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Life Cycle Costing (LCC) CPD

26th April 2022

Focus on CAPex in Ireland

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- Construction – Focus on CAPex
- Traditional Procurement (Design, Bid, Build)
  - –Cost Planning
  - –Tendering & Procurement
  - –Cost Control
  - –Final Account

  - –Hand Over - Finished

Do QSs need to Expand their Focus?

- Increasing Focus on OPex and FM
- Focus on Sustainability, Carbon Emissions & Energy Efficiency
- CWMF
- Latham, Egan, Constructing Excellence, Get it Right Int.
- ISO documents – eg. 19686, 20400, 14067
- ICMS V3
- BIM Roadmaps & Mandates PAS 1192 & ISO 19650
- International Protocols, EU Directives and Local Legislation

Focus on Sustainability

European Union

IGBC
IRISH GREEN BUILDING COUNCIL

bre

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RIAI

Rialtas na hÉireann
Government of Ireland

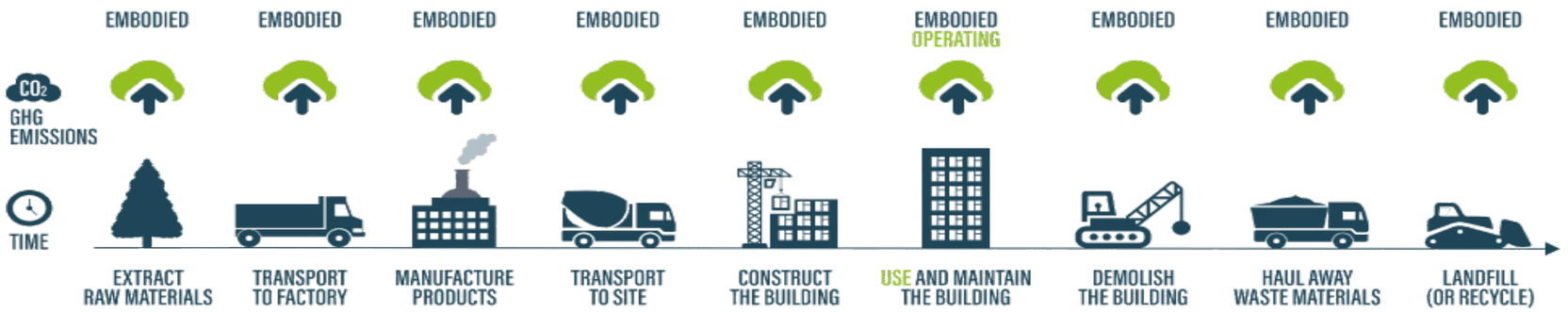
ICMS
INTERNATIONAL COST MANAGEMENT STANDARD

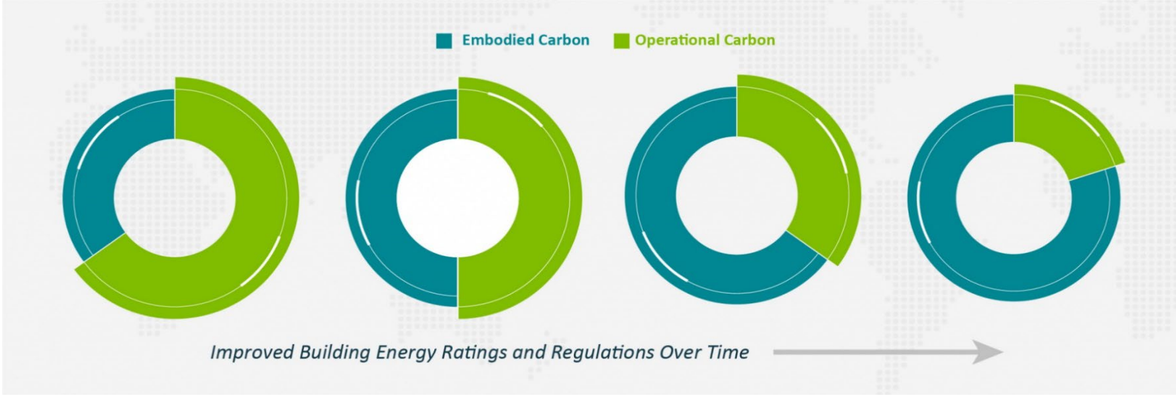
U.S. GREEN BUILDING COUNCIL
LEED
USGBC

Metrics for Measuring Sustainability

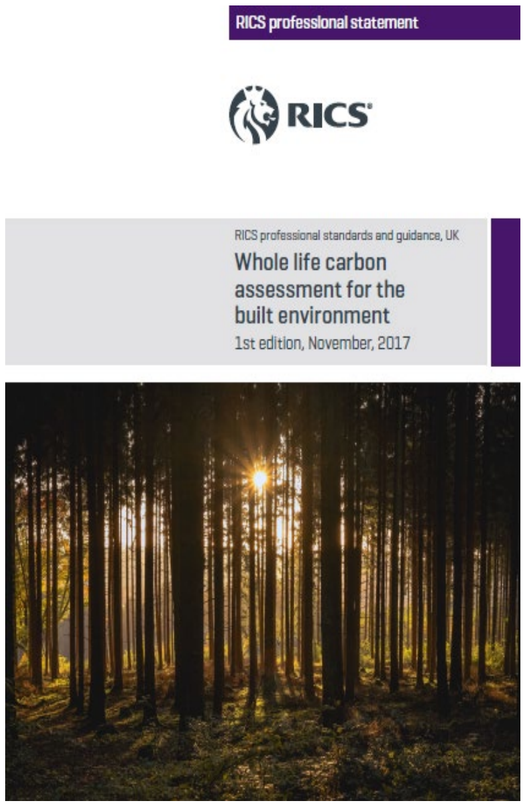
- BREEAM
- LEED
- BER
- Passivhaus
- EPD Construction Products
- LCC
- LCA

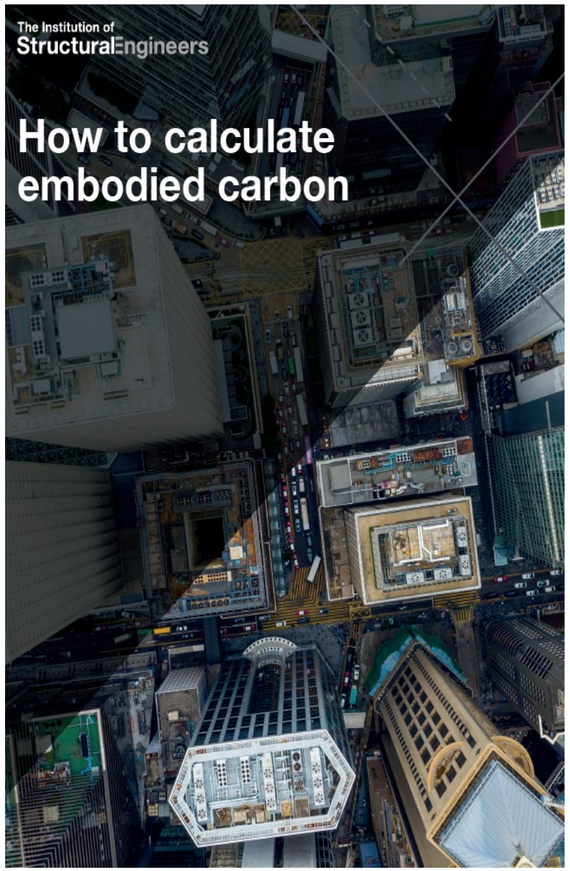
Life Cycle Analysis (Embodied Carbon)

