



# CRAVEzero

Towards the definition of a nZEB cost spreadsheet as a support tool for the design

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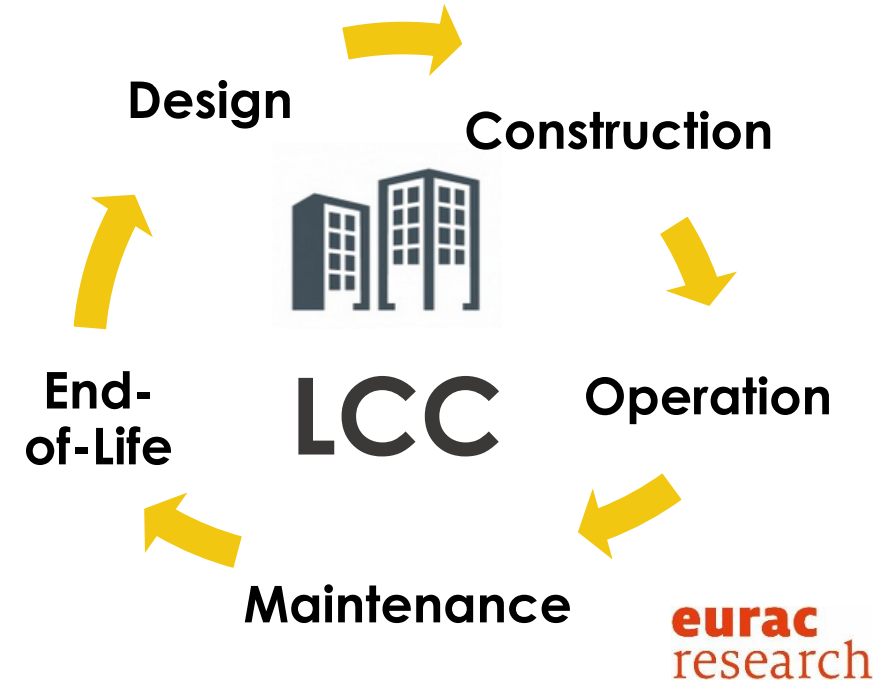
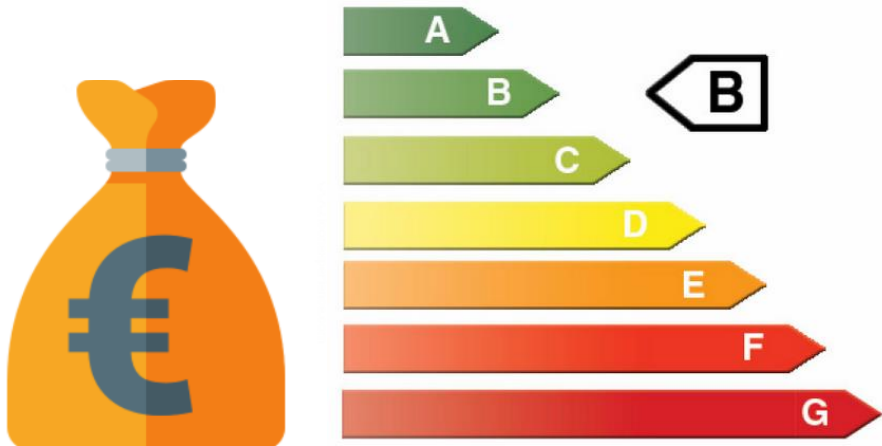
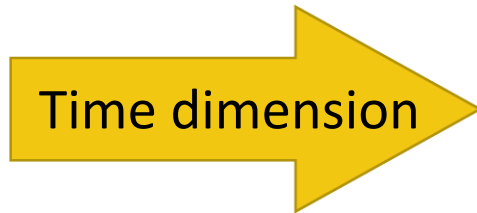
# CRAVEzero

Cost Reduction and market Acceleration for Viable nearly zero-Energy buildings



Initial investment  
Calculated yearly energy demand

Life Cycle Cost



European Commission | Horizon 2020 European Union funding for Research & Innovation



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# CRAVEzero

Cost Reduction and market Acceleration for Viable nearly zero-Energy buildings



01

## Data collection

Case studies

02

## Life Cycle Cost

Methodology

03

## Normalisation

04

## Spreadsheet

05

## Comparative analysis

Results

06

## Sensitivity analysis



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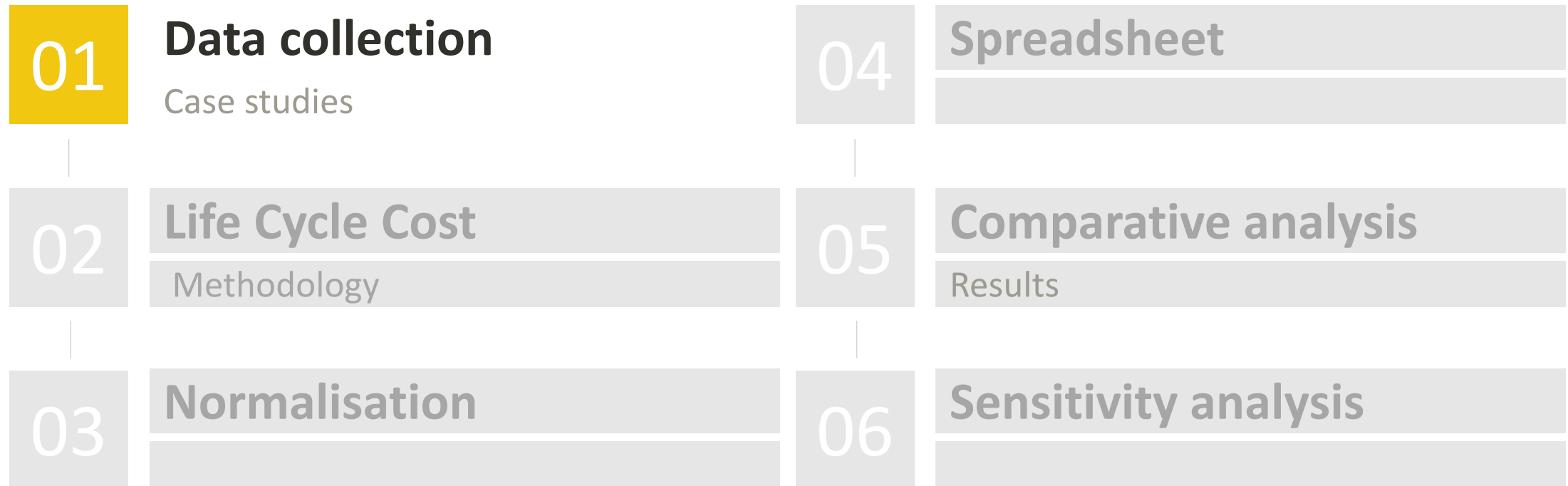


