# 以 BIM 實現 永續循環建築之路

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bsi.

# 講者簡介

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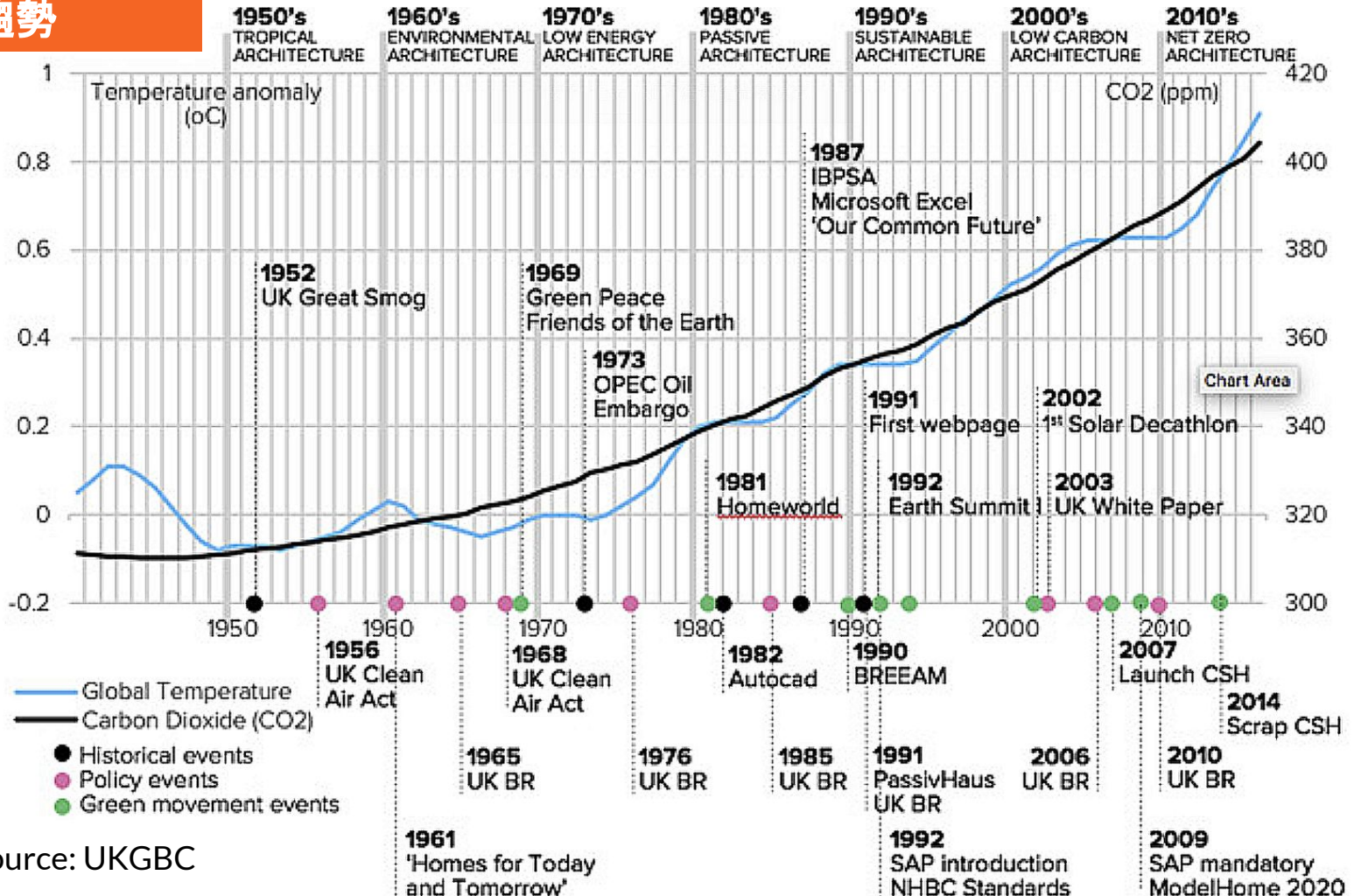
Yuntsui Chang

# 何謂
# 永續循環建築？

# 永續建築趨勢




Source: UKGBC

# 永續建築面向


LEED Zero

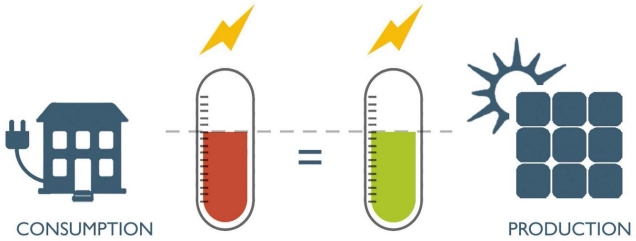
- Carbon
- Energy
- Water
- Waste

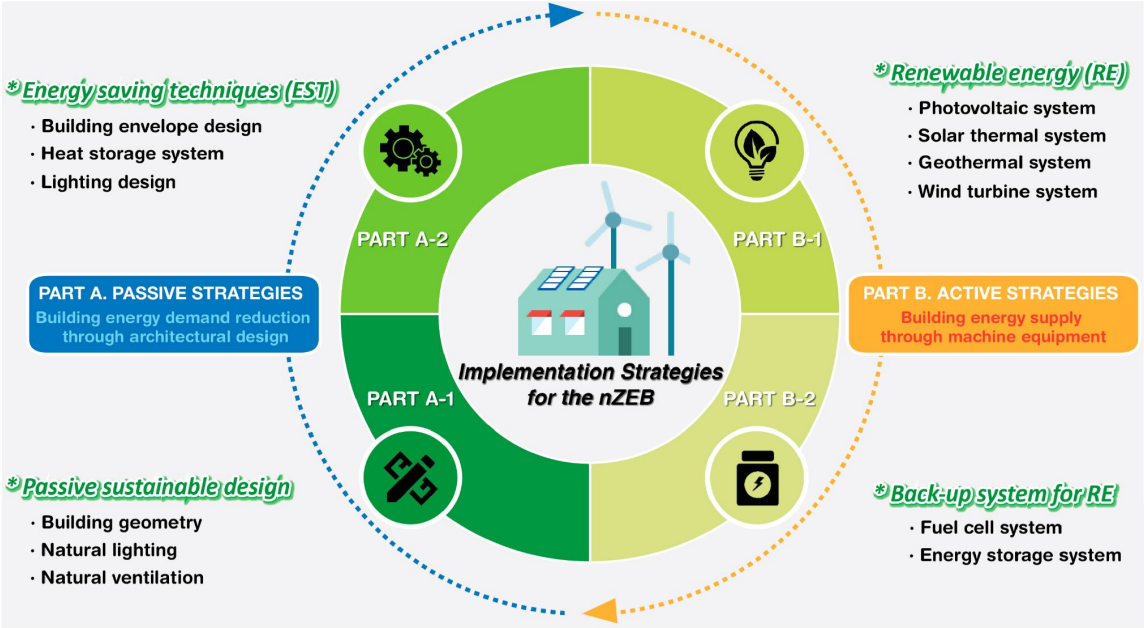
Source: USGBC

# 淨零耗能建築面向

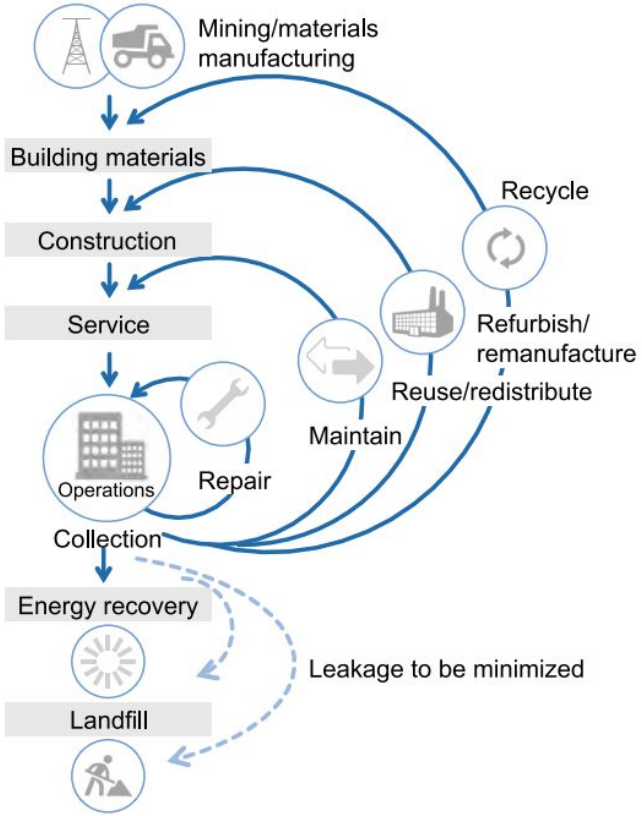
Net-Zero **Site Energy** Building

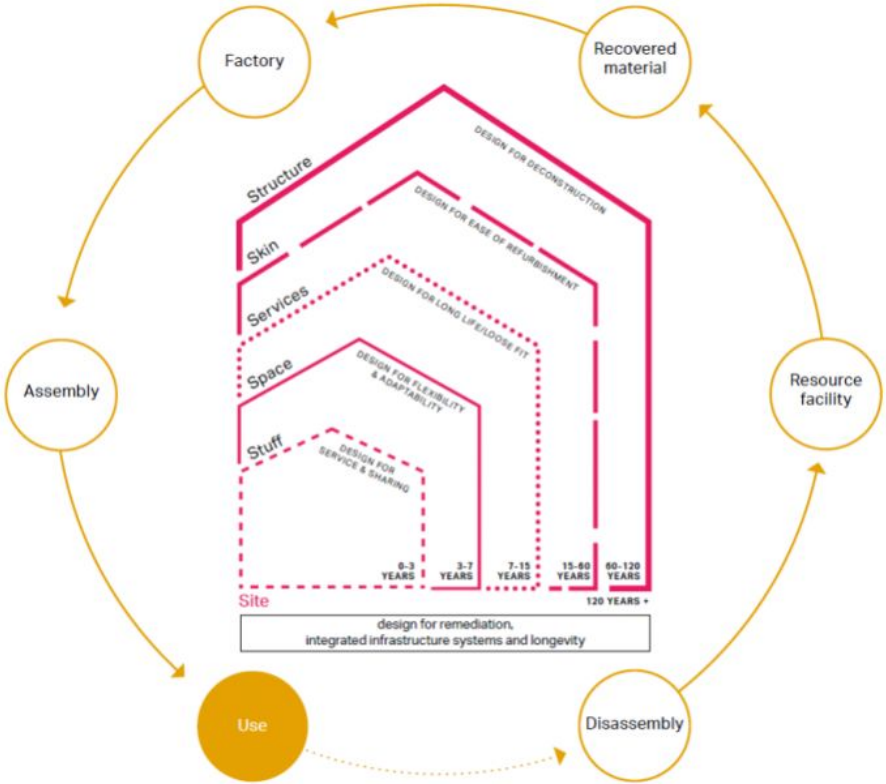
A building that generates (at least) as much energy as it uses on-site. This is the most common use of the "net-zero" term.