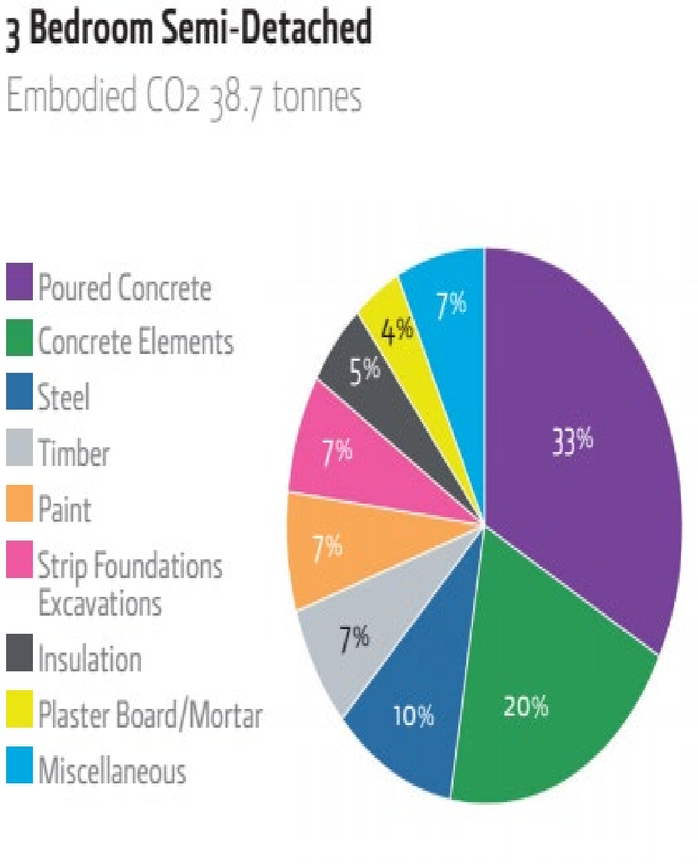




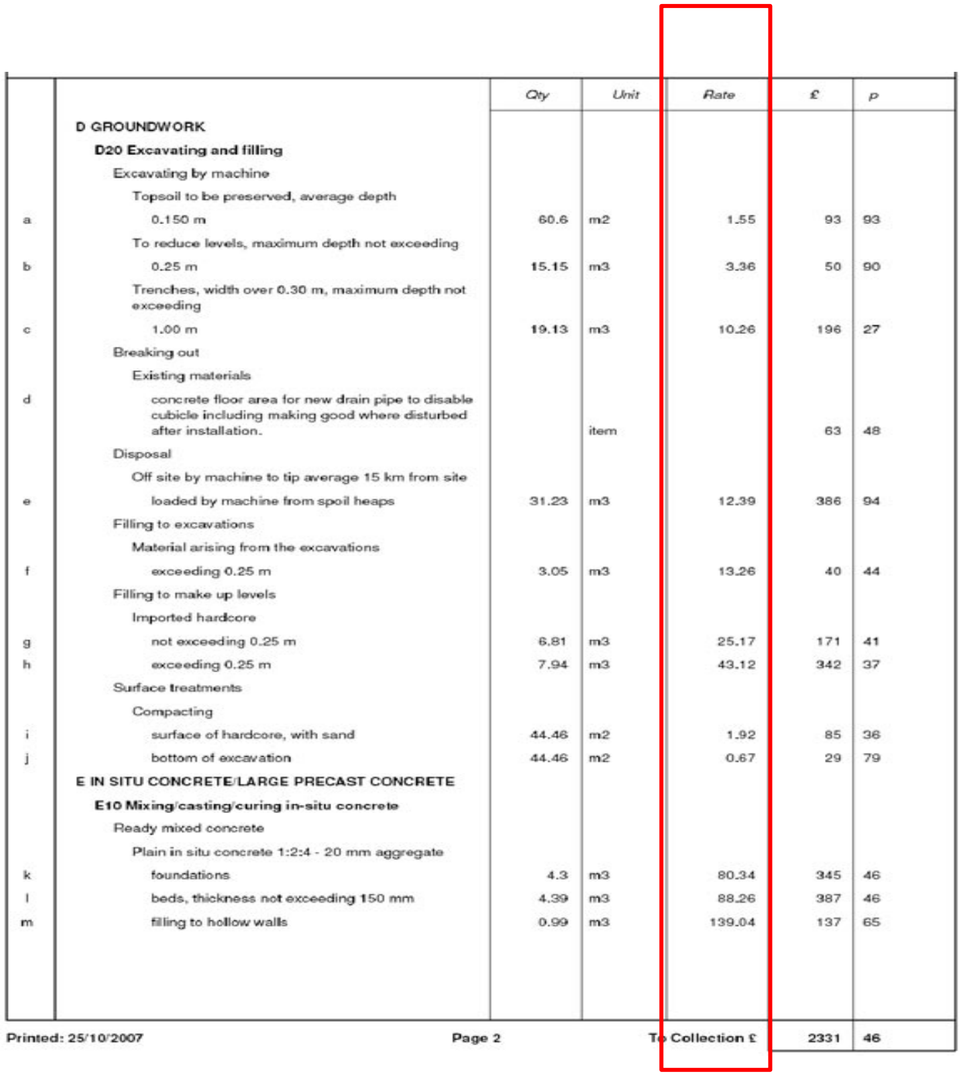
Embodied Carbon







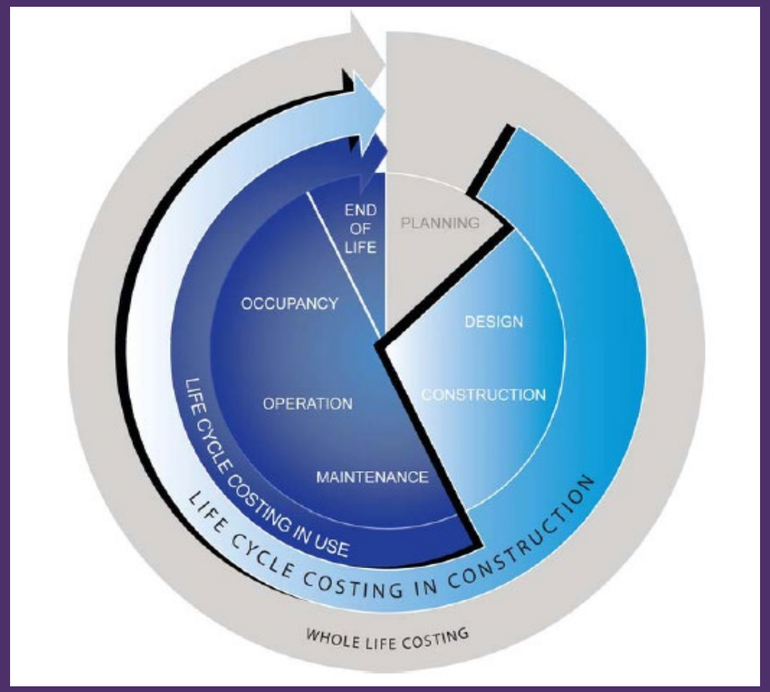
QS Already Use this Methodology



		Qty	Unit	Rate	£	p
	D GROUNDWORK					
	D20 Excavating and filling					
	Excavating by machine					
	Topsoil to be preserved, average depth					
a	0.150 m	60.6	m2	1.55	93	93
	To reduce levels, maximum depth not exceeding					
b	0.25 m	15.15	m3	3.36	50	90
	Trenches, width over 0.30 m, maximum depth not exceeding					
c	1.00 m	19.13	m3	10.26	196	27
	Breaking out					
	Existing materials					
d	concrete floor area for new drain pipe to disable cubicle including making good where disturbed after installation.		item		63	48
	Disposal					
	Off site by machine to tip average 15 km from site					
e	loaded by machine from spoil heaps	31.23	m3	12.39	386	94
	Filling to excavations					
	Material arising from the excavations					
f	exceeding 0.25 m	3.05	m3	13.26	40	44
	Filling to make up levels					
	Imported hardcore					
g	not exceeding 0.25 m	6.81	m3	25.17	171	41
h	exceeding 0.25 m	7.94	m3	43.12	342	37
	Surface treatments					
	Compacting					
i	surface of hardcore, with sand	44.46	m2	1.92	85	36
j	bottom of excavation	44.46	m2	0.67	29	79
	E IN SITU CONCRETE/LARGE PRECAST CONCRETE					
	E10 Mixing/casting/curing in-situ concrete					
	Ready mixed concrete					
	Plain in situ concrete 1:2:4 - 20 mm aggregate					
k	foundations	4.3	m3	80.34	345	46
l	beds, thickness not exceeding 150 mm	4.39	m3	88.26	387	46
m	filling to hollow walls	0.99	m3	139.04	137	65
	Printed: 25/10/2007	**Page 2**		**To Collection £**	**2331**	**46**

kgCO2e/per unit

(W) Life Cycle Costing (LCC)



LCC *An economic evaluation in which all costs arising from* **owning operating and maintaining** *a building over a certain study period or building life cycle are considered to be potentially important. (Fuller & Petersen)*

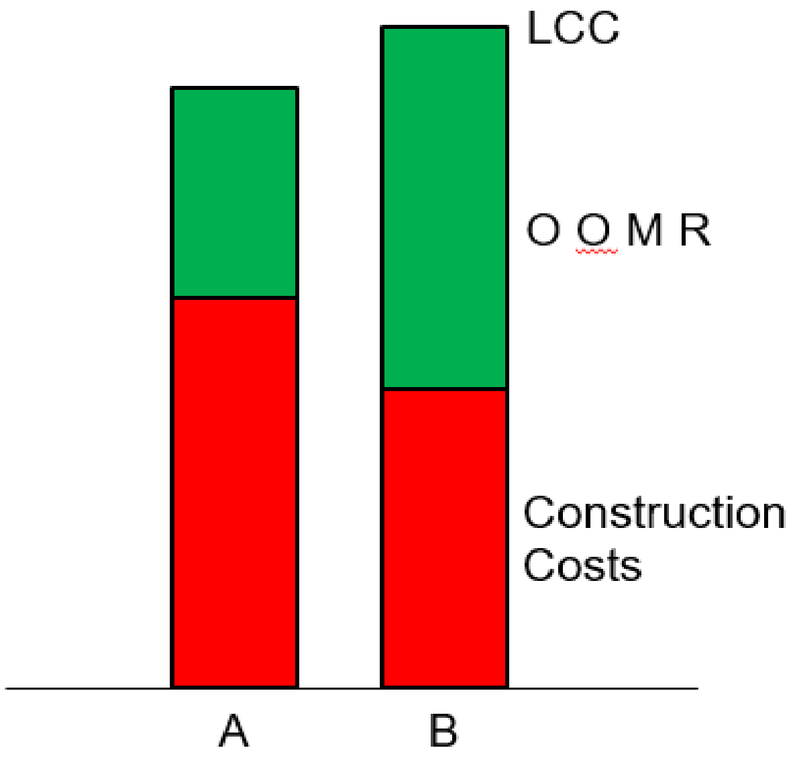
Why are QSs Concerned

- Matrix for Measuring Green Construction with LCA (ICMS)
- Focusing on IRR / Business Case
- Focus on Operating Costs 1:5:200 (FM)
- Procurement - PPP/PFI & Design Bid Maintain
- BIM (focus on Asset Management)