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# 01

# Data Collection

Case studies

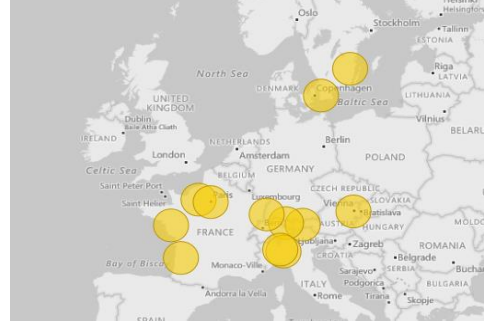
## CRAVEzero nZEB Frontrunner Buildings



Residential



Office



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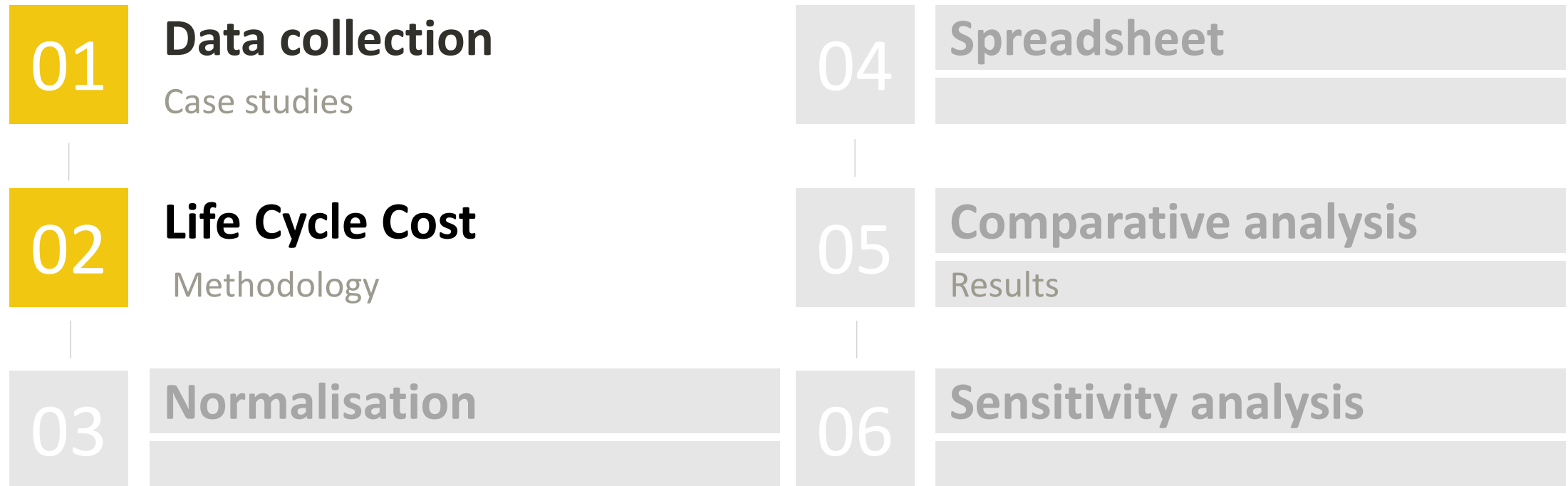


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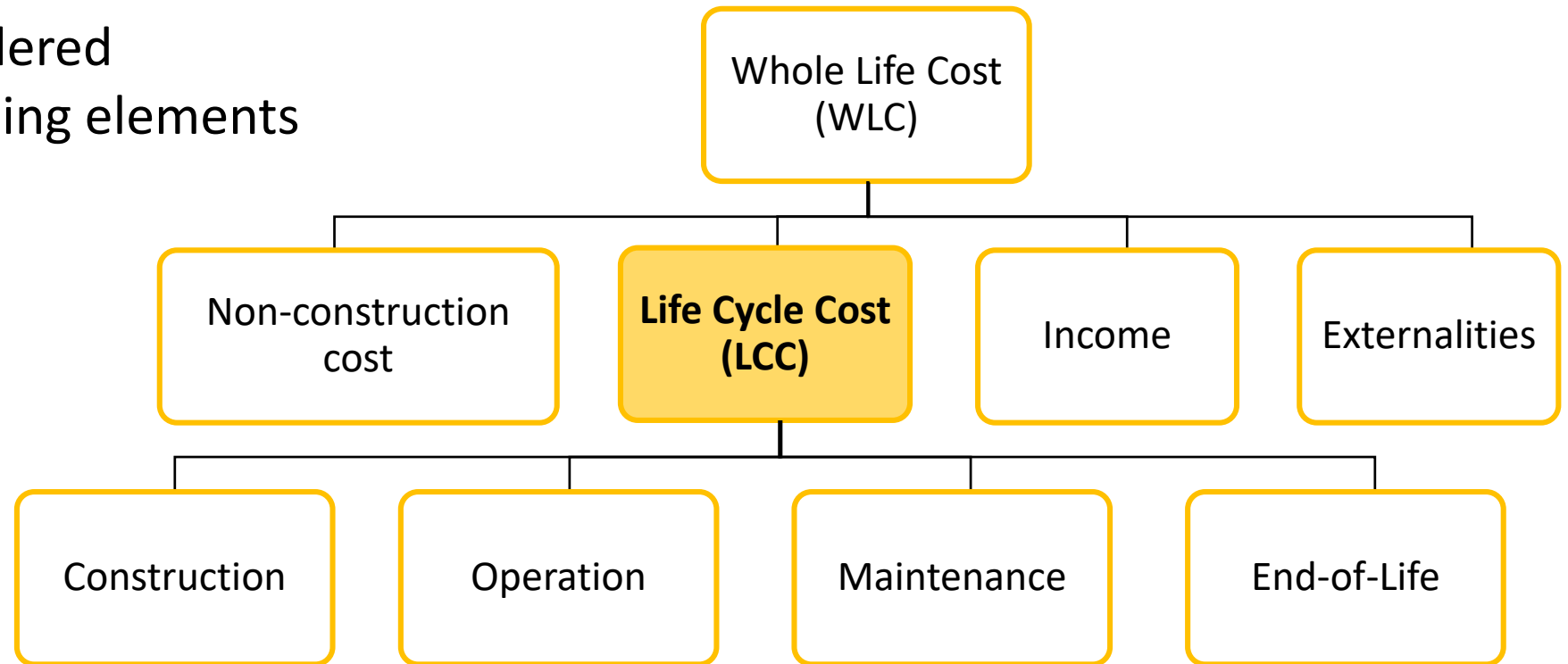
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## Main references: ISO 15686-5:2008 + Code of measurement for cost planning

- Phases to be considered
- Brakedown of building elements

$$LCC = \sum_{n=1}^p \frac{C_n}{(1+d)^n}$$

LCC = NPV (40 years) for the costs associated to each phase



REF: ISO 15686 - Buildings and constructed assets -- Service life planning -- Part 5: Life-cycle costing  
 EEC Code of Measurement for Cost Planning. <https://www.ceecorg.eu/>

