# C.C.DC

#### IMPLIMENTING CIRCULAR ECONOMY PRINCIPLES



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#### UNIVERSITY OF CAMBRIDGE I DEPARTMENT OF ENGINEERING

#### CIVIL ENGINEERING BUILDING



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GRIMSHAW smithandwallwork MAXFORDHAM

AECOM

PROJECT BRIEF







#### CUED MASTERPLAN BRIEF

















### LIFE-CYCLE COSTING

MINIMISING WHOLE LIFE ENERGY WITHIN A COST CONSCIOUS FRAMEWORK





MINIMISING WHOLE LIFE ENERGY WITHIN A COST CONSCIOUS FRAMEWORK



## OBJECTIVE FUNCTION $F = E + C / \alpha$













OBJECTIVE FUNCTION  $F = E + C / \alpha$ 

#### ENERGY COST METRIC – INTEGRATED ENERGY DESIGN





#### ENERGY COST METRIC – BOUNDRY CONDITIONS









#### **ENERGY COST METRIC – BOUNDARY CONDITIONS**





#### **ENERGY COST METRIC – SEMI-SUBJECTIVE DESIGN**



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#### **ENERGY COST METRIC – IN-USE ENERGY**





#### **FAÇADE DfD – ESTIMATING RESIDUAL VALUE**

04 - Composite Cladding Panels

Combined 4



03 - Stick Curtain Wall (Timber Mullions)





















05 - Masonry Wall



Energy (Production) + Energy (Transport) + Energy (Assembly) + Energy (Recycling)

Total EE

(GJ/Kg)

0.209

0.015

0.215

0.215

= Embodied Energy per material

06 - Rainscreen



Embodied Energy per facade m<sup>2</sup> (GJ/m<sup>2</sup>)



2.922 EEnergy (Aluminium) + EEnergy (Combined DGU)

01 - Stick Curtain Wall (Aluminium Mullions)

= Embodied Energy per facade m<sup>2</sup>



**Total lifetime** building Embodied Energy (GJ/year)\*



Annualised Building Embodied Energy (GJ/year)



02 - Stick Curtain Wall (Steel Mullions)

Embodied Energy per facade m<sup>2</sup> x Facade Area

9418

= Total lifetime building embodied energy



EEnergy (Production) / Projected life time

= Annualised Building embodied energy

0.047 1.335 2461 34 Comis ned (1GU) 89 0.023

Ufetime Et Ufetime Et (Kalding) Styler<sup>2</sup> Styler Euriding Lifetime EE (Sal/Sr) Building Ufetime BC (66/70) Bolify Annualited EP Total E E (61/52) Tetal EE GL/m<sup>2</sup> Ufetime EE (Rackling) (60/97) Nass Uletime 85 (Kg/mž) (Ks//Kg Hass Ufstime EE Ufstime EE 04(7m2) (64/94) (64/94) Total EC Gi/m<sup>2</sup> Tutal EE Total CE (SU/m<sup>1</sup>) Primary Materials Mais (sg/m2) Primary Noterials Friesary Naterials Primary Materials Mais (sg/m2) Total EE (61/5g) Total EE GL/m<sup>2</sup> Printary Materials Nasi (Kg/m2) Total EE (GAVRE) Frimary Naterials Mess (%//n2) Annualized i Mine SE (6//11 48.0 Steel Sab Fra Facing Brick Block Timber Glass (DGU) We lat if prue

Combined (TGU)

#### MAXIMISING UPGRADABILITY





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GRIMSHAW

#### IMPLEMENTING DfD PRINCIPLES









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Construction

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Construction

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Technical Design

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Construction

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#### RAMBOLL

Job number	2800
Sheet number	SK/S/050
Date	05/07/18
Eng	PDA
Checked	LSA





# THANK YOU