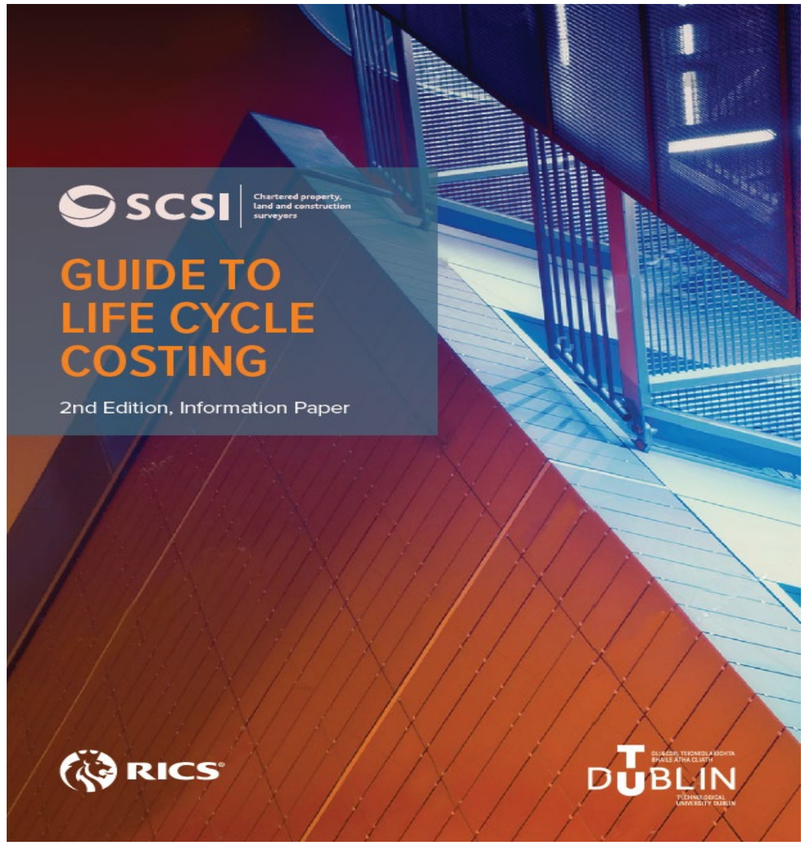
Benefits LCC (for the long road)

- **Feasibility & Appraisal (Macro)**
  - Rent Vs Construct
  - Refurbish Vs New Build
  - Traditional Vs Sustainable
- **Design Decisions (Micro)**
  - Component Selection
- **Measuring Sustainability (LEED BREEAM)**
  - Energy Modelling
  - Evaluation on Credits
  - Payback of renewable technologies
- **Asset Management**
  - Budget for the Facilities manager

Decision based on LCC



Guide to LCC 2nd Edition



- Documentation and Standardisation
- Benefits and Challenges of LCC
- LCC & ICMS 3
- Green Procurement
- MEAT and LCC
- Calculations
- LCC Data
- Tutorials

ICMS – New CHC and LCC & Carbon Emissions

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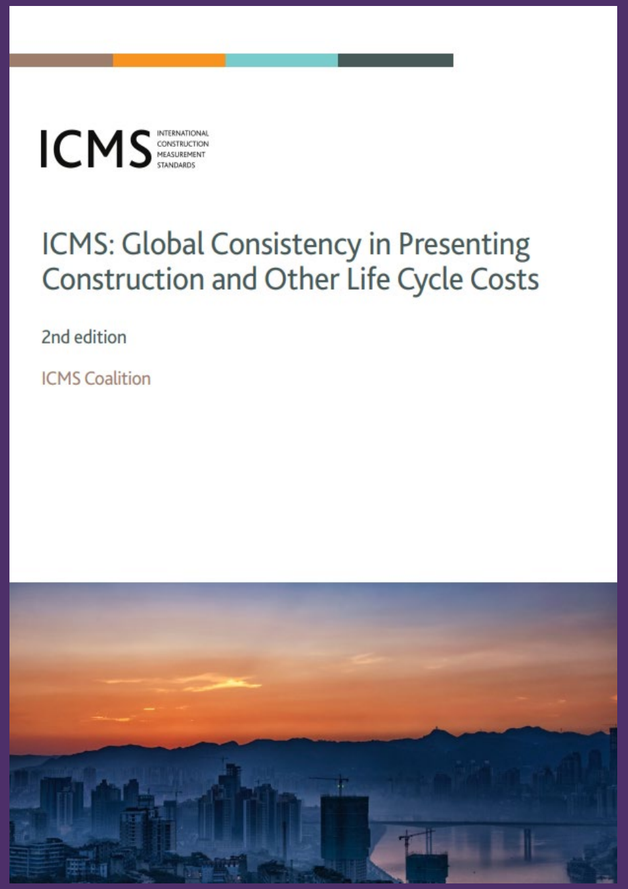
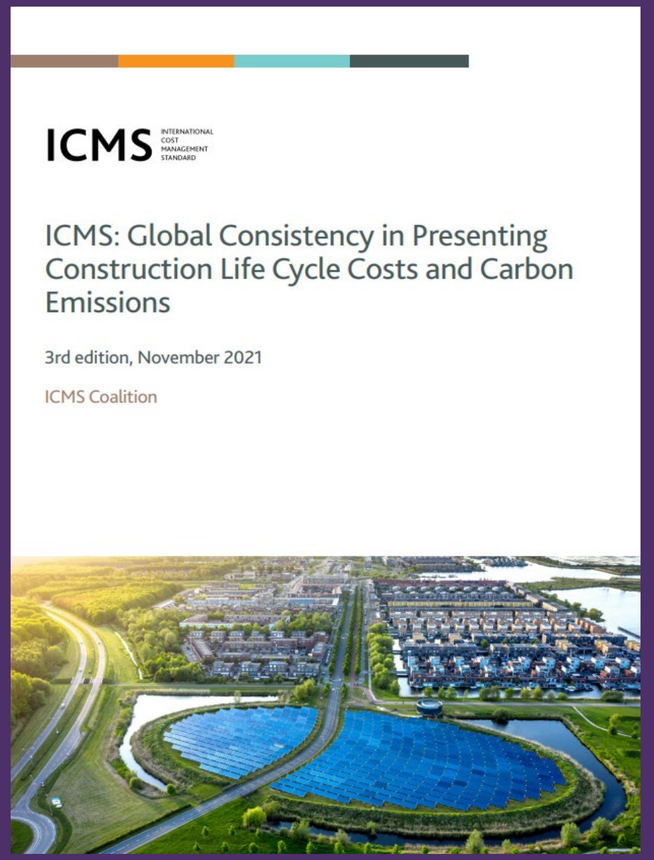


