING

Clarifying scope and terminology

ISO addresses the confusion over terminology – regarding the difference between whole life cost (WLC) and life cycle cost (LCC)

Whole Life Cost (WLC)

- Non Construction Costs

Life Cycle Cost (LCC)

- Income
- Externalities

- Construction
- Maintenance
- Operation
- Occupancy
- End of Life
Decision based on LCC

[Diagram showing a comparison between A and B. LCC (Life Cycle Cost) is represented as a green bar, OOMR (Operations, O&M, Repair) as a red bar, and Construction Costs as a combined bar.]

RICS (Royal Institution of Chartered Surveyors) and Chartered Surveyors Ireland logos are visible at the bottom of the page.
Changes since 2003

FINAL REPORT

Task Group 4: Life Cycle Costs in Construction
Version 01 July 03

May 2007

Final Report

Life cycle costing (LCC) as a contribution to sustainable construction: a common methodology

Final Report

DAVIS LANGDON
Management Consulting

RICS
the mark of property professionalism worldwide
2008 – International Standard

• ISO 15686-5.
  – Definitions
  – Terminology & Abbreviations
  – Scope of LCC in Levels
  – Breakdown Structure/Elemental Classification
  – Information for Presentation of Cost Estimate
• BCIS Supplement to ISO 15686-5.
  – Presents a UK LCC Cost Structure aligns to ISO 15686 – 5
  – More detail than ISO
  – Templates & Worked Examples
  – Dealing with Risk
  – Standard Presentation of LCC
2011 – SCSI Task Force in LCC

SCSI LCC Guidance Notes
Produced in Consultation with ISO

– Definitions & Terminology
– Information from SCSI LCC Workshop 2010
– More detail on calculations
  • Using Financial Tables and Excel in calculating formulae
– Example Template with embedded calc’s
– Worked Example
2013 – NRM3 (Consultation!)

RICS NRM 3
Measurement Rules – OMC & Cost planning of Maintenance Works

- Template Summary Page
- Measure rules for OMC
- Measurement Rules for Cost Planning
- Measurement Rules for asset specific LCC
- Presentation of Cost Estimate
- Templates and Annex’s
Basis of Life Cycle Costs

The Calculations and Presentation of the Calculations

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Calculations are based on:

- Time value of Money
- Calculations in domains we are not traditionally familiar with using in cost calculations
  - Interest rates
  - Time profiles
  - Escalation rates
Establish LLC Cash Flow – Cyclical LCC Cashflow

Difficult to compare options with cash profiles!
Initial Cost
+ PV1+PV2+PV3+PV4

Escalation >

LCC COMPARISON THROUGH NPV

Construction Costs

O O M R

A B
What is the PV of a Pint of Guinness that costs €4.50 today in 30 years escalating at 4% at a discount rate of 6%

2011 – 4.50
Price Today

2031 – 9.85

20 Years

Present Value
3.07

Discount at 6%

SCA

Escalate – 4%

SPV
SO HOW! DO YOU CARRY OUT LCC CALCULATIONS?

Present Value Formulae: based on

One Off Payment

\[
\frac{1}{1+r^n} \quad r = \text{discount rate}, \ n = \text{study period (usually years)}
\]

Series of Payments (annual)

\[
\text{PV Factor} = \frac{1}{1+r^n} \quad r = \text{real discount rate}
\]

Financial Criteria

- Today’s Cost
- Discount Rate: i - %
- Price Escalation Rate: e - %
- Study Period: N – Years (n, t)

1\text{st Stage}

Real Discounted Rate (r) = \frac{(1+i)-1}{(1+e)}

2\text{nd Stage}

PV Factor = \frac{1}{1+r^n}

\[
\text{PV Factor} = \frac{1}{1+r^1} + \frac{1}{1+r^2} + \frac{1}{1+r^3} + \frac{1}{1+r^4} + \frac{1}{1+r^5} + \frac{1}{1+r^6} + \frac{1}{1+r^7} + \frac{1}{1+r^8}
\]
Series Payments

$$SPV^*_\text{factor} = \left[\frac{[1+e]}{[1+i]}\right]^n$$

$$UPV^*_\text{factor} = \frac{1-\left[\frac{[1+e]}{[1+i]}\right]^n}{\left[\frac{[1+i]}{[1+e]}\right]-1}$$

- Financial Calculator Required
- Easier to look up Financial Tables
- Even Easier to write formulae in Excel!
### Discount Factors

Discount Rate **d = 8%**

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Robert P. Charette, May 2005, Rev. 2
• Typing formulae into Excel

\[ f = \frac{1 - \left(\frac{1 + e}{1 + i}\right)^n}{\left(\frac{1 + i}{1 + e}\right) - 1} \]

\[ = (1 - \left(\frac{1 + B2}{1 + C2}\right)^E) / ((\frac{1 + C2}{1 + B2}) - 1) \]

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Total = A2 x E2 = F
Using the PV functions in Excel

=PV(interest_rate, number_payments, payment, [FV], [Type])

For a SPV calculation of £325 in 8 years at a discount rate of 3% the data would be inputted into the formulae as follows (Churcher, 2008, p. 22; TechontheNet):