# 02

# Life Cycle Cost

Methodology

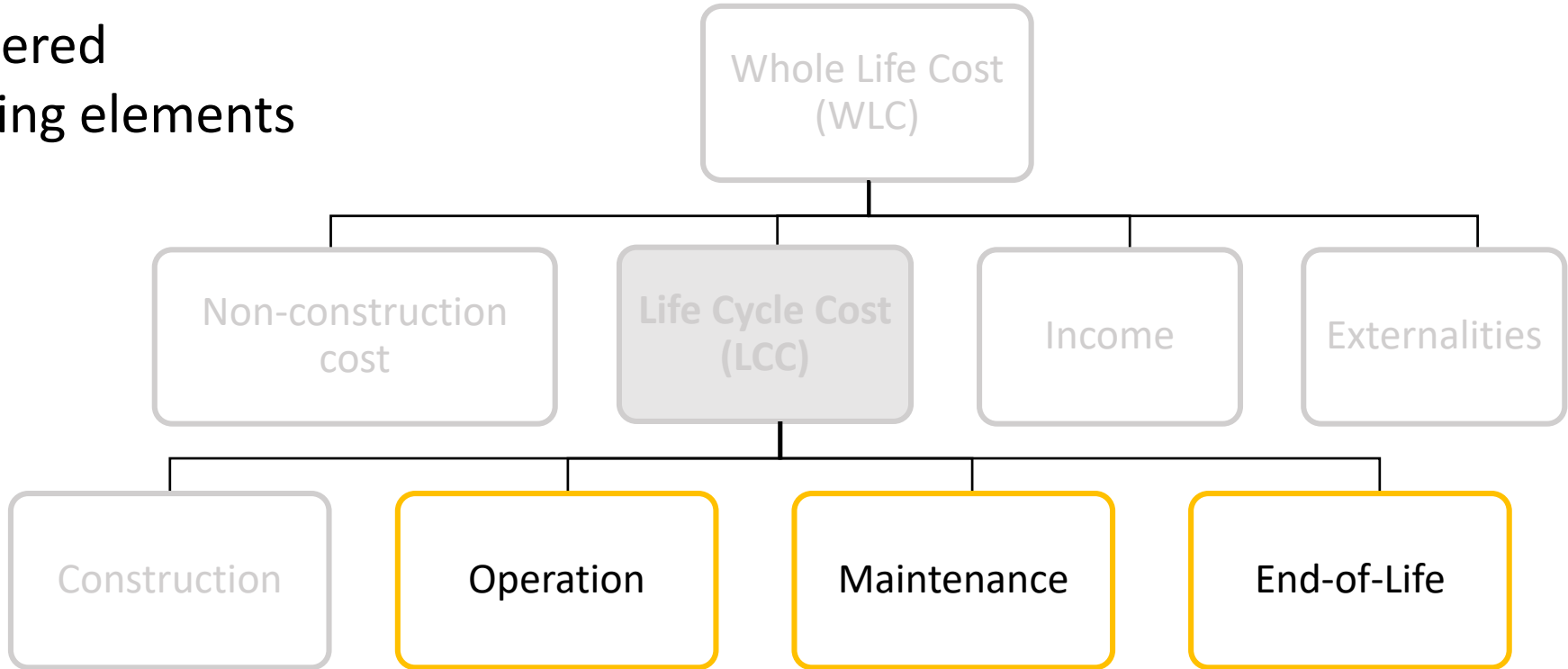


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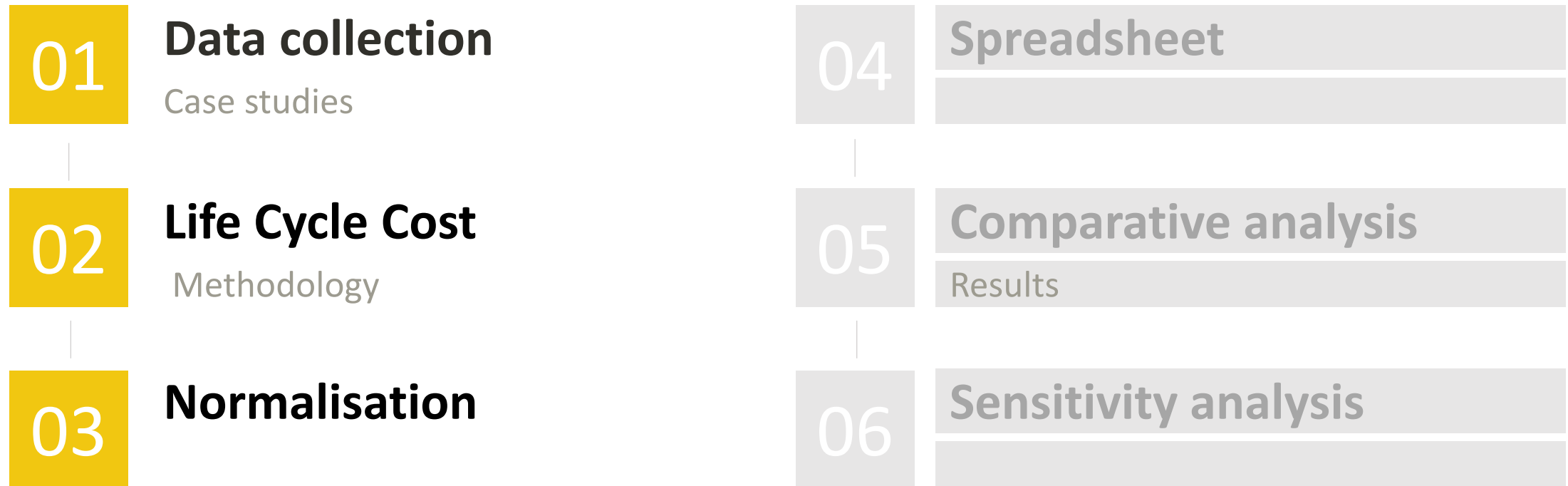
REF: ISO 15686 - Buildings and constructed assets -- Service life planning -- Part 5: Life-cycle costing  
 EEC Code of Measurement for Cost Planning. <https://www.ceecorg.eu/>

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Cost Reduction and market Acceleration for Viable nearly zero-Energy buildings



# 03


# Normalisation




 <p><b>Construction costs:</b> Cost index from <a href="http://constructioncosts.eu">http://constructioncosts.eu</a></p>	 <p><b>Energy costs:</b> Average prices from Eurostat</p>
 <p><b>Climate conditions:</b> Heating degree days</p>	 <p><b>Building surface:</b> Gross floor area</p>




Construction Cost Index	
France	103.87%
Austria	100.67%
Germany	96,62 %
Italy	91,63 %
Sweden	134,19 %



**Energy costs:**  
Average prices from Eurostat



**Building surface:**  
Gross floor area



**Climate conditions:**  
Heating degree days

# CRAVEzero

Cost Reduction and market Acceleration for Viable nearly zero-Energy buildings



**01** **Data collection**  
Case studies

**02** **Life Cycle Cost**  
Methodology

**03** **Normalisation**

**04** **Spreadsheet**

**05** **Comparative analysis**  
Results

**06** **Sensitivity analysis**

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## General project information

**General Project Information / Energy Costs**  
(CRAVEzero cost Spreadsheet based on ISO 15686 and EconCalc - for internal use only)

**LEGEND**

Cell to be filled-in with input values | Cell to be filled-in with text, comments and references | Automatic calculation

**PROJECT DATA**

Name:

Nation/Regionality:

Location:

Author:

Building User/Typology:

Construction year:

Variants:

**BUILDING SURFACES AND VOLUMES**

Gross floor area (GFA):  m<sup>2</sup>

Net floor area (NFA):  m<sup>2</sup>

Gross volume:  m<sup>3</sup>

Net volume:  m<sup>3</sup>

**UNHEATED AREAS**

Gross floor area (GFA):  m<sup>2</sup>

Net floor area (NFA):  m<sup>2</sup>

Gross volume:  m<sup>3</sup>

Net volume:  m<sup>3</sup>

**OTHER AREAS**

Balconies, terraces, winter gardens, porches...:  m<sup>2</sup>

Other surfaces:  Description  m<sup>2</sup>

## Whole Life Cost

**WHOLE-LIFE COST**

**NON-CONSTRUCTION COSTS**

	#1	#2
<b>COST OF LAND</b>		
Area	<input type="text"/>	<input type="text"/> m <sup>2</sup>
Building Index	<input type="text"/>	<input type="text"/> m <sup>2</sup> /m <sup>2</sup>
Volume to build	<input type="text"/>	<input type="text"/> m <sup>3</sup>
Floor height	<input type="text"/>	<input type="text"/> m
Surface building Area	<input type="text"/> #DIV/0!	<input type="text"/> #DIV/0! m <sup>2</sup>
<b>PRICE</b>		
	<input type="text"/>	<input type="text"/> €/m <sup>2</sup>
	<input type="text"/>	<input type="text"/> €
<b>ENABLING COSTS</b>	<input type="text"/>	<input type="text"/> €
	<input type="text"/>	<input type="text"/> €
	<input type="text"/>	<input type="text"/> €
<b>PLANNING FEES</b>	<input type="text"/>	<input type="text"/> €
	<input type="text"/>	<input type="text"/> €
	<input type="text"/>	<input type="text"/> €
<b>USER SUPPORT COSTS</b>		
Property management	<input type="text"/>	<input type="text"/> €
Use charges	<input type="text"/>	<input type="text"/> €
Administration	<input type="text"/>	<input type="text"/> €
<b>FINANCE COSTS</b>		
Interest or costs of money	<input type="text"/>	<input type="text"/> €
<b>TOT.</b>	<input type="text"/>	<input type="text"/> €

## Construction cost

**Life Cycle Cost**

**CONSTRUCTION COSTS (Based on ISO15686)**

	MATERIALS	LABOR	OTHER COSTS
	AGGREGATED	AGGREGATED	AGGREGATED
	QUANTITY	PRICE	YEAR
<b>Building elements</b>			
A1: Roofs			Building element tot: 159.846 €
A1.01: Flat roof			Building element tot: 159.846 €
A1.01.01: DA-21 wooden frame (ventilat)	Area: 107 m <sup>2</sup>	5.347 €/m <sup>2</sup>	572.206 €
terrace wood	107 m <sup>2</sup>	11.275 €	11.275 €
terrace substructure	107 m <sup>2</sup>	3.081 €	3.081 €
floor fill	107 m <sup>2</sup>	180.0 €	180.0 €
hard insulation (EPS)	107 m <sup>2</sup>	2.027.4 €	2.027.4 €
stainless sheathing	107 m <sup>2</sup>	2.028.4 €	2.028.4 €
stainless support	107 m <sup>2</sup>	114.0 €	114.0 €
Layer 7	107 m <sup>2</sup>	- €	- €
Layer 8	107 m <sup>2</sup>	- €	- €
Layer 9	107 m <sup>2</sup>	- €	- €
Layer 10	107 m <sup>2</sup>	- €	- €
A1.01.02: DA-22 terrace (ventilat nat)	Area: 107 m <sup>2</sup>	7.645 €	818.450 €
terrace relative floor	107 m <sup>2</sup>	2.072 €	2.072 €
floor fill	107 m <sup>2</sup>	120.2 €	120.2 €
hard insulation (EPS)	107 m <sup>2</sup>	1.981.0 €	1.981.0 €
stainless sheathing	107 m <sup>2</sup>	1.921.4 €	1.921.4 €
stainless support	107 m <sup>2</sup>	72.9 €	72.9 €
Layer 6	107 m <sup>2</sup>	- €	- €
Layer 7	107 m <sup>2</sup>	- €	- €
Layer 8	107 m <sup>2</sup>	- €	- €
Layer 9	107 m <sup>2</sup>	- €	- €
Layer 10	107 m <sup>2</sup>	- €	- €



# LCC Spreadsheet

CRAVEzero nZEB spreadsheet



## Section 1: Investment cost

- Share for design/materials/labour
- Design cost (preliminary, etc.)
- Cost for materials and labour
- Brakedown for building elements



## Section 2: Life Cycle Cost

- Yearly LCC
- Brakedown for life cycle phases
- Energy and maintenance

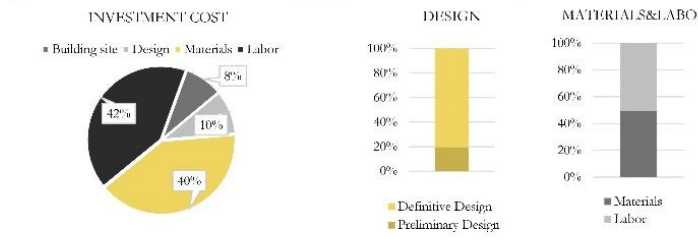


### DEMO CASE 9 – SOLALLÉN – SKANSKA

**GENERAL INFORMATION**

Architect: Skanska Teknik  
 Energy concept: Net ZEB  
 Location: Växjö (Sweden)  
 Construction Date: 2015  
 Net floor area: 1778 m<sup>2</sup>  
 Primary Energy Demand: 109 kWh/(m<sup>2</sup>a)  
 Key technologies: Well insulated and air tight, Balanced ventilation with heat recovery, Ground source heat pump, Photovoltaic panels

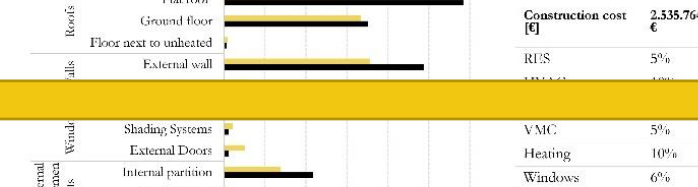
### INVESTMENT COSTS



INVESTMENT COSTS	DESIGN COSTS	BUILDING SITE MANAGEMENT	CONSTRUCTION COSTS
3.095.764 €	300.000 €	260.000 €	2.535.764 €

Material and labor cost [€]

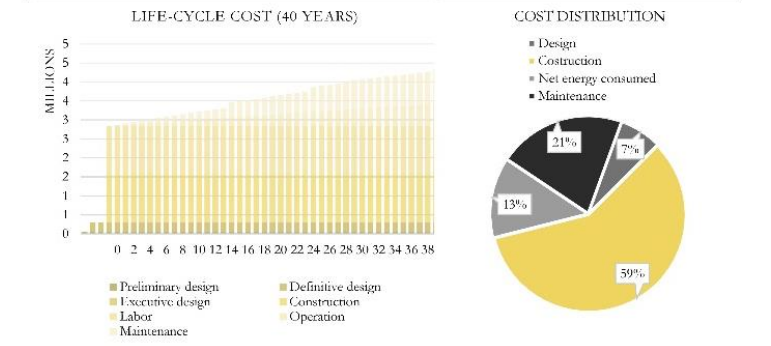
Impact of nZEB technologies on the investment cost