2019



2021

ICMS: LCC & Carbon

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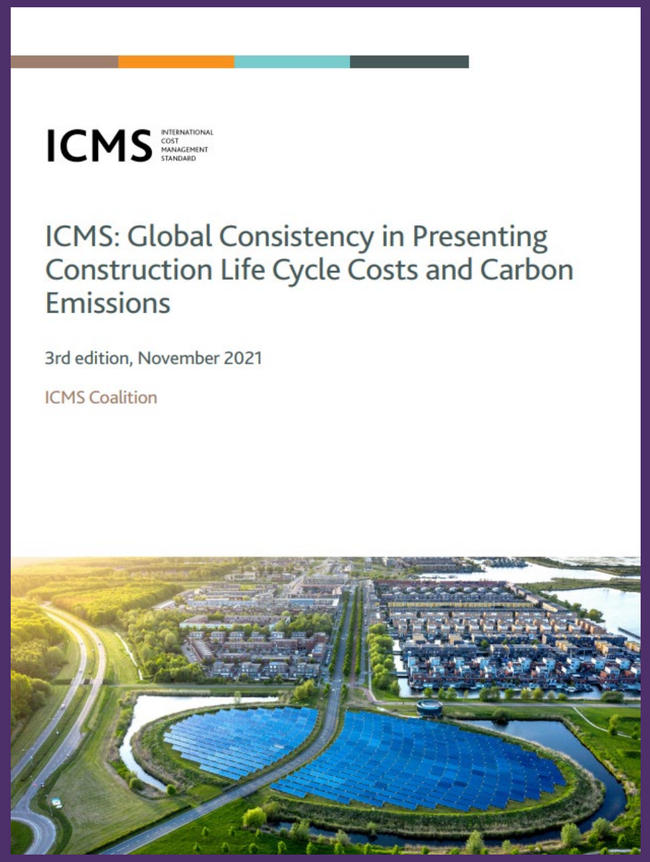
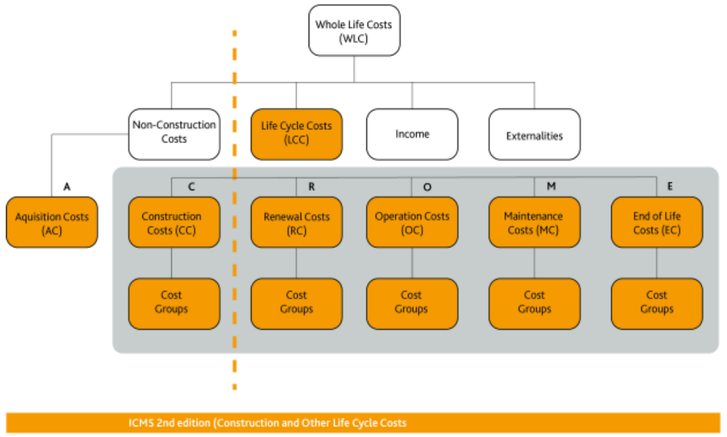
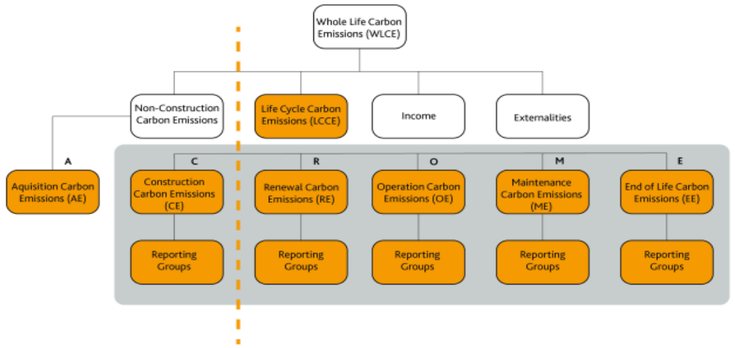


Figure 2: The relationship between ICMS, Life Cycle Costs (LCC) and Whole Life Costs (WLC)



'Occupancy Costs' are considered part of the 'Non-Construction Costs'.

Figure 3: Cost and Carbon Emission (CCE) reporting framework



Thus the reporting structures for costs and carbon emissions are identical.

ISO 15686-5 & ICMS 3 - LCC

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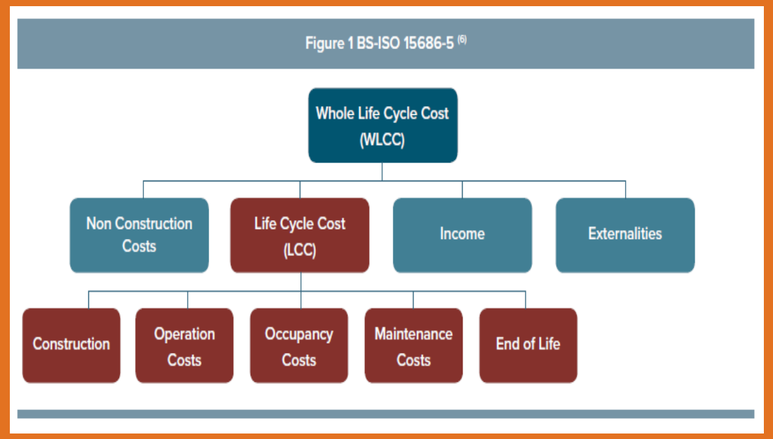
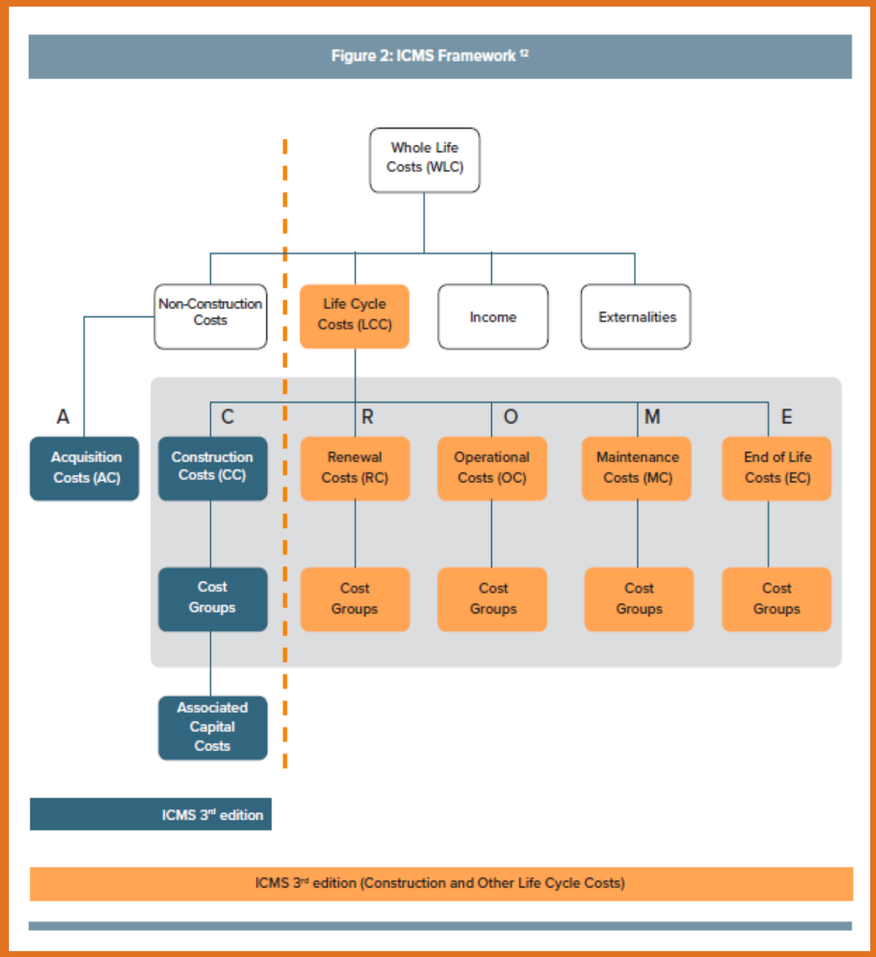


LCC may be reported at a lesser level of detail than the underlying analysis in ICMS.

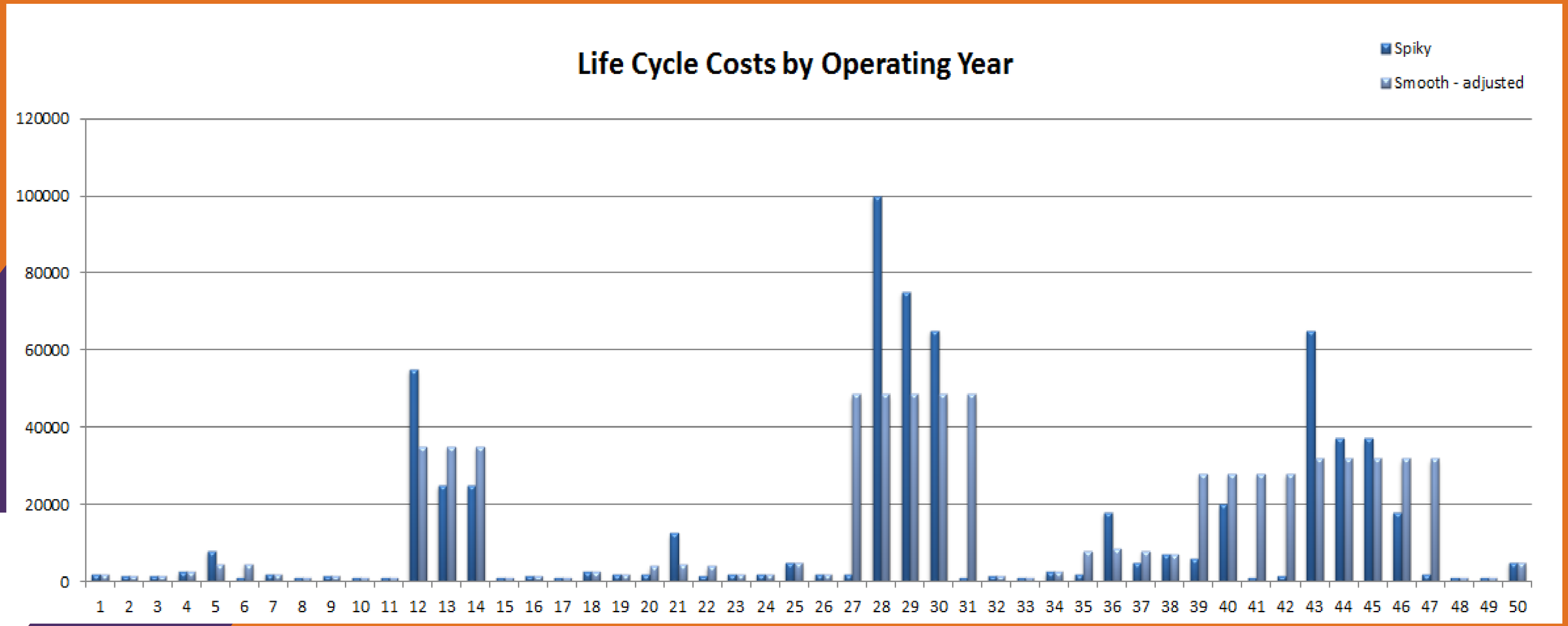


Current Use of LCC in Irish Public Procurement

- **Tendering where Vendor is involved over a longer period than construction**

- Public Private Partnerships (PPPs)
  - (even if its not part of their tender it must be part of their risk analysis)
- Design Build
  - Most Economically Advantageous Tender (MEAT)
  - Contractor influences OPex through their design
- Limited in Cost Management