# 循環建築面向



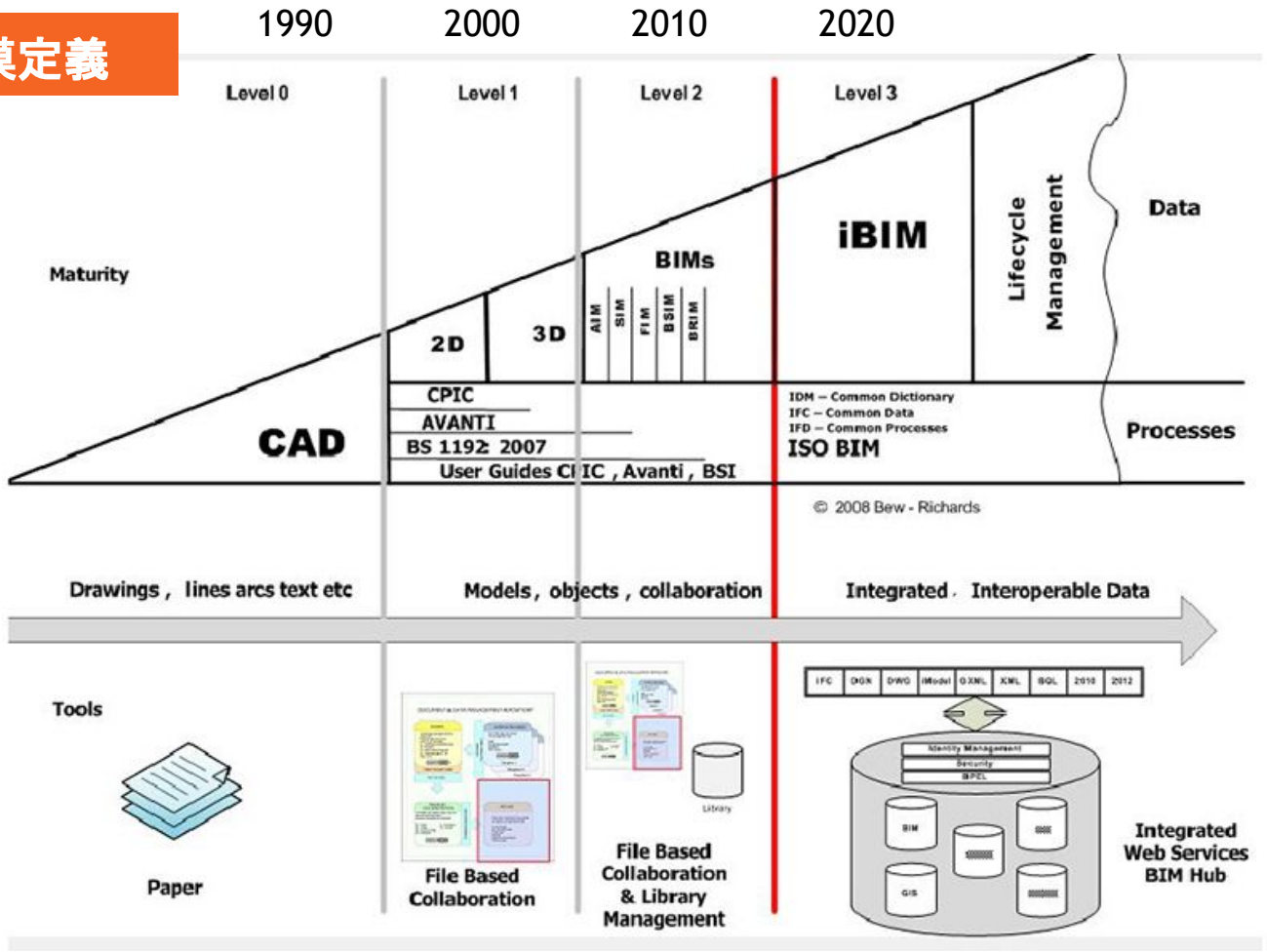

Source: Ellen MacArthur Foundation

# 永續循環建築面向


Understanding Carbon
$CO_2$
$CO_2$
$CO_2$
$CO_2$
Embodied Carbon
Manufacture, transport and
installation of construction materials
Operational Carbon
Building energy consumption