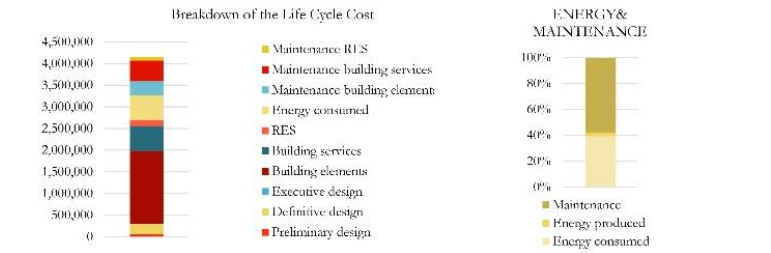
**Final Energy Consumption**

Construction cost [€]	2.535.764
RES	5%
VMC	5%
Heating	10%
Windows	6%
Energy demand heating [kWh]	32.688
Energy demand cooling [kWh]	785
Energy demand DHW [kWh]	11.138
Household electricity [kWh]	47.258
Annual RES generation [kWh]	32.688
Annual CO <sub>2</sub> Emissions [kgCO <sub>2</sub> ]	48.895

### LIFE CYCLE COSTS



WLCC (40)	MAINTENANCE	MAINT./INVEST.	LCC (40)	ENERGY (40)	RES/LCC
5.548.872 €	916.519 €	30%	4.588.972 €	576.689 €	3%



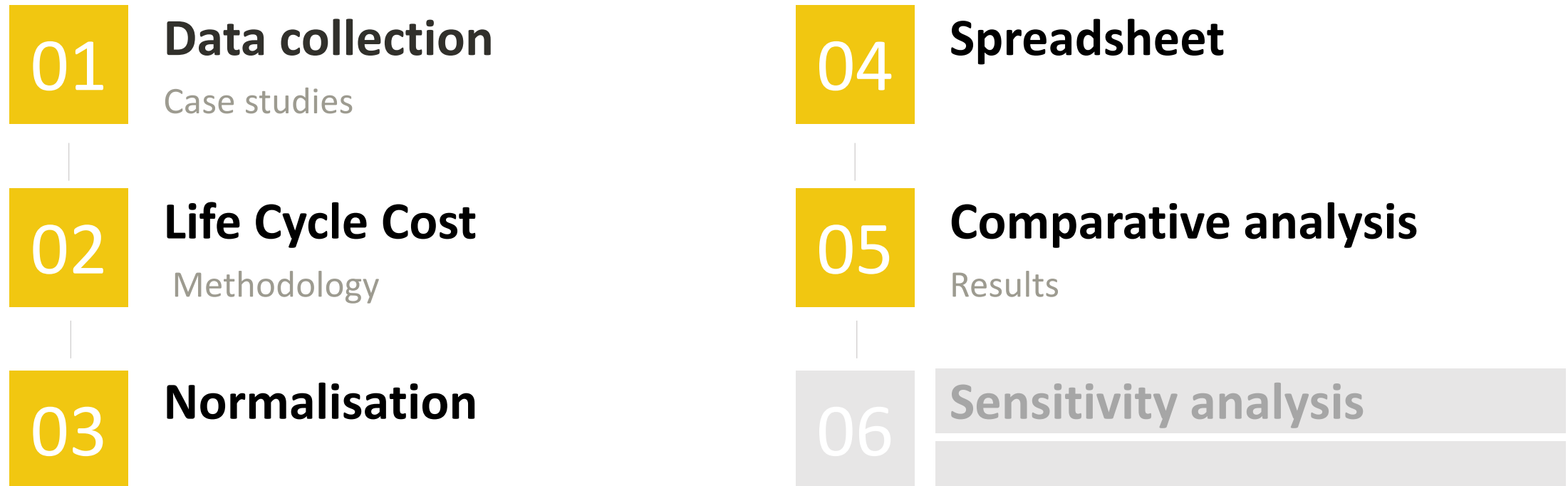
### BREAKDOWN OF THE UNITARY LCC

Phase	Category	Value
Investment	Design	143 €/m <sup>2</sup>
	Construction	1208 €/m <sup>2</sup>
	Building site management	124 €/m <sup>2</sup>
LCC (40)	Energy	275 €/m <sup>2</sup>
	Maintenance	436 €/m <sup>2</sup>
Operation	Energy	21 €/m <sup>2</sup>
	Maintenance	156 €/m <sup>2</sup>
Other		13 €/m <sup>2</sup>



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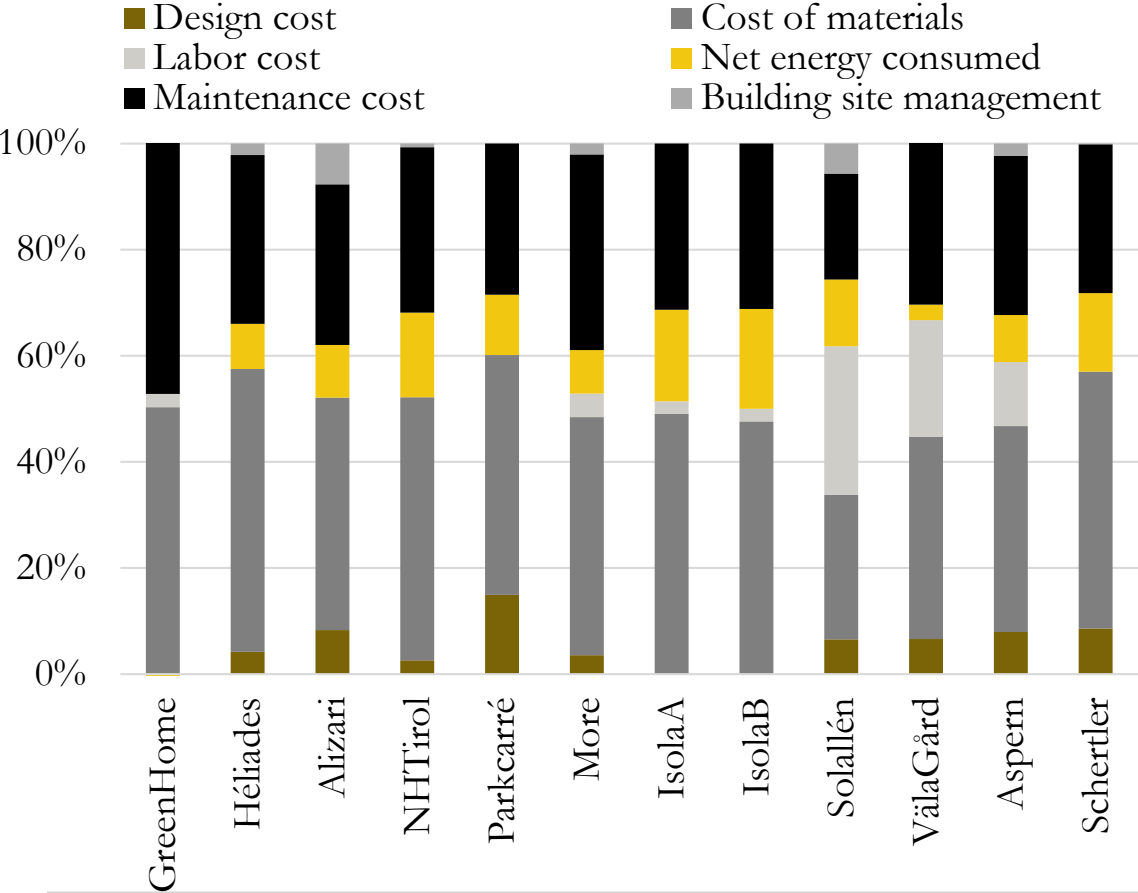