Procurement - PPPs



Public Procurement in Ireland

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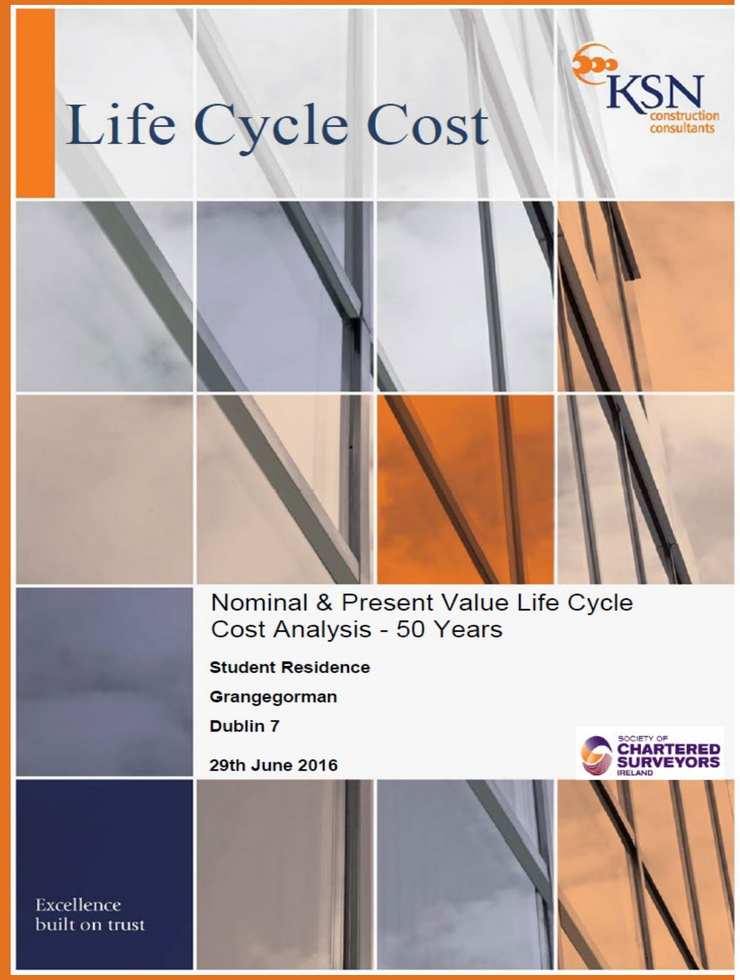
Capital Works Management Framework (2008)
Guidance Notes 2.2

‘Planning and Control of Capital Costs’

“Whole life costs are an important consideration throughout the design process, and should be integrated at each stage in cost plan development” GN. 2.2

Capital Cost Plan = Life Cycle Cost Plan

Example



KSN construction consultants

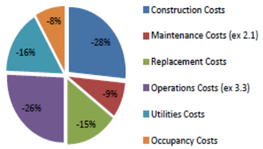
WLCC WLCC Summary Years 50

GIFA 20,465

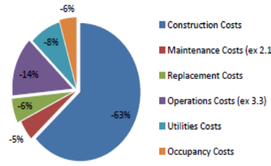
Beds 674

		Real LCC	€/m2	Nominal LCC	€/m2	Total Present Value	€/m2
	1.1 Construction Costs	-44,400,000	-2,170	-44,400,000	-2,170	-44,400,000	-2,1
	1.2 Other Construction Costs	-14,800,000	-723	-14,800,000	-723	-14,800,000	-7
CC	1.0 Construction Costs	-59,200,000	-2,893	-59,200,000	-2,893	-59,200,000	-2,8
	2.0 Maintenance Costs (ex 2.1)	-10,345,900	-506	-19,201,921	-938	-4,328,436	-2
	2.1 Replacement Costs	-16,120,000	-788	-32,953,296	-1,610	-5,268,323	-2
	3.0 Operations Costs (ex 3.3)	-30,839,800	-1,507	-57,238,462	-2,797	-12,902,512	-6
	3.3 Utilities Costs	-17,726,200	-866	-35,323,753	-1,726	-7,731,805	-3
	4.0 Occupancy Costs	-10,139,319	-495	-18,818,508	-920	-4,242,008	-2
	5.0 End of Life Costs (Incl 2.1)						
LLC	Life Cycle Cost (2.0 - 5.0)	-85,171,219	-4,162	-163,535,940	-7,991	-34,473,084	-1,6
TLLC	Total Life Cycle Cost (Incld Construction)	-144,371,219	-7,055	-222,735,940	-10,884	-93,673,084	-4,5
	6.0 Non Construction Costs						
	7.0 Income	326,890,000	15,973	606,705,644	29,646	136,761,658	6,6
WLC	Whole Life Cycle Cost	182,518,781	8,919	383,969,705	18,762	43,088,573	2,1
VAT	Vat (Incld in 1.2)						
WLC	Whole Life Cycle Cost (Inc. VAT)	182,518,781	8,919	383,969,705	18,762	43,088,573	2,1

Nominal Costs



Present Value



		Annual Costs	€/m2	%	674 beds €/bed
NAE	Net Annual Real Expediture				
	2.0 Maintenance Costs	-206,918	-10.11	12%	-307.00
	2.1 Replacement Costs (averaged)	-322,400	-15.75	19%	-478.34
	3.0 Operations Costs	-616,796	-30.14	36%	-915.13
	3.3 Utilities	-354,524	-17.32	21%	-526.00
	4.0 Occupancy Costs	-202,786	-9.91	12%	-300.87
NAE	Net Annual Real Expeniture	-1,703,424	-83.24	100%	-2527.34

KSN construction consultants

CF Cashflow €1,000's **NOMINAL CASH FLOW** Years 50

		Total	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	1.1 Construction	-44,400,000	-44,400																					
	1.1 Other Construction	-14,800,000	-14,800																					
	1.0 Construction	-59,200,000	-59,200																					
	2.1 Major Replacement	-32,953,296		0	0	0	0	-145	0	0	-621	0	-162	0	-509	0	0	-1,180	-742	0	0	0	-3,144	0
2.2/7	Maintenance (2.2-2.6 ex Rpl)	-19,201,921		-212	-216	-221	-226	-231	-236	-242	-247	-253	-258	-264	-270	-276	-283	-289	-295	-302	-309	-316	-323	-330
	2.0 Replacement & Maintenance	-52,155,217		-212	-216	-221	-226	-377	-236	-242	-869	-253	-421	-264	-780	-276	-283	-1,469	-1,038	-302	-309	-316	-3,467	-330
	3.0 Operations Costs	-92,562,215		-994	-1,017	-1,041	-1,065	-1,090	-1,116	-1,142	-1,169	-1,196	-1,224	-1,253	-1,282	-1,312	-1,342	-1,374	-1,406	-1,439	-1,473	-1,507	-1,542	-1,578
	4.0 Occupancy Costs	-18,818,508		-207	-212	-217	-222	-227	-232	-237	-242	-248	-253	-259	-265	-271	-277	-283	-290	-296	-303	-309	-316	-324
	5.0 End of Life Costs (Incl in 2.1)																							
LLC	Life Cycle Cost	-163,535,940		-1,413	-1,446	-1,479	-1,513	-1,694	-1,584	-1,621	-2,279	-1,696	-1,898	-1,776	-2,326	-1,859	-1,902	-3,126	-2,733	-2,037	-2,084	-2,132	-5,326	-2,232
	6.0 Non Construction Costs (Incl. Finance)	-142,689,826		-5,708	-5,708	-5,708	-5,708	-5,708	-5,708	-5,708	-5,708	-5,708	-5,708	-5,708	-5,708	-5,708	-5,708	-5,708	-5,708	-5,708	-5,708	-5,708	-5,708	-5,708
	7.0 Income	606,705,644		6,685	6,835	6,989	7,146	7,307	7,472	7,640	7,812	7,987	8,167	8,351	8,539	8,731	8,927	9,128	9,334	9,544	9,758	9,978	10,202	10,432
WLC	Whole Life Cycle Cost / Net Income (Leveraged)	300,479,879		-436	-318	-198	-74	-94	180	311	-175	583	561	867	505	1,164	1,318	295	893	1,799	1,967	2,138	-831	2,492
NI	%Profit/Capital Employed	210.58%																						
	Unleveraged - Nominal Cash Flow																							
LLC	Life Cycle Cost (Incld Construction)	-222,735,940	-59,200	-1,413	-1,446	-1,479	-1,513	-1,694	-1,584	-1,621	-2,279	-1,696	-1,898	-1,776	-2,326	-1,859	-1,902	-3,126	-2,733	-2,037	-2,084	-2,132	-5,326	-2,232
	6.0 Non Construction Costs (Incl. Finance)	Capital																						
	7.0 Income	606,705,644		6,685	6,835	6,989	7,146	7,307	7,472	7,640	7,812	7,987	8,167	8,351	8,539	8,731	8,927	9,128	9,334	9,544	9,758	9,978	10,202	10,432
WLC	Whole Life Cycle Cost / Net Income	383,969,705	-59,200	5,272	5,390	5,510	5,633	5,614	5,888	6,019	5,532	6,291	6,269	6,575	6,212	6,872	7,025	6,002	6,600	7,507	7,674	7,845	4,876	8,200
IRR	IRR (Unleveraged)	10.6%																						
PB	Payback Period (Nominal)	10.27																						