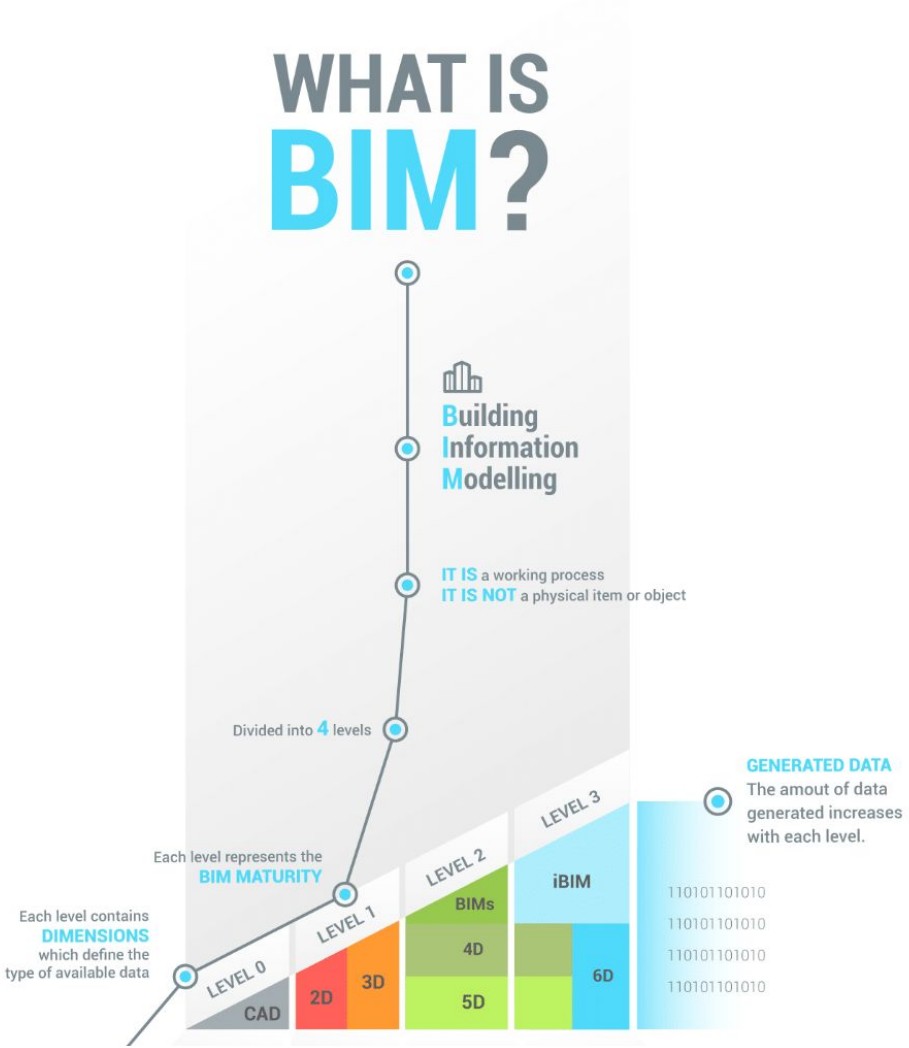
# 何謂
# 建築資訊塑模？

# 建築資訊塑模定義

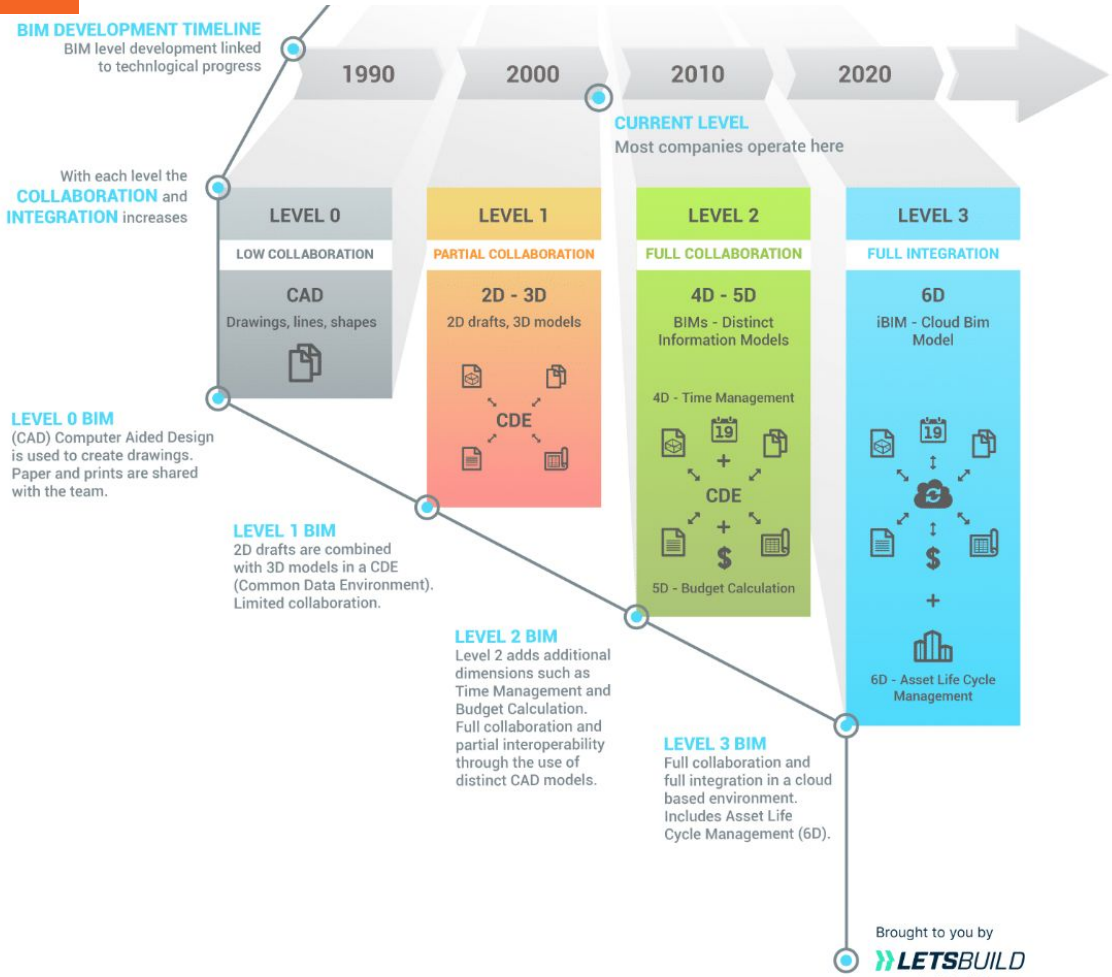



Source: UK GOV

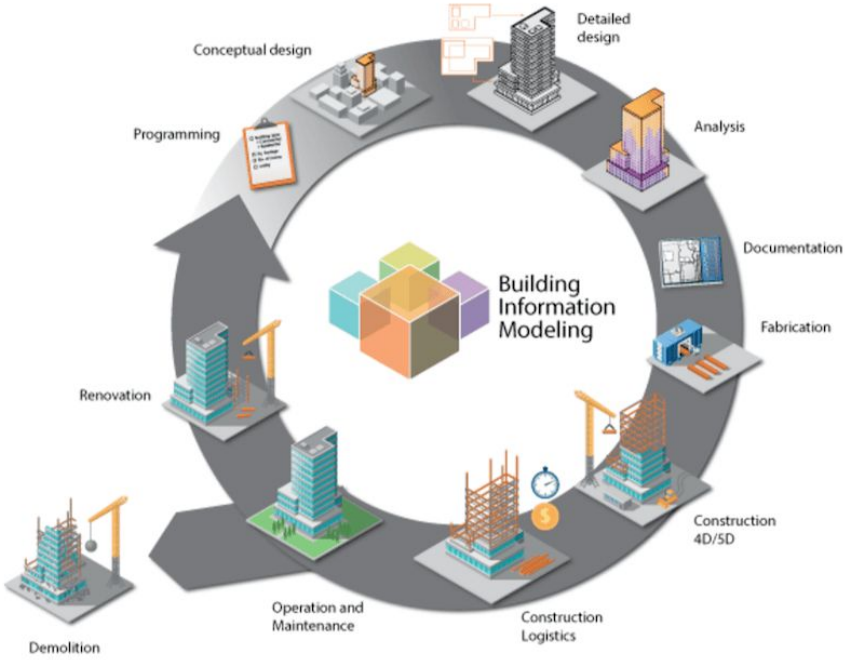
# 建築資訊塑模定義


WHAT IS
BIM?
Building
Information
Modelling
IT IS a working process
IT IS NOT a physical item or object
Divided into 4 levels
Each level represents the
BIM MATURITY
Each level contains
DIMENSIONS
which define the
type of available data
LEVEL 0
CAD
LEVEL 1
2D
3D
LEVEL 2
BIMs
4D
5D
LEVEL 3
iBIM
6D
GENERATED DATA
The amout of data
generated increases
with each level.
110101101010
110101101010
110101101010
110101101010

# 建築資訊塑模定義


BIM DEVELOPMENT TIMELINE
BIM level development linked to technlogical progress
1990
2000
2010
2020
CURRENT LEVEL
Most companies operate here
With each level the COLLABORATION and INTEGRATION increases
LEVEL 0
LOW COLLABORATION
CAD
Drawings, lines, shapes
LEVEL 1
PARTIAL COLLABORATION
2D - 3D
2D drafts, 3D models
CDE
LEVEL 2
FULL COLLABORATION
4D - 5D
BIMs - Distinct Information Models
4D - Time Management
CDE
5D - Budget Calculation
LEVEL 3
FULL INTEGRATION
6D
iBIM - Cloud Bim Model
6D - Asset Life Cycle Management
LEVEL 0 BIM
(CAD) Computer Aided Design is used to create drawings. Paper and prints are shared with the team.
LEVEL 1 BIM
2D drafts are combined with 3D models in a CDE (Common Data Environment). Limited collaboration.
LEVEL 2 BIM
Level 2 adds additional dimensions such as Time Management and Budget Calculation. Full collaboration and partial interoperability through the use of distinct CAD models.
LEVEL 3 BIM
Full collaboration and full integration in a cloud based environment. Includes Asset Life Cycle Management (6D).
Brought to you by
LETSBUILD

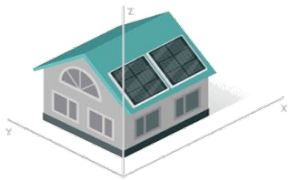
# 建築資訊塑模面向


Conceptual design
Detailed design
Programming
Analysis
Documentation
Building Information Modeling
Fabrication
Renovation
Construction 4D/5D
Operation and Maintenance
Construction Logistics
Demolition


2D data exchange
Architect
Installer
Engineer
Structural engineer
Facility Manager
Project Manager
Construction Manager
Builder


BIM interoperability
Architect
Installer
Engineer
Structural engineer
BIM
Facility Manager
Project Manager
Construction Manager
Builder

## 3D (Model)



3D BIM
GEOMETRY

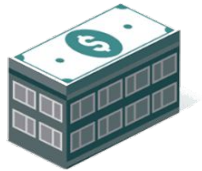
Gives the stakeholder the insight and tools to more efficiently plan, design, construct, and manage buildings and infrastructure.

## 4D (Scheduling)

4D BIM
TIME

Improve site planning and scheduling optimization and also increase the preparedness of stakeholders by better communicating the next steps.

## 5D (Quantity Surveying)



5D BIM
MONEY

Visualize budget analysis and cost estimation for a project, also predicted and actual cost of a project over time.

## 6D (Sustainability)

6D BIM
SUSTAINABILITY

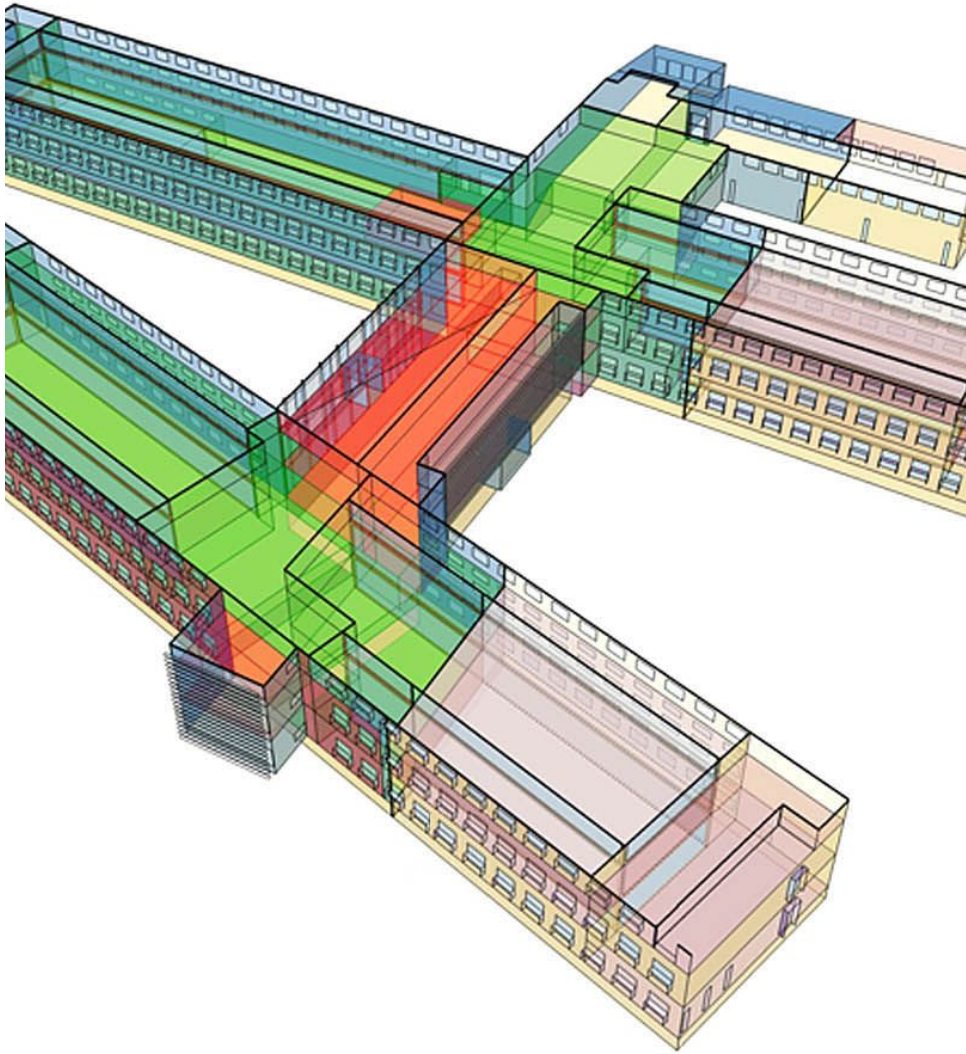
Help reduce energy consumption in the long run and improve operational management after construction is completed.

## 7D (Facility Management)

7D BIM
FACILITY MANAGEMENT

Improves operations and facility management by building owners and managers.