# 06

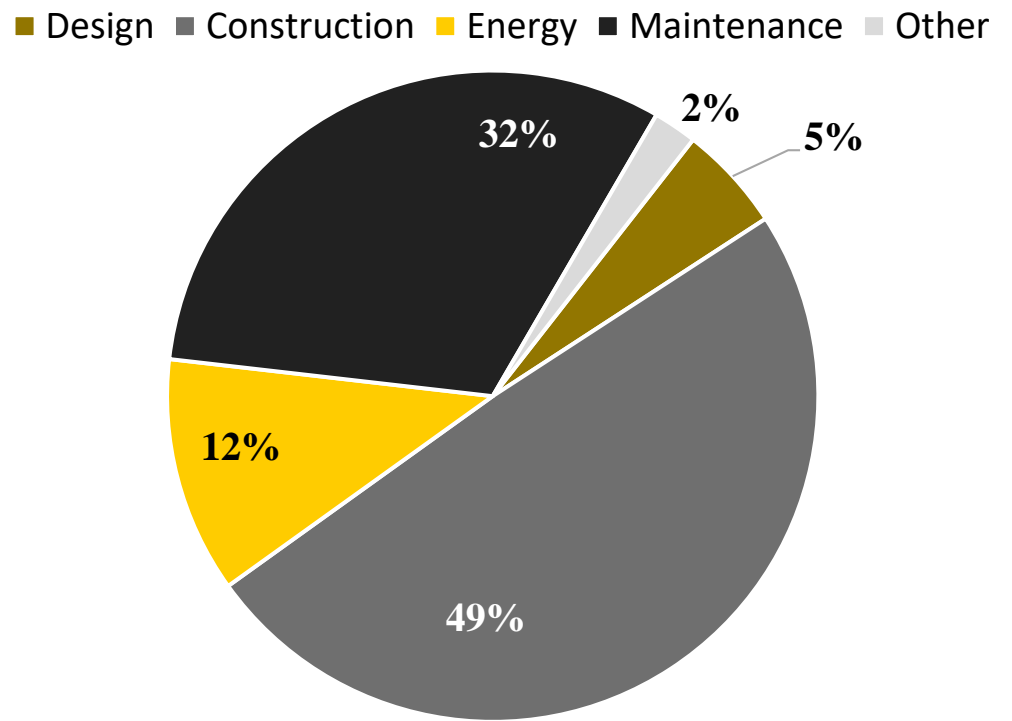
# Comparative Analysis



LCC breakdown



LCC breakdown – average

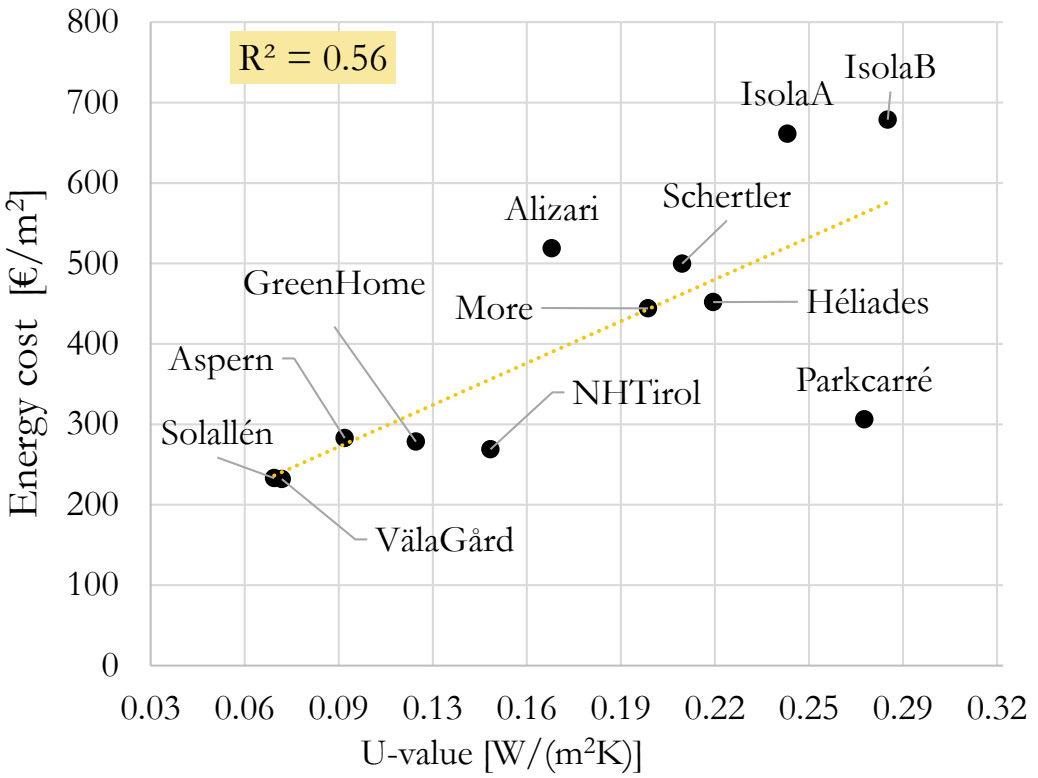


# 06

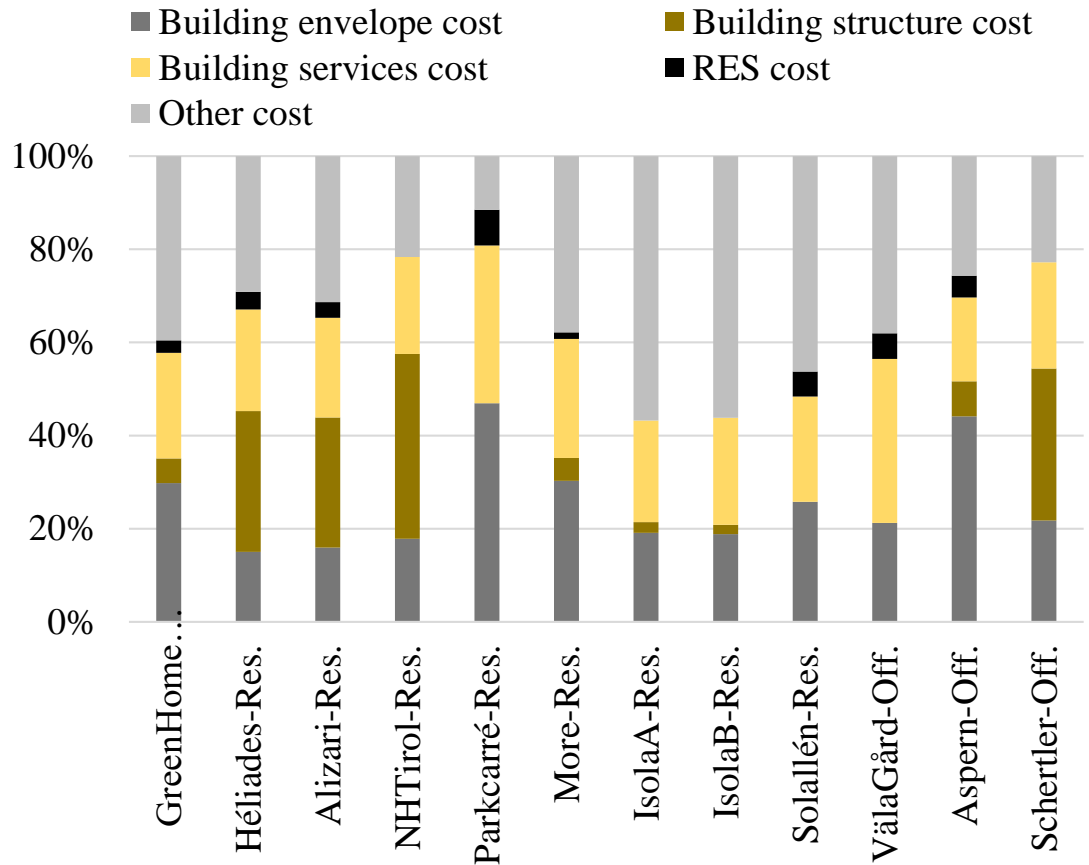
# Comparative Analysis



Correlation between energy cost and U-value



Construction cost breakdown



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# 04

# Sensitivity Analysis

Case study: Résidence Alizari

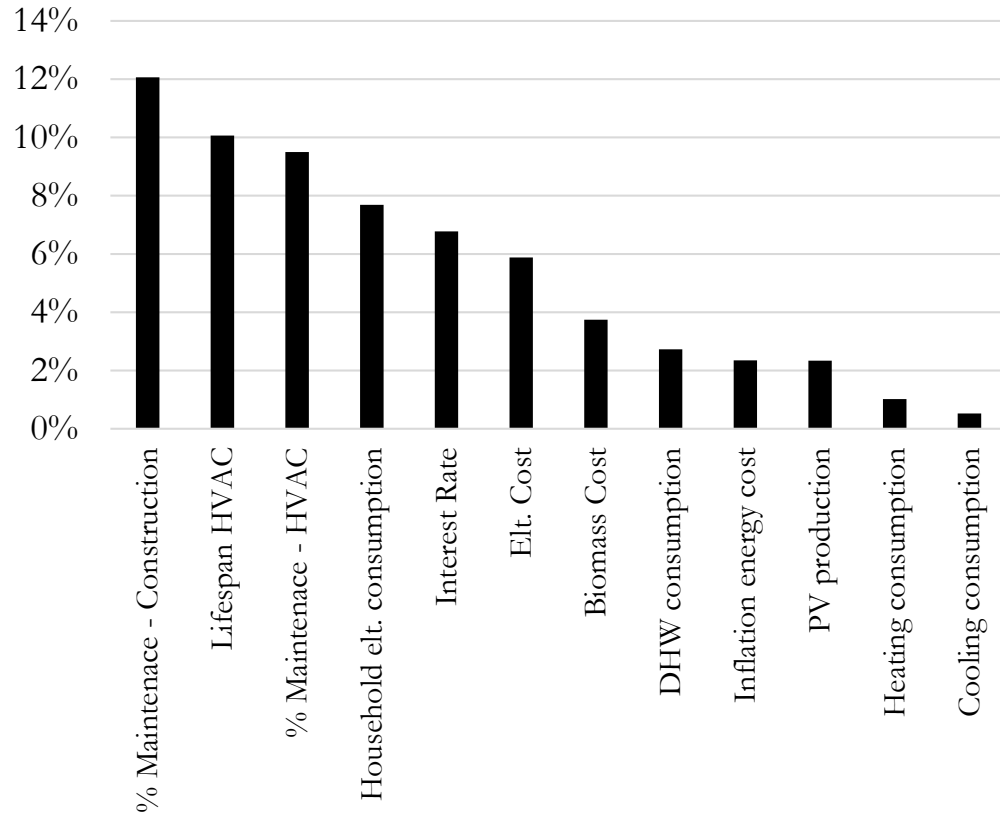


Figure 1. Sensitivity index (s%) of boundary and assumptions – Résidence Alizari.

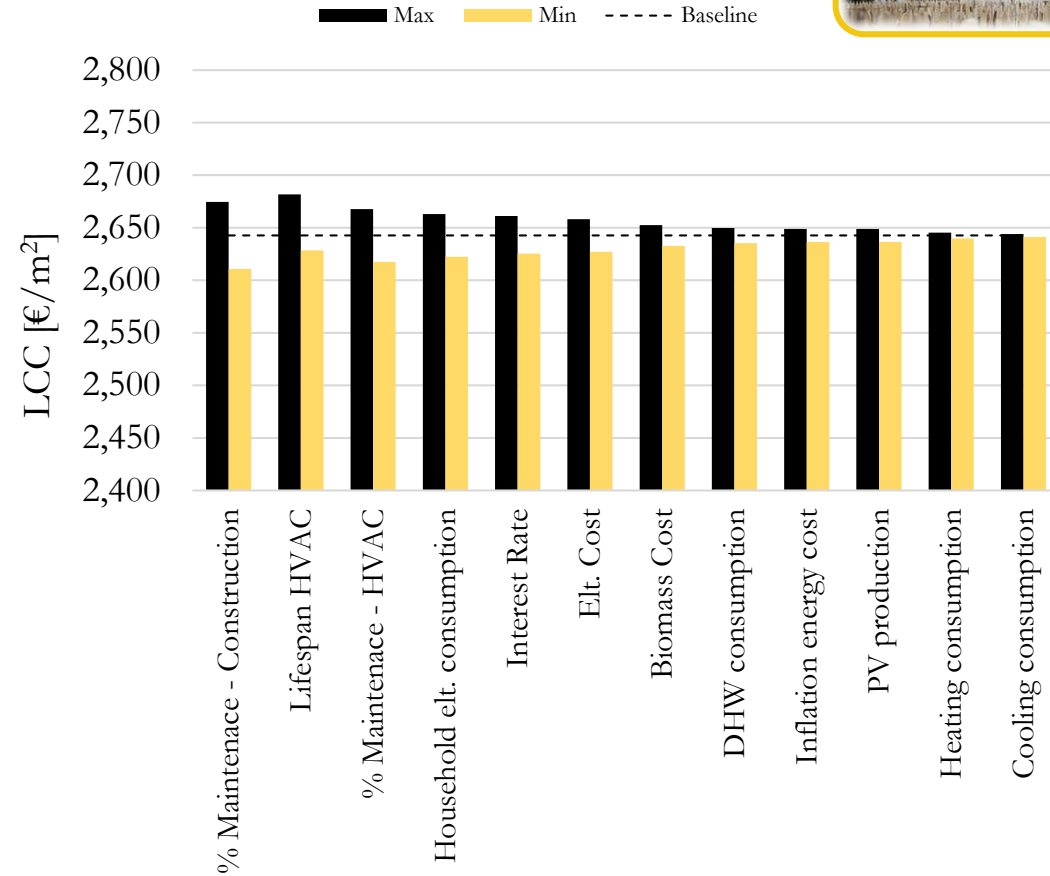


Figure 2. LCC variability according to the variations of boundaries and assumptions – Résidence Alizari.

# Conclusions and Further Development

- An **operative methodology** for an EU-wide evaluation of life cycle cost.
  - Overview of the main results for **11 exemplary case studies** was reported...
  - ...providing useful **benchmarks** for nZEB comparison and increasing the reliability of LCC.
- 
- Starting point for the development of an effective **LCC tool** (beta version available at [cravezero.eu](http://cravezero.eu)).
  - The broad application of the LCC analysis can foster the market uptake of nZEBs, highlighting the **cost-effectiveness and benefits during the life cycle**.