Reported Barriers to Implementation

- Contractors don’t have a role in design
- So Many Variables in Calculations
- Confusion with terminology (LCA, LCC, WLLC)
- Complicated & Longwinded Calcs
- Access to Life Cycle Cost Databases
- No useful rules of measurement or guidance notes
- Clients not Requesting it/don’t understand it
- What software do I use?
- **Training**

New GPP Policy

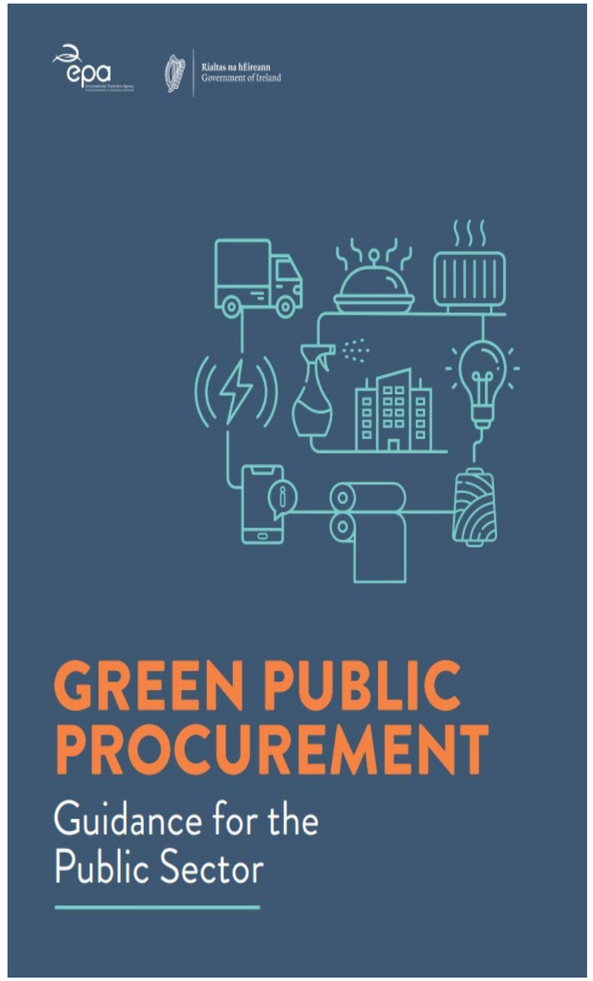
EU Directives

Directive 2014/24/EU (EU, 2014)

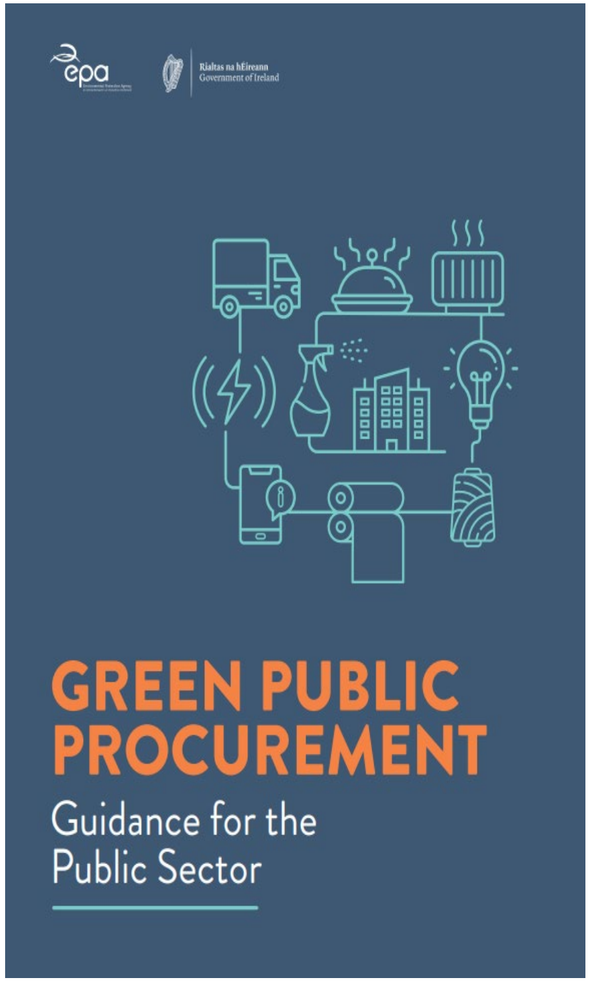
Directive 2014/24/EU (EU, 2014)

EPA GPP

2021 – Implement by 2023



Green Procurement



GPP IS DEFINED AS:

"A process whereby public and semi-public authorities meet their needs for goods, services, works and utilities by choosing solutions that have a **reduced impact on the environment throughout their life-cycle**, as compared to alternative products/solutions."[3]

This edition of the guidance includes fully updated Irish GPP criteria for **ten priority sectors:**

- Road transport vehicles and services
- Indoor and outdoor lighting
- ICT products and services (including data centres)
- Heating equipment (including boilers, cogeneration, trigeneration and heat pumps)
- Food and catering services
- Energy-related products (white goods/appliances, electronic displays, vacuum cleaners)
- Cleaning products and services
- Paper products and printing services
- Design, construction and management of office buildings
- Textile products and services (including uniforms and laundry services)

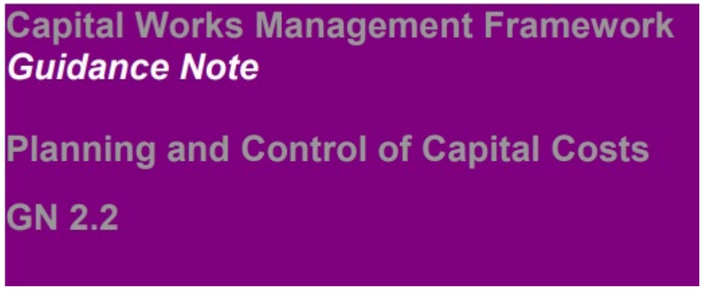
Ireland has committed to implementing green public procurement (GPP) in all tenders using public funds by 2023. This will require a major shift in the practices of public bodies and the businesses they contract with. This second edition of the **EPA Green Public Procurement Guidance** supports this transition by providing:

Green Public Procurement

- Irish Public Authorities are major consumers of good and services.
- Using their purchasing power to choose environmentally friendly goods, services and works.
- Main Techniques Available for CAs.
  - The specification of sustainable production processes and materials
  - Evaluation of tendering companies for their green track record and proposed sustainability practices
  - **LCC and LCA evaluation in design cost planning**
  - **MEAT utilising sustainability metrics such as LCA and LCC to select the most sustainable option**
  - Discounting abnormally low tenders on the grounds of compliance of environmental law.

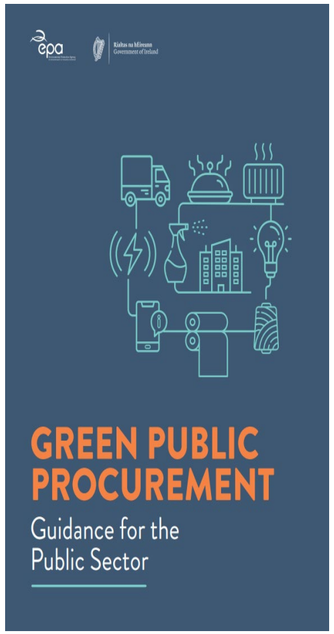
MEAT

- MEAT is a tender arrangement which meets the current economic needs of the Government and also their economic needs of the future, by evaluating a tender that considers **more than just the lowest price**.
- However, rarely is MEAT used as it was intended, and the lowest cost tender in many cases is still selected.
- The EU (2014/24/EU) & EPA GPP - MEAT should be expanded to take account of LCC and sustainability.