# BIM如何實現永續建築？



# BIM 與永續建築

*BIM for Sustainability Analyses*

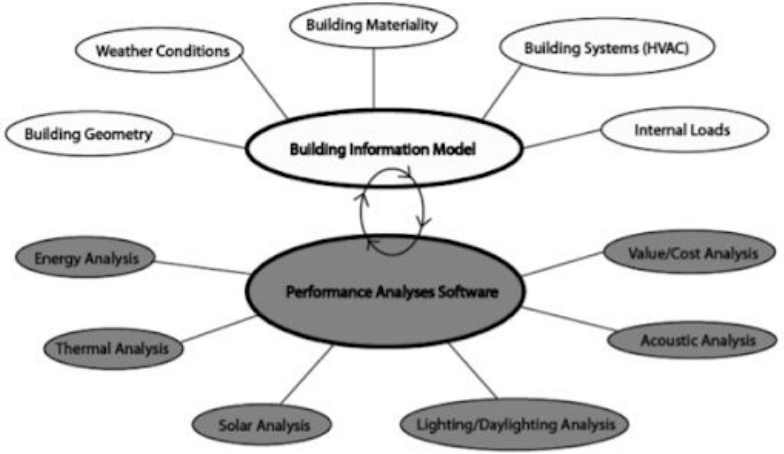
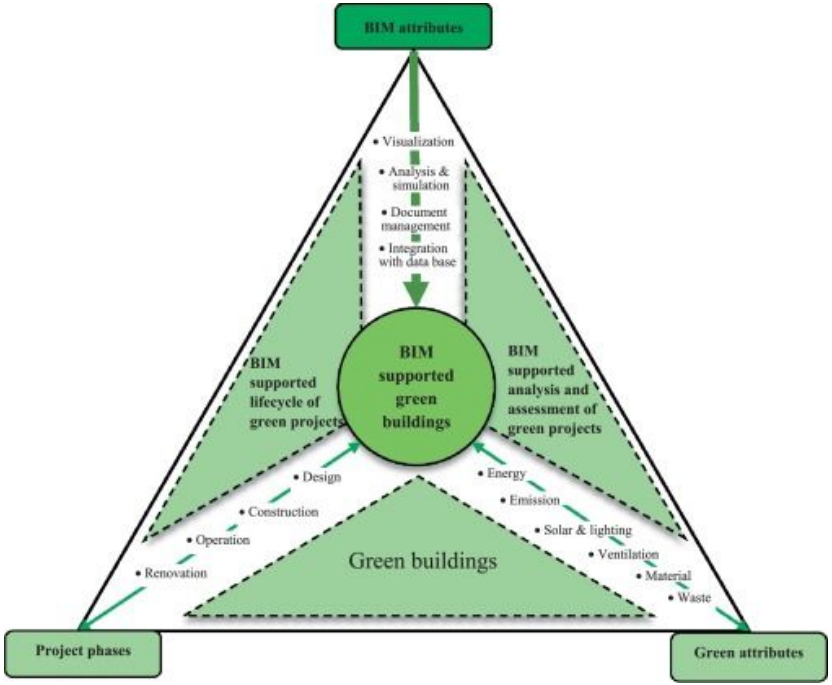
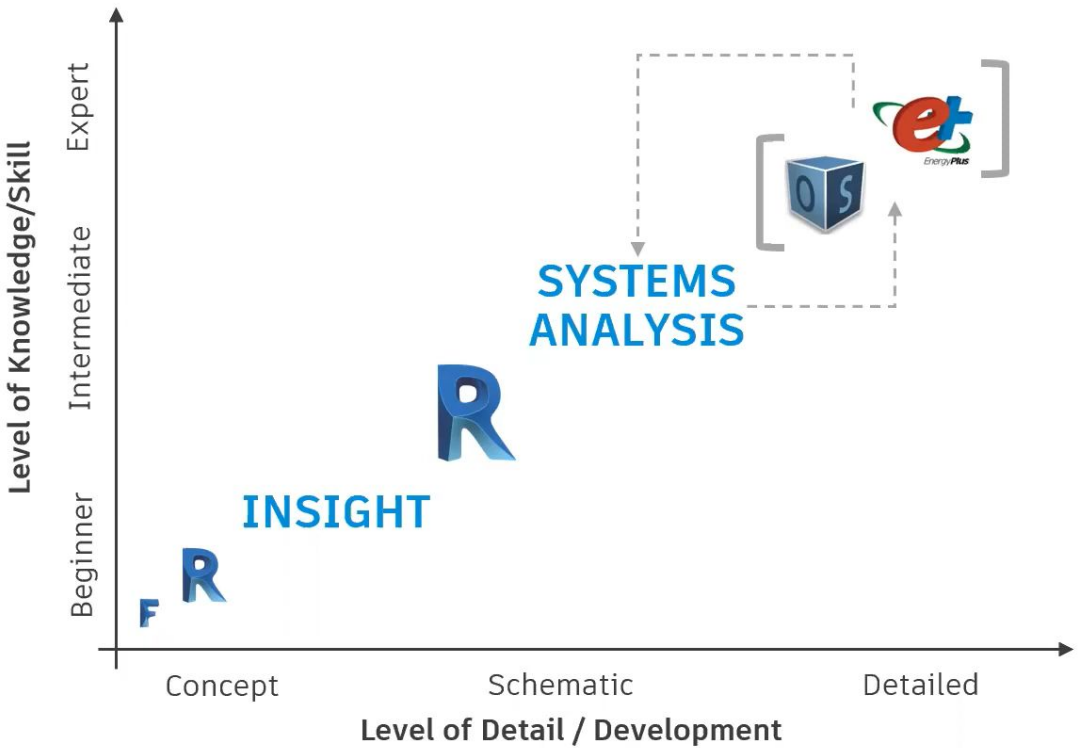