Thank you!

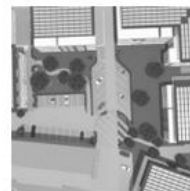
News



Residence Alizari



CRAVEzero Kick-Off Meeting



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[www.cravezero.eu](http://www.cravezero.eu)

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# LCC spreadsheet

CRAVEZero nZEB spreadsheet



<b>Design</b> 192 €/m <sup>2</sup>	Preliminary	10 €/m <sup>2</sup>
	Definitive	- €/m <sup>2</sup>
	Executive	182 €/m <sup>2</sup>
	Building Elements	340€/m <sup>2</sup>
	Materials	197€/m <sup>2</sup>
	RES	44 €/m <sup>2</sup>
	Other	- €/m <sup>2</sup>
	Labor	- €/m <sup>2</sup>
	Building site management	- €/m <sup>2</sup>
	Consumed	Heating 75 €/m <sup>2</sup> Cooling 11 €/m <sup>2</sup> DHW 57 €/m <sup>2</sup> Household el.+ aux. 188 €/m <sup>2</sup>
<b>Construction</b> 581 €/m <sup>2</sup>	Produced	167 €/m <sup>2</sup>
	Envelope	152 €/m <sup>2</sup>
	HVAC	201 €/m <sup>2</sup>
<b>Energy</b> 146 €/m <sup>2</sup>	RES	13 €/m <sup>2</sup>
	<b>Other</b> 0 €/m <sup>2</sup>	
	<b>Operation</b> 512 €/m <sup>2</sup>	
<b>Investment</b> 773 €/m <sup>2</sup>	<b>Maintenance</b> 366 €/m <sup>2</sup>	
	<b>Other</b> 0 €/m <sup>2</sup>	
<b>LCC (40)</b> 1285€/m <sup>2</sup>		

Example Case Study Parkcarré (K&M)

Normalised gross surface

# 04

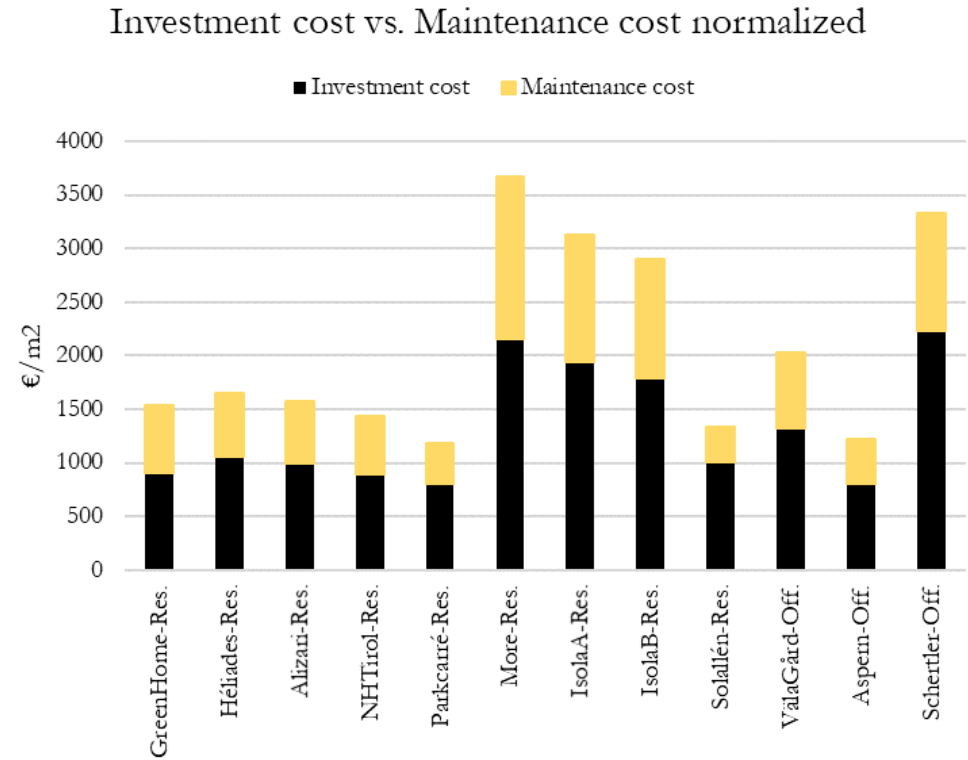
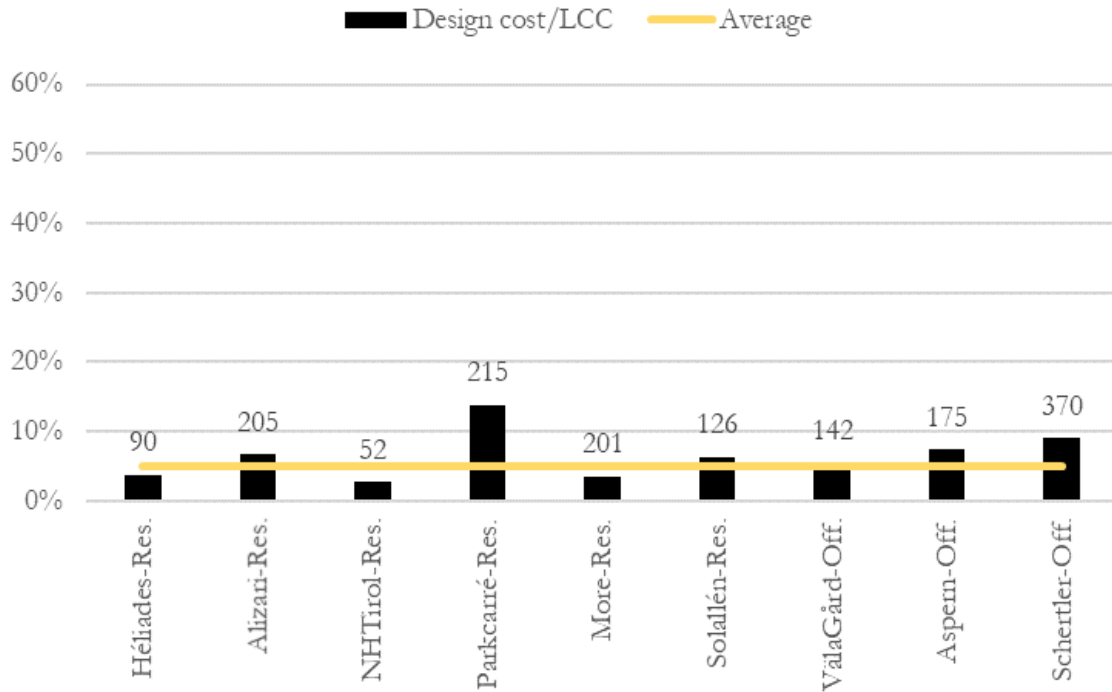
# LCC Case Study analysis

Comparative analysis – case studies



Design cost (% - €/m<sup>2</sup>)

Investment/maintenance €/m<sup>2</sup>



# LCC Case Study analysis

Comparative analysis – case studies



Breakdown of investment cost for construction element

Construction costs breakdown