An Roinn Caiteachais Phoiblí agus Athchóirithe
Department of Public Expenditure and Reform

Public Spending Code



LCC and MEAT

- LCC in the MEAT encourages contractors to develop, and clients to evaluate, a tender which will reduce the Opex.

  -in traditional an LCC evaluation provides no real value, as the design and specification is fixed.

  -The most beneficial use of LCC is throughout the design process.

- If LCC is to be included in traditional procurement tender evaluation, a mechanism should be utilised where contractors can make proposals to the design and specification.

Problem in Ireland is:

- Unlike many of our European Neighbours
  - **Traditional Procurement Prevails**

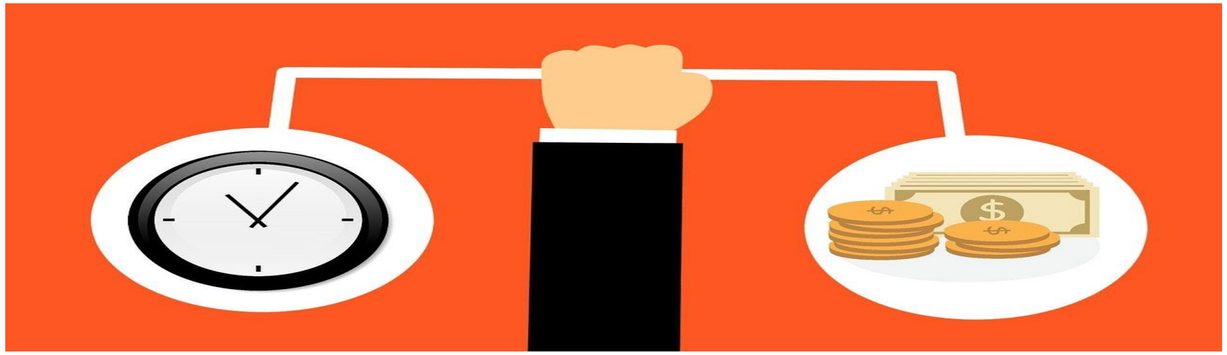
- So are we using LCC in Traditional Public Procurement ?
  - **No. (Not in the formulated sense)**
  - **Very Occasionally when client requested**

Opportunities for LCC in Procurement

- Incremental Analysis throughout Design Process (CWMF)
- ICMS / LCC & Carbon
- Value Engineering in Design & Component Selection
- Contractor role in VE and Spec Selection
- Constructability for Fee
- Parallel Tendering and Specialists w/ Design (especially with M&E)
- Earlier Contractor Involvement (ECI)
  - Two Stage Tendering (Novation or fee)
  - Design Build
  - Management Contracting / Construction Management

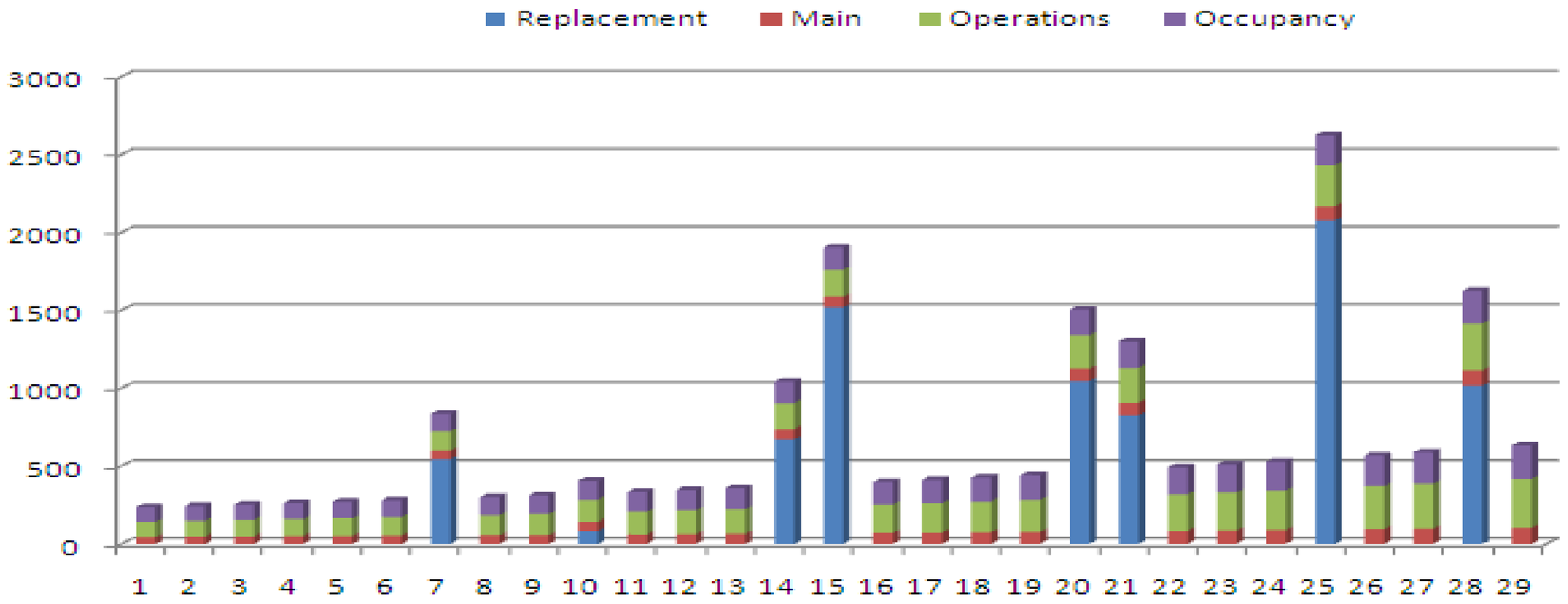
Representing LCC

- Cash Flows
- **Total Net Present Value**
- Payback Period
- Internal Rate of Return
- Annual Equivalent Cost
- Net Savings
- Savings to Investment Ratio



- Nominal Costs
- Present Value
- Real Costs

LCC is Ultimately Cash Flows - Cyclical Maintenance & Replacement

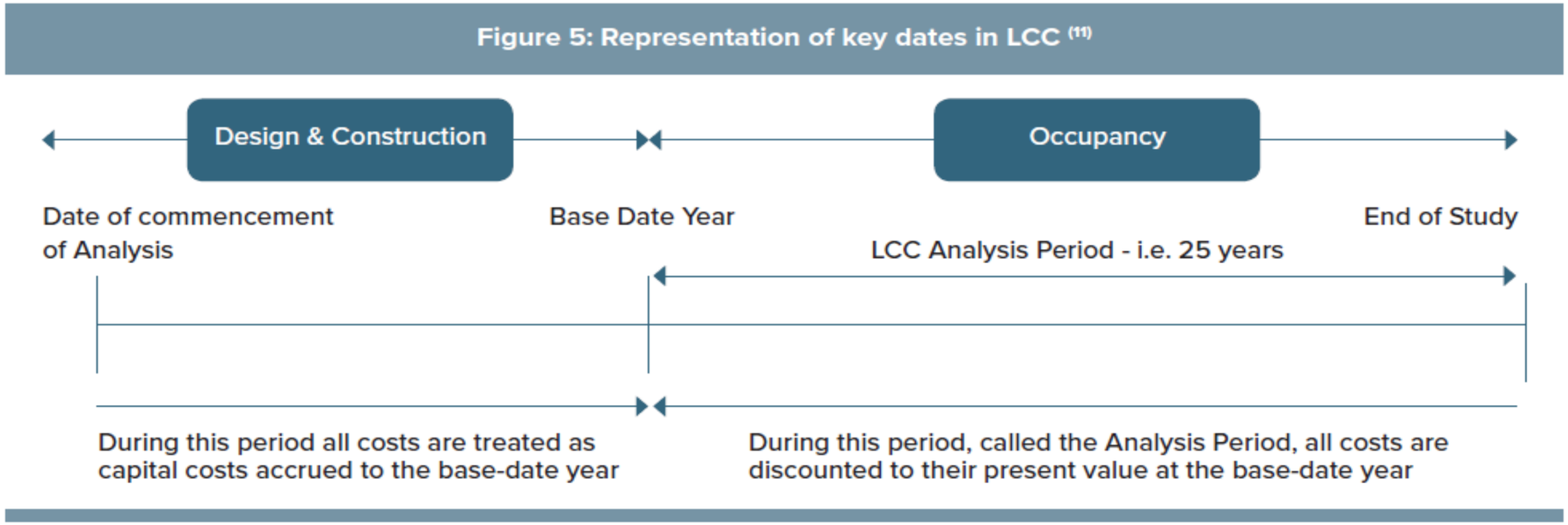


LCC as Cash Flows - Quite Common

- Hard to Compare with Cash Flows
- So what do you Do?
- Cash Flows and Total NPV
- Discount to an equivalent Time/Base
  - i.e discount to lump sum NPV so that you can compare

LCC Calculations

- NPV to Common Date
- Base Date (Year 0)



LCC Calculations

- Escalation Rates (Inflation)
  - Different products different rates
  - Energy Rates
- Discount Rates
  - Interest Rates
  - Opportunity Cost
- Time
  - Economic life
  - Functional life
  - Physical Life

$$\frac{1}{(1+r)^n}$$

r = discount rate, n = study period (usually years)