**Figure 1.** Typical information flow in BIM-based building performance (or sustainability) analyses.

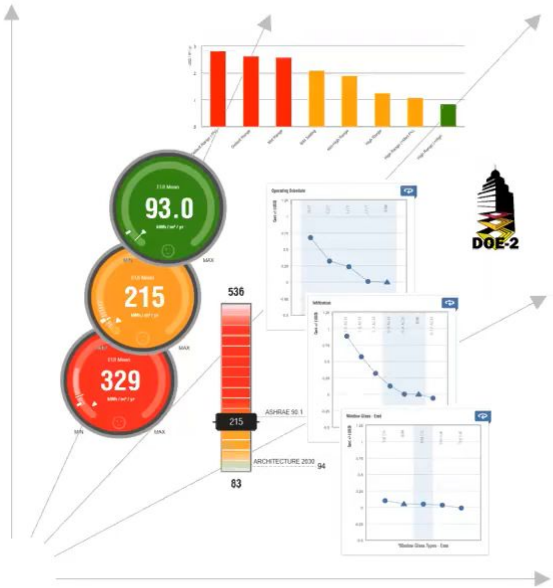


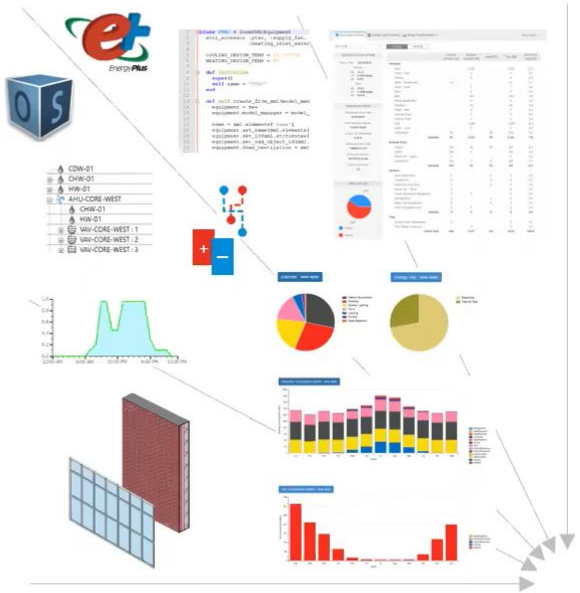
# 建築能源分析與資訊




Source: UIIDL Channel

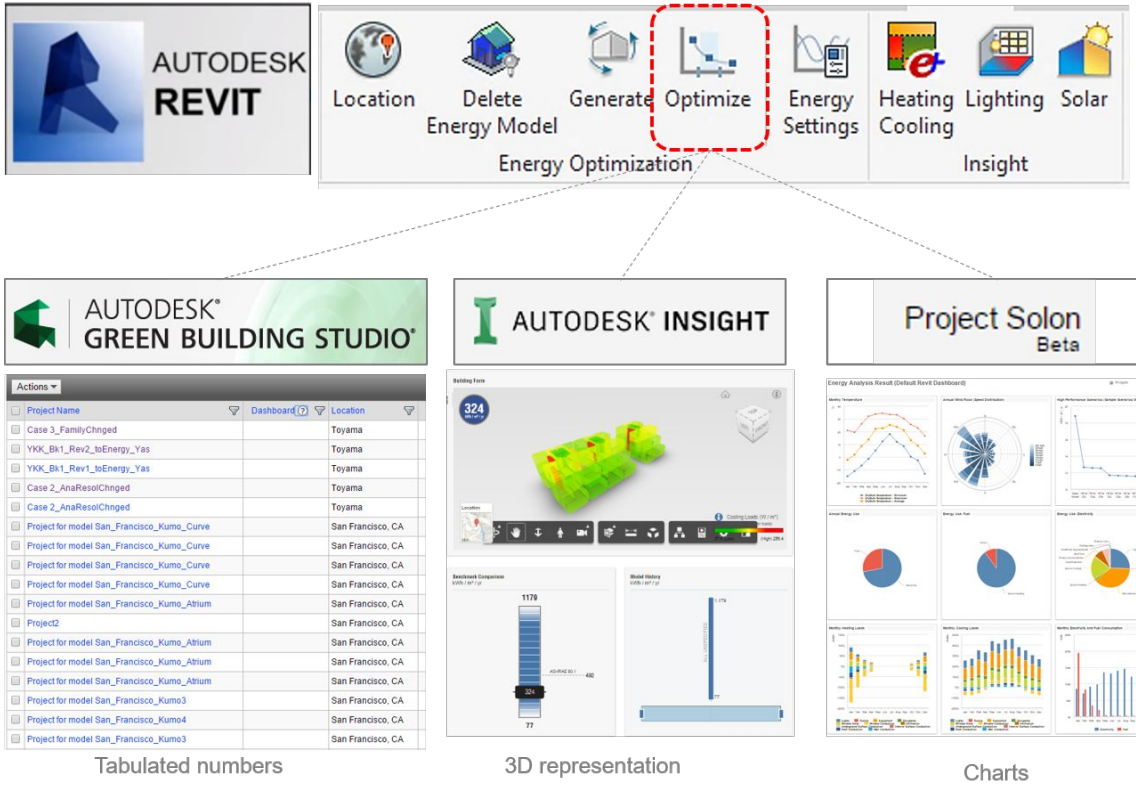
# 建築能源分析與資訊



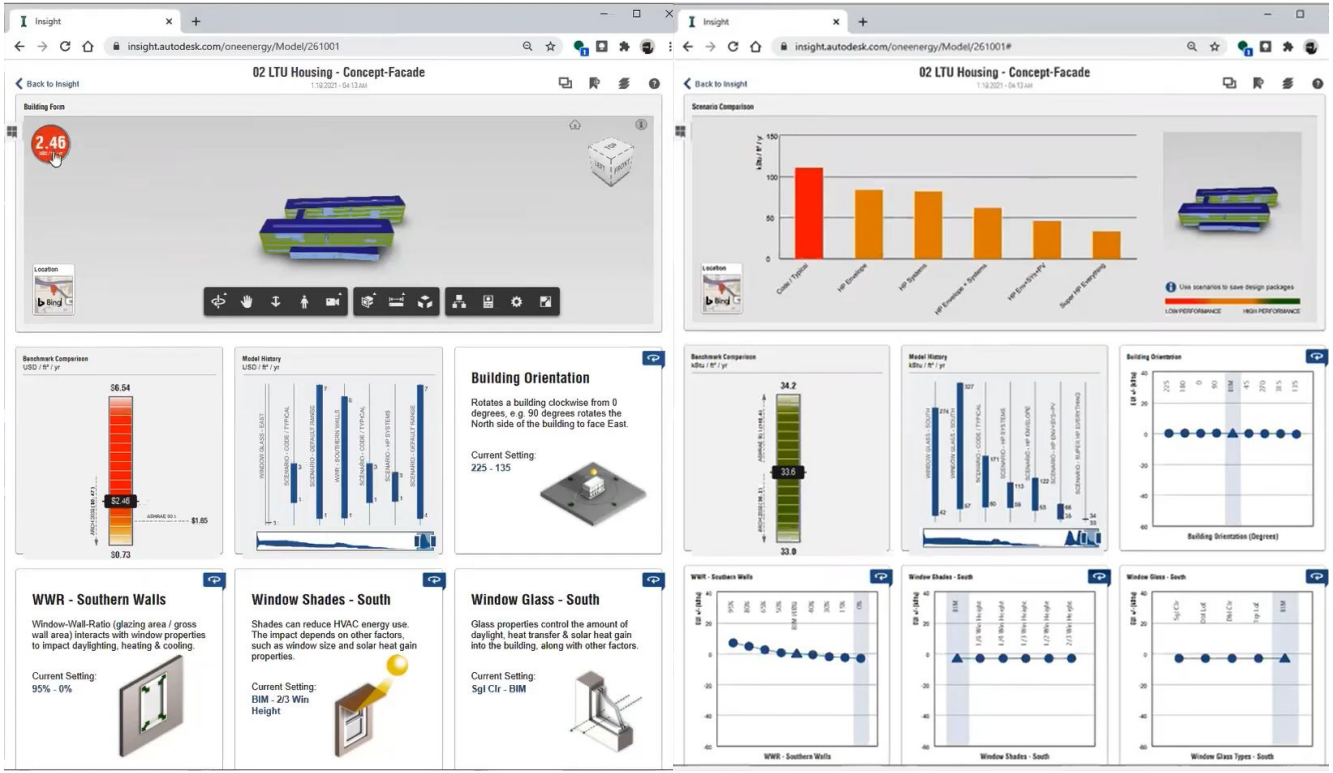




Source: UIIDL Channel

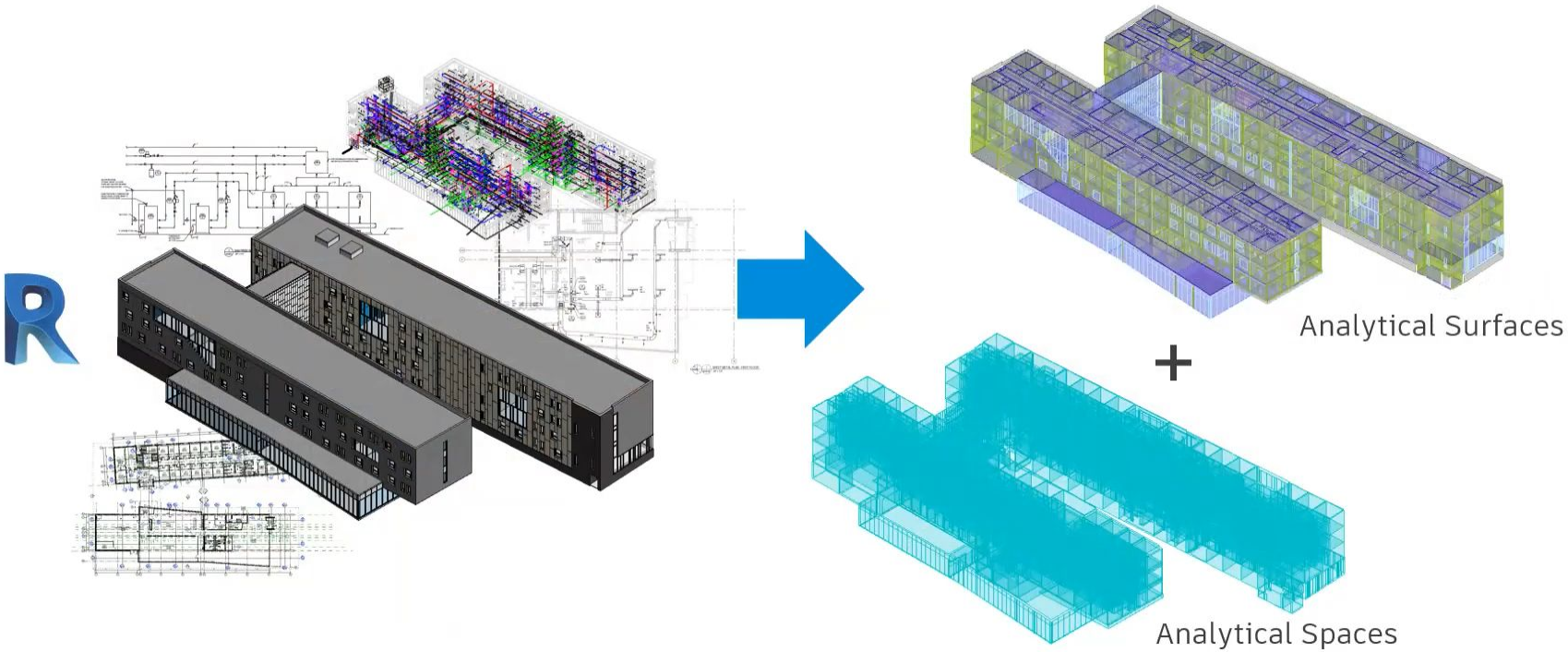
# 建築能源分析與優化


AUTODESK
REVIT
Location
Delete Energy Model
Generate
Optimize
Energy Settings
Heating Cooling
Lighting
Solar
Energy Optimization
Insight
AUTODESK® GREEN BUILDING STUDIO®
AUTODESK® INSIGHT
Project Solon
Beta
Actions
Project Name
Dashboard
Location
Case 3_FamilyChnged Toyama
YKK_Bk1_Rev2_toEnergy_Yas Toyama
YKK_Bk1_Rev1_toEnergy_Yas Toyama
Case 2_AnaResolChnged Toyama
Case 2_AnaResolChnged Toyama
Project for model San_Francisco_Kumo_Curve San Francisco, CA
Project for model San_Francisco_Kumo_Curve San Francisco, CA
Project for model San_Francisco_Kumo_Curve San Francisco, CA
Project for model San_Francisco_Kumo_Curve San Francisco, CA
Project for model San_Francisco_Kumo_Atrium San Francisco, CA
Project2 San Francisco, CA
Project for model San_Francisco_Kumo_Atrium San Francisco, CA
Project for model San_Francisco_Kumo_Atrium San Francisco, CA
Project for model San_Francisco_Kumo_Atrium San Francisco, CA
Project for model San_Francisco_Kumo3 San Francisco, CA
Project for model San_Francisco_Kumo4 San Francisco, CA
Project for model San_Francisco_Kumo3 San Francisco, CA
Tabulated numbers
3D representation
Charts

# 建築能源分析與優化


Insight
insight.autodesk.com/oneenergy/Model/261001
02 LTU Housing - Concept-Facade
Back to Insight
Building Form
2.46
Benchmark Comparison
USD / ft² / yr
$6.54
$2.46
$1.85
$0.73
Model History
Building Orientation
Rotates a building clockwise from 0 degrees, e.g. 90 degrees rotates the North side of the building to face East.
Current Setting:
225 - 135
WWR - Southern Walls
Window-Wall-Ratio (glazing area / gross wall area) interacts with window properties to impact daylighting, heating & cooling.
Current Setting:
95% - 0%
Window Shades - South
Shades can reduce HVAC energy use. The impact depends on other factors, such as window size and solar heat gain properties.
Current Setting:
BIM - 2/3 Win Height
Window Glass - South
Glass properties control the amount of daylight, heat transfer & solar heat gain into the building, along with other factors.
Current Setting:
Sgl Clr - BIM
Insight
insight.autodesk.com/oneenergy/Model/261001#
02 LTU Housing - Concept-Facade
Back to Insight
Scenario Comparison
Code / Typical
HP Envelope
HP Systems
HP Envelope + Systems
HP Env+Sys+PV
Super HP Everything
Use scenarios to save design packages
LOW PERFORMANCE
HIGH PERFORMANCE
Benchmark Comparison
kBtu / ft² / yr
34.2
33.6
33.0
Model History
Building Orientation
Building Orientation (Degrees)
WWR - Southern Walls
Window Shades - South
Window Glass Types - South