=PV(0.03,8,0,325,0)

In this case, the third number in the calculation is 0 as only one payment applies. Alternatively if the formula was used to calculate the PV of a recurring cost of £325 every year for 8 years at a 3% discount rate the following would be inputted into the function bar in excel (fₙ):

=PV(0.03,8,325,0,0)
Most LCC carried out in Excel – leverage the cost plan

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<th>(i)</th>
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Standardized Method of Life Cycle Costing for Construction Procurement

RICS the mark of property professionalism worldwide

SOCIETY OF CHARTERED SURVEYORS IRELAND

BS ISO 15686-6:2008
Building & constructed assets – Service Life planning – Part 6: Life cycle costing

nrm
RICS new rates of measurement

ORDERED COST ESTIMATING AND COST PLANNING FOR MAINTENANCE WORKS

Working Group on Sustainability and Life Cycle Costing
Society of Chartered Surveyors Ireland
Guide to Life Cycle Costing
### Training with Excel

| Ref | Description       | Qty | Unit | Rate | Cost  | Replacement Action | Scale of Replacement Qty | Uplift Factor | Replace Rate | Factored Replace Cost | Interv | Design Life | Lifting Factor | Factored Life | Real (base) LCC | (e) | SPV factor | SCA factor |
|-----|-------------------|-----|------|------|-------|-------------------|-------------------------|-------------------------|--------------|-------------------|------------------|---------|-------------|-----------------|---------------|-----------------|-----|------------|------------|
|     |                   |     |      |      |       |                   |                         |                          |              |                   |                  |         |             |                 |               |                 |     |            |            |
| 1   | Cost Plan Items   |     |      |      |       |                   |                         |                          |              |                   |                  |         |             |                 |               |                 |     |            |            |
| 2   |                   |     |      |      |       |                   |                         |                          |              |                   |                  |         |             |                 |               |                 |     |            |            |
| 3   |                   |     |      |      |       |                   |                         |                          |              |                   |                  |         |             |                 |               |                 |     |            |            |
| 4   |                   |     |      |      |       |                   |                         |                          |              |                   |                  |         |             |                 |               |                 |     |            |            |
| 5   |                   |     |      |      |       |                   |                         |                          |              |                   |                  |         |             |                 |               |                 |     |            |            |
| 6   |                   |     |      |      |       |                   |                         |                          |              |                   |                  |         |             |                 |               |                 |     |            |            |
| 7   |                   |     |      |      |       |                   |                         |                          |              |                   |                  |         |             |                 |               |                 |     |            |            |
| 8   |                   |     |      |      |       |                   |                         |                          |              |                   |                  |         |             |                 |               |                 |     |            |            |
| 9   |                   |     |      |      |       |                   |                         |                          |              |                   |                  |         |             |                 |               |                 |     |            |            |
| 10  |                   |     |      |      |       |                   |                         |                          |              |                   |                  |         |             |                 |               |                 |     |            |            |
| 11  |                   |     |      |      |       |                   |                         |                          |              |                   |                  |         |             |                 |               |                 |     |            |            |
| 12  |                   |     |      |      |       |                   |                         |                          |              |                   |                  |         |             |                 |               |                 |     |            |            |
| 13  |                   |     |      |      |       |                   |                         |                          |              |                   |                  |         |             |                 |               |                 |     |            |            |
| 14  |                   |     |      |      |       |                   |                         |                          |              |                   |                  |         |             |                 |               |                 |     |            |            |
| 15  |                   |     |      |      |       |                   |                         |                          |              |                   |                  |         |             |                 |               |                 |     |            |            |
| 16  |                   |     |      |      |       |                   |                         |                          |              |                   |                  |         |             |                 |               |                 |     |            |            |
| 17  |                   |     |      |      |       |                   |                         |                          |              |                   |                  |         |             |                 |               |                 |     |            |            |
| 18  |                   |     |      |      |       |                   |                         |                          |              |                   |                  |         |             |                 |               |                 |     |            |            |
| 19  |                   |     |      |      |       |                   |                         |                          |              |                   |                  |         |             |                 |               |                 |     |            |            |
| 20  |                   |     |      |      |       |                   |                         |                          |              |                   |                  |         |             |                 |               |                 |     |            |            |
| 21  |                   |     |      |      |       |                   |                         |                          |              |                   |                  |         |             |                 |               |                 |     |            |            |
| 22  |                   |     |      |      |       |                   |                         |                          |              |                   |                  |         |             |                 |               |                 |     |            |            |
| 23  |                   |     |      |      |       |                   |                         |                          |              |                   |                  |         |             |                 |               |                 |     |            |            |
| 24  |                   |     |      |      |       |                   |                         |                          |              |                   |                  |         |             |                 |               |                 |     |            |            |
| 25  |                   |     |      |      |       |                   |                         |                          |              |                   |                  |         |             |                 |               |                 |     |            |            |

**Note:** Integer cost is included in PV cost.

**Populates Real Cash Flow**
Ultimately - Roll Up to Summary
Thankyou

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