Equation 1: PV Factor [6]

Basis of Calculations

$$\frac{1}{(1+r)^n}$$ r = discount rate, n = study period (usually years)

Equation 1: PV Factor [6]

1st Stage

$$\text{Real Discounted Rate (r)} = \left[\frac{(1+i)}{(1+e)}\right] - 1$$

Equation 2: Real Discount Rate [13]

$$\text{PVFactor} = \frac{1}{(1+r)^1} + \frac{1}{(1+r)^2} + \frac{1}{(1+r)^3} + \frac{1}{(1+r)^4} + \frac{1}{(1+r)^5} + \cdots$$

Equation 4: Accumulated PV Factor [13]

$$\text{UPV Factor} = \frac{(1+r)^n - 1}{r(1+r)^n}$$

Equation 5: UPV Factor [4]

$$\text{UPV Factor} = \frac{(1+r)^n - 1}{r(1+r)^n} \qquad \text{SPV* Factor} = \left[\frac{[1+e]}{[1+i]}\right]^n$$

Equation 6: SPV*/UPV* Factor [4]

Table 1: 8% Table [34]

d= 8% d= 8%

DISCOUNT FACTORS

Discount Rate d = 8%

Year	Single Compound Amount SCA	Single Present Value SPV	Uniform Capital Recovery UCR	Uniform Present Value UPV	Uniform Sinking Fund USF	Uniform Compound Amount UCA
1	1.0800	0.9259	1.0800	0.9259	1.0000	1.0000
2	1.1664	0.8573	0.5608	1.7833	0.4808	2.0800
3	1.2597	0.7938	0.3880	2.5771	0.3080	3.2464
4	1.3605	0.7350	0.3019	3.3121	0.2219	4.5061
5	1.4693	0.6806	0.2505	3.9927	0.1705	5.8666
6	1.5869	0.6302	0.2163	4.6229	0.1363	7.3359
7	1.7138	0.5835	0.1921	5.2064	0.1121	8.9228
8	1.8509	0.5403	0.1740	5.7466	0.0940	10.637
9	1.9990	0.5002	0.1601	6.2469	0.0801	12.488
10	2.1589	0.4632	0.1490	6.7101	0.0690	14.487
11	2.3316	0.4289	0.1401	7.1390	0.0601	16.645
12	2.5182	0.3971	0.1327	7.5361	0.0527	18.977
13	2.7196	0.3677	0.1265	7.9038	0.0465	21.495
14	2.9372	0.3405	0.1213	8.2442	0.0413	24.215
15	3.1722	0.3152	0.1168	8.5595	0.0368	27.152
16	3.4259	0.2919	0.1130	8.8514	0.0330	30.324
17	3.7000	0.2703	0.1096	9.1216	0.0296	33.750
18	3.9960	0.2502	0.1067	9.3719	0.0267	37.450
19	4.3157	0.2317	0.1041	9.6036	0.0241	41.446
20	4.6610	0.2145	0.1019	9.8181	0.0219	45.762
21	5.0338	0.1987	0.0998	10.017	0.0198	50.423
22	5.4365	0.1839	0.0980	10.201	0.0180	55.457
23	5.8715	0.1703	0.0964	10.371	0.0164	60.893
24	6.3412	0.1577	0.0950	10.529	0.0150	66.765
25	6.8485	0.1460	0.0937	10.675	0.0137	73.106
26	7.3964	0.1352	0.0925	10.810	0.0125	79.954
27	7.9881	0.1252	0.0914	10.935	0.0114	87.351
28	8.6271	0.1159	0.0905	11.051	0.0105	95.339
29	9.3173	0.1073	0.0896	11.158	0.0096	103.97
30	10.063	0.0994	0.0888	11.258	0.0088	113.28
35	14.785	0.0676	0.0858	11.655	0.0058	172.32
40	21.725	0.0460	0.0839	11.925	0.0039	259.06
45	31.920	0.0313	0.0826	12.108	0.0026	386.51
50	46.902	0.0213	0.0817	12.233	0.0017	573.77

Note : All amounts end-of-year

Functions in Excel

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

Equation 7: PV Function MS Excel

=PV(0.03,8,0,325,0) = 256.56

Equation 8: PV Function Example (1)

=PV(0.03,8,325,0,0) = 2281.40

Equation 9: PV Function Example (2)

LCC Data

- Biggest Issue in LCC is access to meaningful data
- Data collected and categorised in a myriad of ways
- ICMS lead to consistency, where robust data can be used and preferably shared to introduce more certainty into the prediction and control of LCC

Access to Data

- **Unstructured Historical Data**
  - FM Departments
  - Accounts Departments
  - QS Databases
  - PFI/PPP Data
- **Structured Historical Data**
  - BCIS UK Online
  - RS Means Online
- **Data from Modelling**
  - 1st Estimating Principles
- **Data from Suppliers**

Tutorials

Life Cycle Costing in Excel 1 – Video
LCC Excel Template - 1
LCC Excel Solution - 1

Life Cycle Costing in Excel 2 – Video
LCC Excel Template - 2
LCC Excel Solution - 2

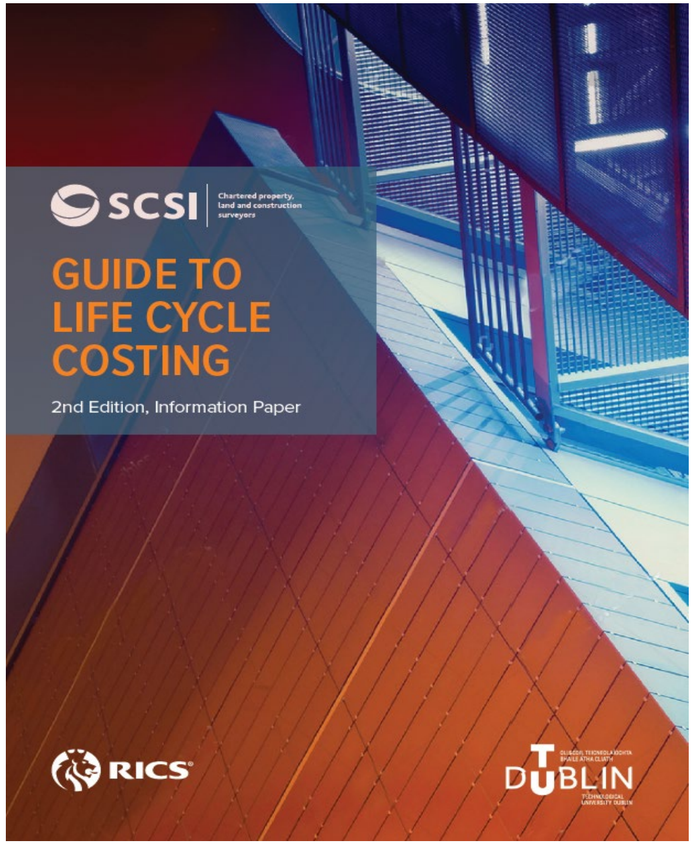
Life Cycle Costing Exercise 1 - Video
LCC Excel Template - 1
LCC Excel Solution - 1

Life Cycle Costing Exercise 2 - Video
LCC Excel Template - 2
LCC Excel Solution - 2

Life Cycle Costing Exercise 3 - Video
LCC Excel Template - 3
LCC Excel Solution - 3

Life Cycle Costing Exercise 4 - Video
LCC Excel Template - 4
LCC Excel Solution - 4

LCC with ICMS – Video
LCC ICMS Template
LCC ICMS Solution



LCC Calculations (ICMS)

- ICMS in Forecast Costs (Nominal Costs)
- Discounted Costs (NPVs)
- But to Calculate Forecast Costs you need Real Costs
- Not very onerous

Template for Life Cycle Costs for a Project

ICMS INTERNATIONAL CONSTRUCTION MEASUREMENT STANDARDS

- $M NPV = $M as paid × Discounting Factor.
- $M as paid = amount at the time of payment.
- Discounting Factor should take into account the effect of different times of payments more than once.

Cost code	Description	<Insert Project Type>					
		$M as paid	Discounting Factor	$M NPV	$/Qty	% by Category	% of Total
	Project Quantity				(insert Qty)		
					(insert Qty's Attribute)		
	Life Cycle Cost (CC plus NPV of RC, OC, MC, and EC)						**100.0%**
1.	Acquisition Costs (AC) [Part of Non- Construction Costs]						
2.	Construction Costs (CC)						
3.	Renewal Costs (RC)						
4.	Operation Costs (OC)						
5.	Maintenance Costs (MC)						
6.	End of Life Costs (EC)						
1.	**Acquisition Costs (AC)**					**100.0%**	
1.01.	Site acquisition						
1.02.	Administrative, finance, legal and marketing expenses						

Summary

- LCC not currently carried out in Traditional Procurement
- LCC in PPP and Design Build
- LCC is in the CWMF
- LCC is incorporated in ICMS
- Knowledge and Training
- Collection of LCC data

Thank you!