# 建築能源分析與管理




Source: UIIDL Channel

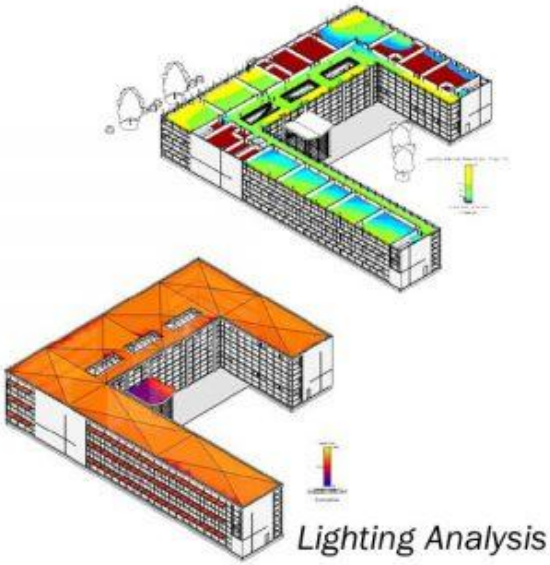
# 建築效能分析與模型

## Integrated with Design Environments

Revit

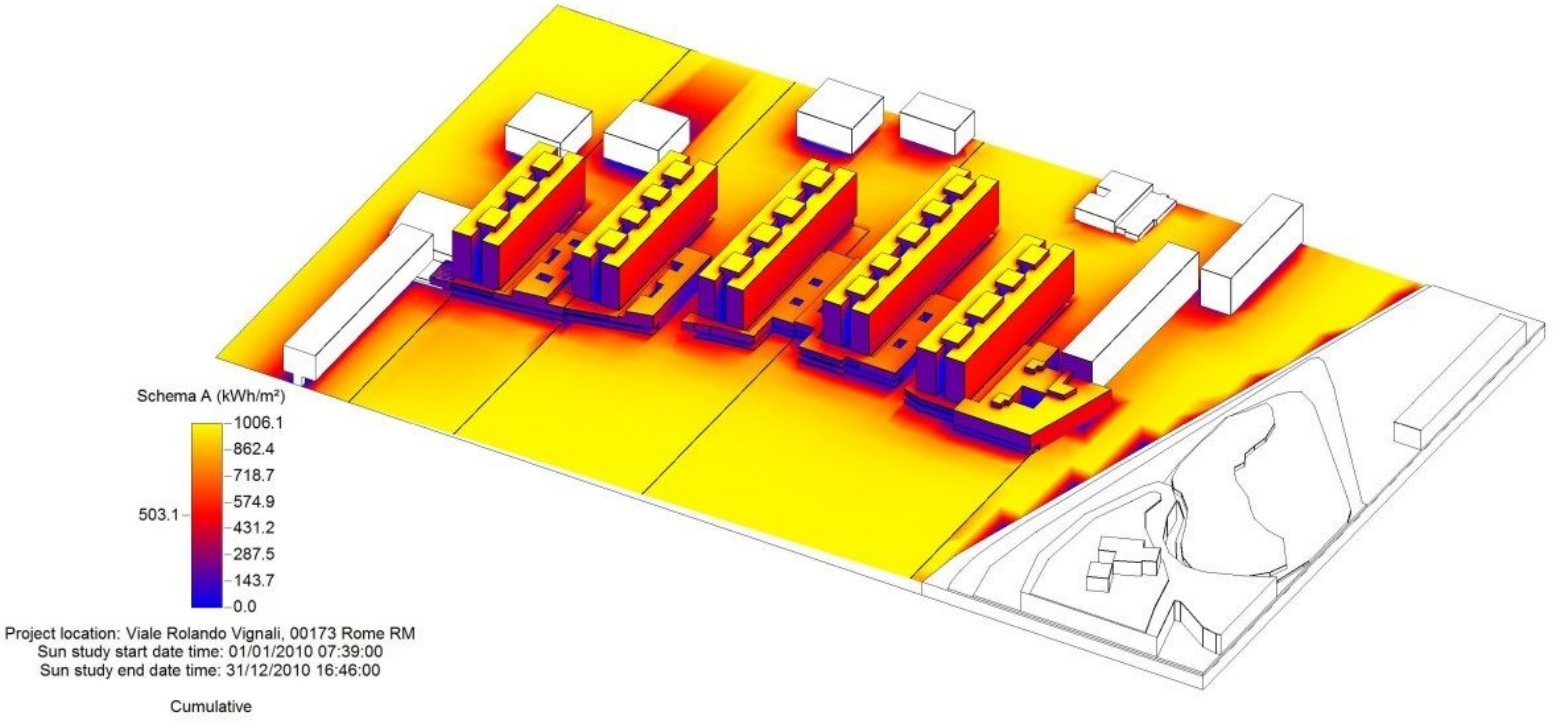

FormIt 360

Insight 360

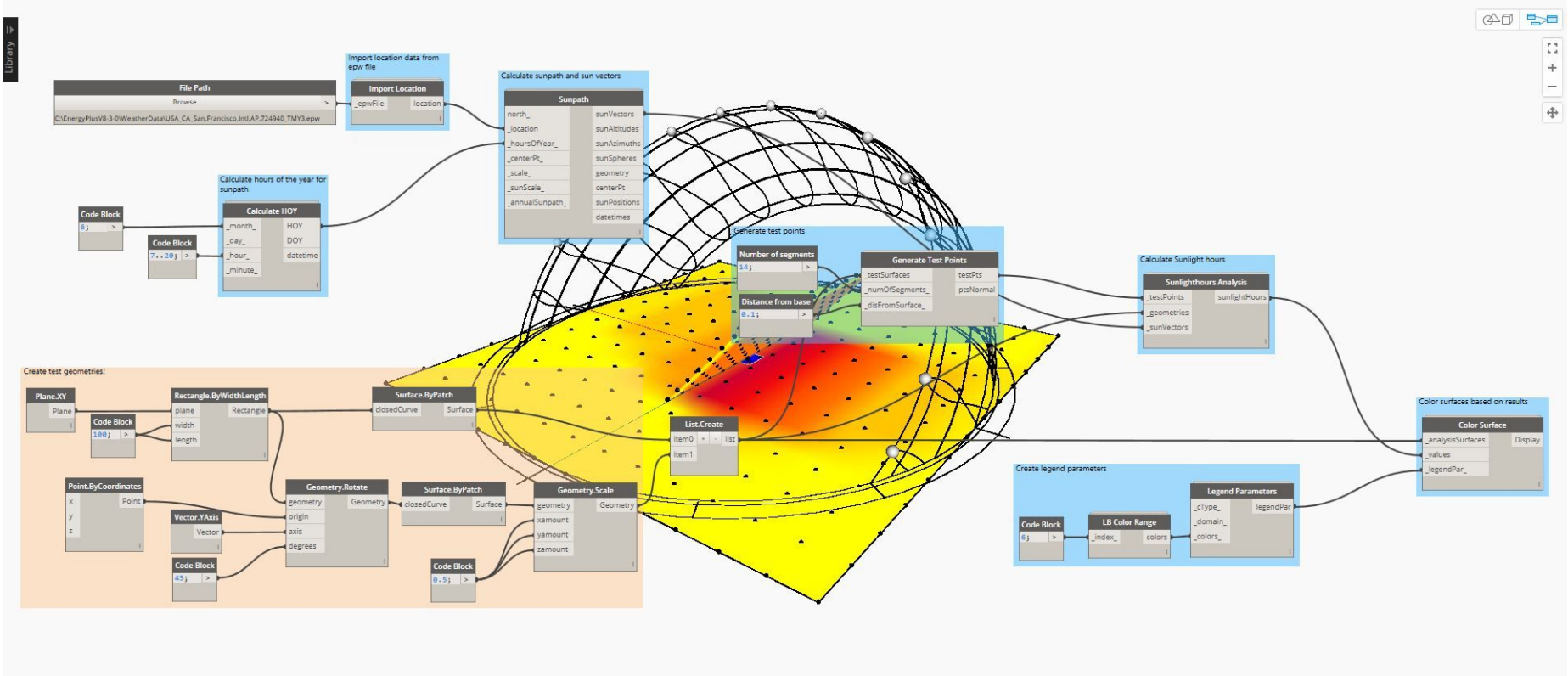


Lighting Analysis

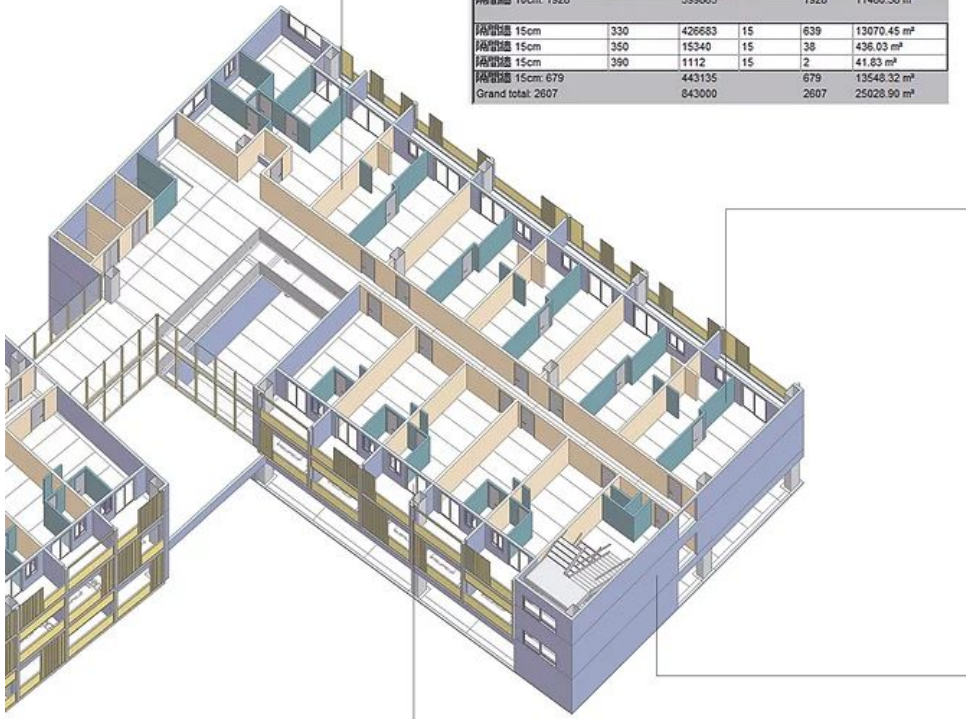
# Building Solar Analysis



# Building Solar Analysis



# BIM如何實現循環建築？



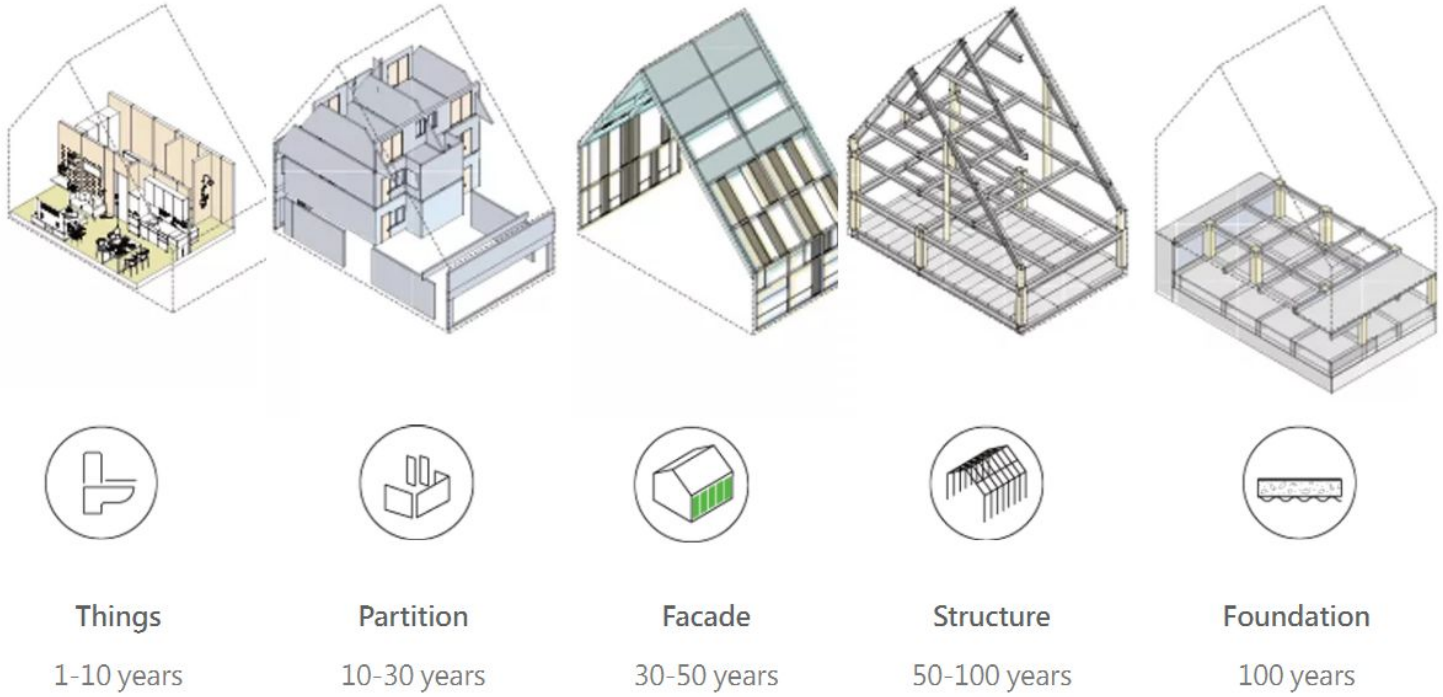
<隔間牆>

| A 類型 | B 高度 | C 長度 | D 寬度 | E 數量 | F 面積 |
|---|---|---|---|---|---|
| 隔間牆 10cm | 320 | 71890 | 10 | 275 | 1887.66 m² |
| 隔間牆 10cm | 330 | 152338 | 10 | 813 | 4341.21 m² |
| 隔間牆 10cm | 350 | 175638 | 10 | 840 | 5251.71 m² |
| 隔間牆 10cm: 1928 | | 399865 | | 1928 | 11480.58 m² |
| 隔間牆 15cm | 330 | 426683 | 15 | 639 | 13070.45 m² |
| 隔間牆 15cm | 350 | 15340 | 15 | 38 | 436.03 m² |
| 隔間牆 15cm | 390 | 1112 | 15 | 2 | 41.83 m² |
| 隔間牆 15cm: 679 | | 443135 | | 679 | 13548.32 m² |
| Grand total: 2607 | | 843000 | | 2607 | 25028.90 m² |

<帷幕牆>

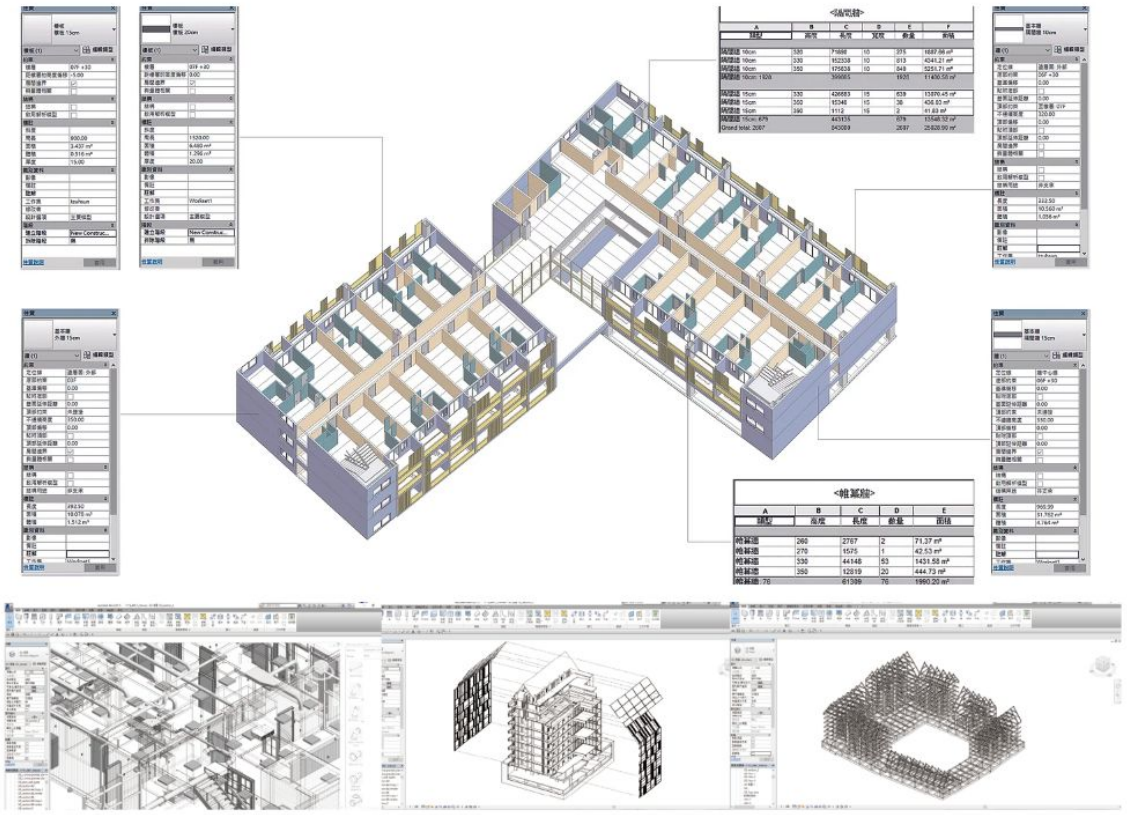
| A 類型 | B 高度 | C 長度 | D 數量 | E 面積 |
|---|---|---|---|---|
| 帷幕牆 | 260 | 2767 | 2 | 71.37 m² |
| 帷幕牆 | 270 | 1575 | 1 | 42.53 m² |
| 帷幕牆 | 330 | 44148 | 53 | 1431.58 m² |
| 帷幕牆 | 350 | 12819 | 20 | 444.73 m² |
| 帷幕牆: 76 | | 61309 | 76 | 1990.20 m² |

# 循環建築與建築構件




Source: BaF

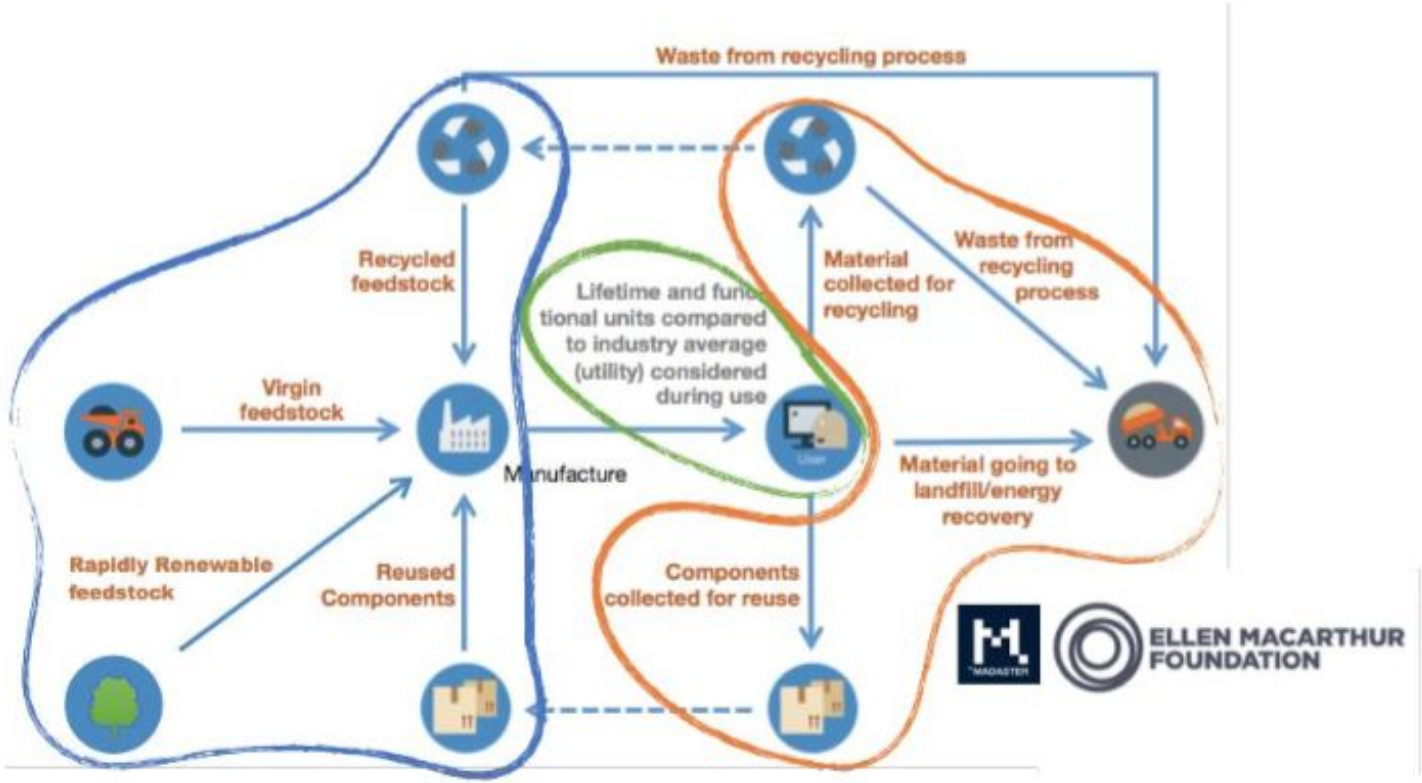
# 循環建築與建材護照



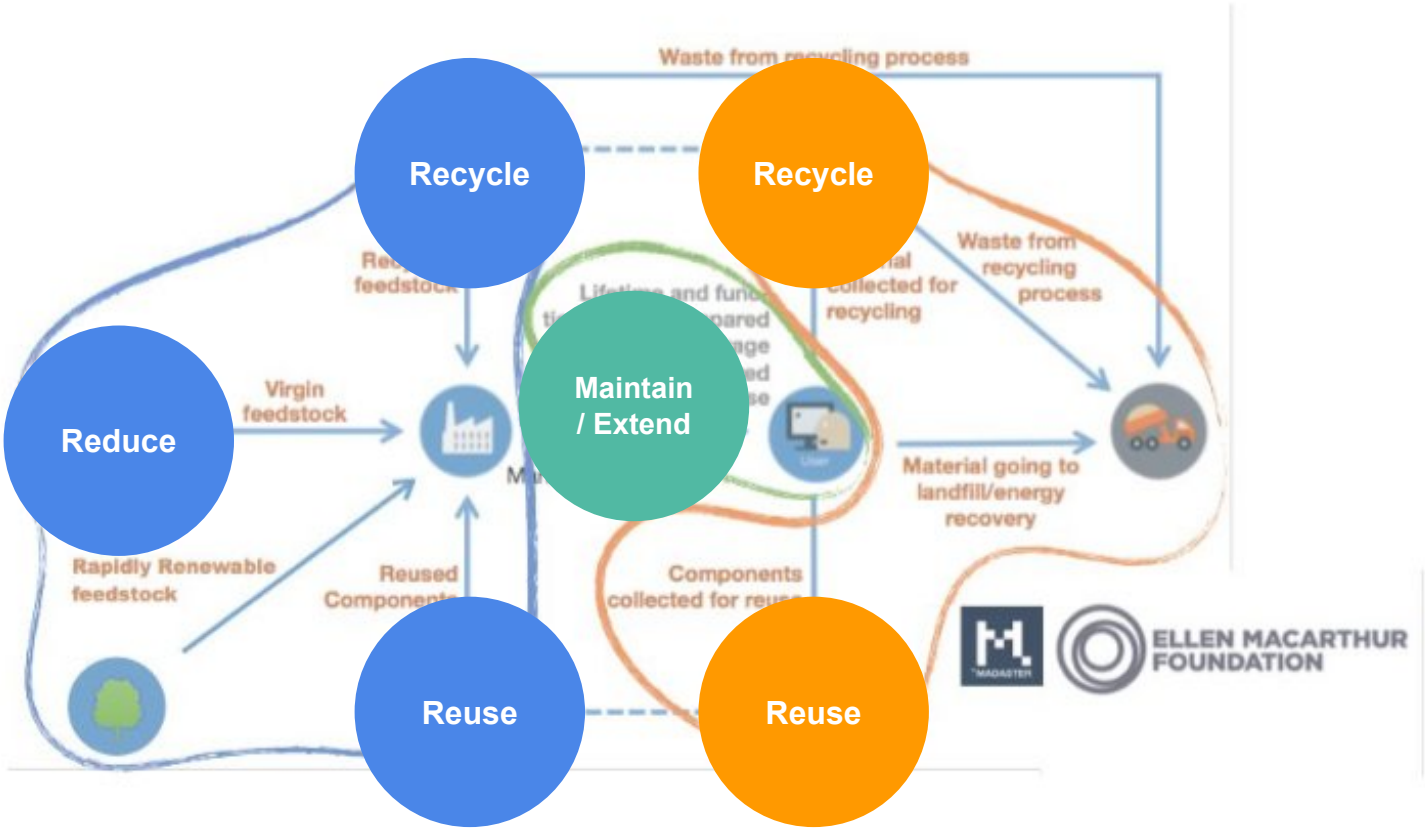
System(MEP/HVAC)　Facade / Partition　Structure

Source: BaF

# 循環建築分析


Waste from recycling process
Recycled feedstock
Material collected for recycling
Waste from recycling process
Lifetime and functional units compared to industry average (utility) considered during use
Virgin feedstock
Manufacture
Material going to landfill/energy recovery
Rapidly Renewable feedstock
Reused Components
Components collected for reuse
ELLEN MACARTHUR FOUNDATION

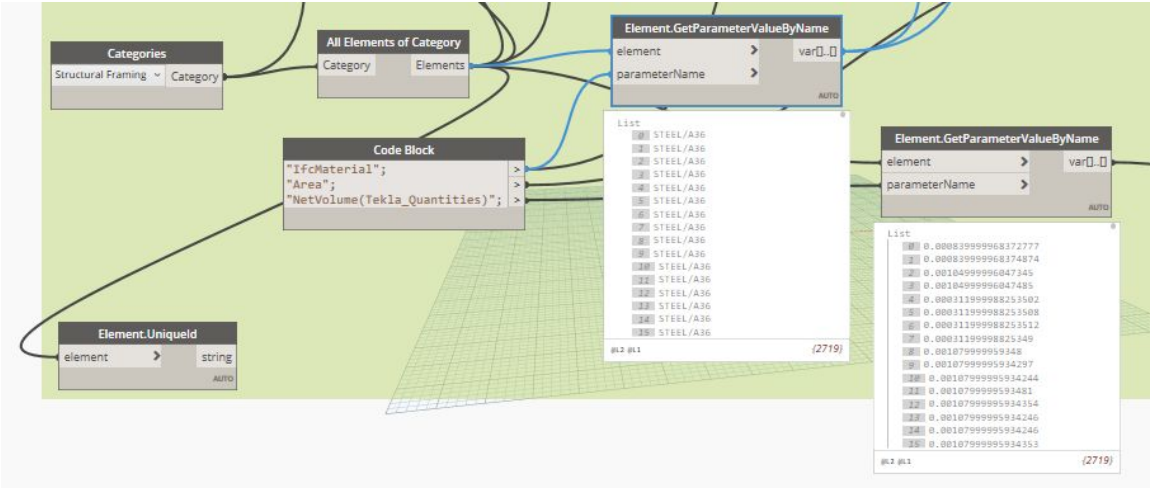
# 循環建築分析

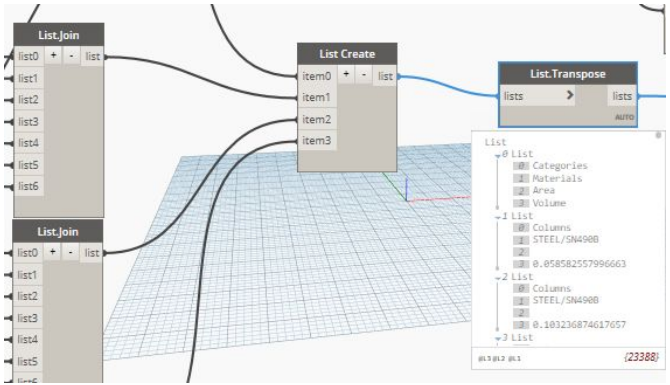

Recycle
Recycle
Reduce
Maintain / Extend
Reuse
Reuse
Waste from recycling process
Waste from recycling process
Virgin feedstock
Material going to landfill/energy recovery
Rapidly Renewable feedstock
Reused
Components collected for reuse
ELLEN MACARTHUR FOUNDATION

# 循環建築分析

## 1. 從建築模型提取資料

- Retrieve the Material , Volume of each Elements
- Combine information from different Element



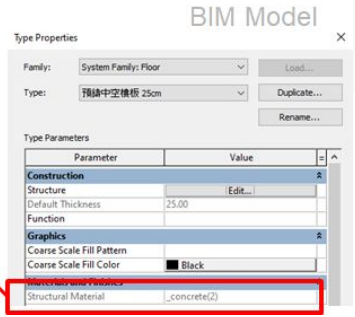



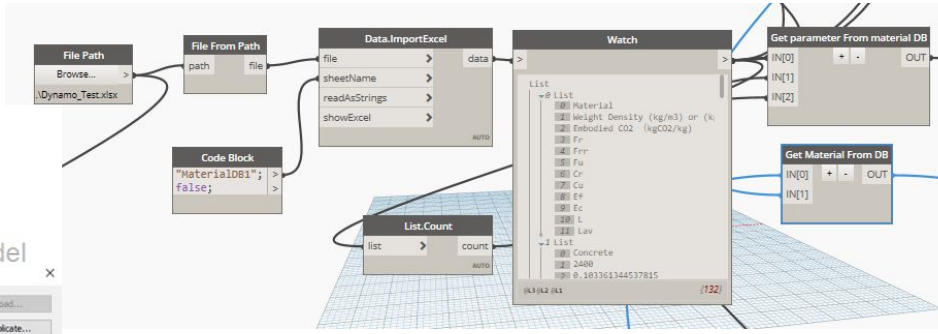
## 2. 連結建築模型與建材整合資訊

- Match the name of materials inside the BIM model with data in Excel
- Retrieve the Material Properties from Excel

Material Database in Excel

| Material | Weight Density (kg/m3) | Embodied CO2 (kgCO2/kg) | Fr | Frr | Fu | Cr | Cu | Ef | Ec | I | Lav |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Concrete | 2400 | 0.103 | 0.2 | 0 | 0 | 0.2 | 0 | 0.75 | | 1 | 1 |
| Steel | 7850 | 2.510 | 0.9 | 0 | 0 | 0.9 | 0 | 0.75 | | 1 | 1 |
| Brick | 1600 | 0.205 | 0 | 0 | 0 | 0 | 0 | 0.75 | | 1 | 1 |
| Glass | 2580 | 1.44 | 0 | 0 | 0 | 0 | 0 | 0.75 | | 1 | 1 |

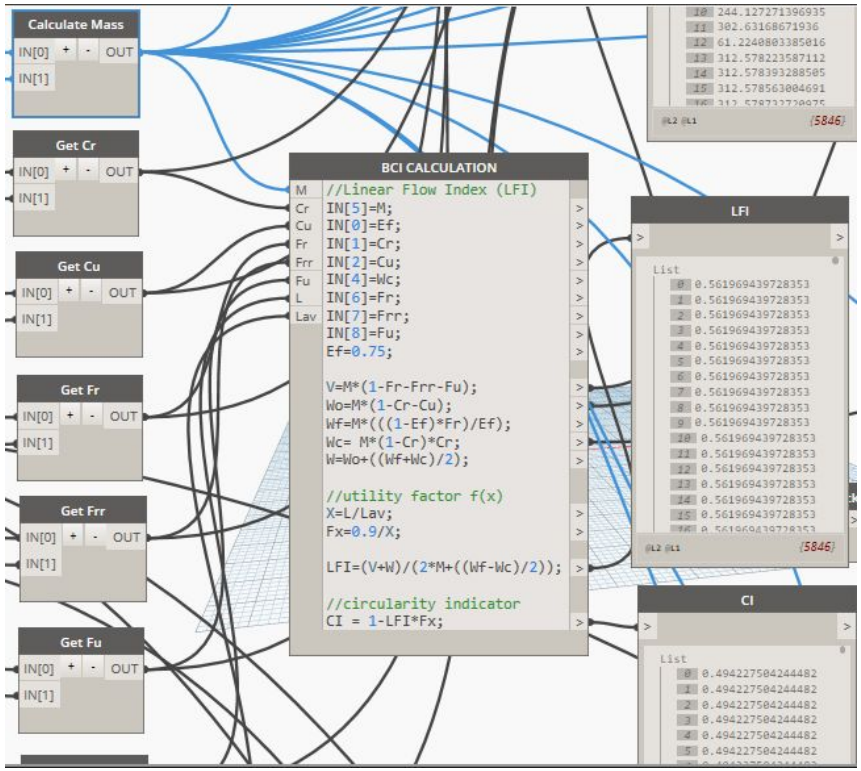


# 循環建築分析

## 3. 計算建築循環度與材料碳排

- Calculate Mass = Volume * Density
- CI = 1 - LFI*Fx
- BCI = Σ(CI*Mass) / ΣMass
- Embodied CO2 = Mass * Specific CO2
  - (kgCO2 = kg * kgCO2/kg)



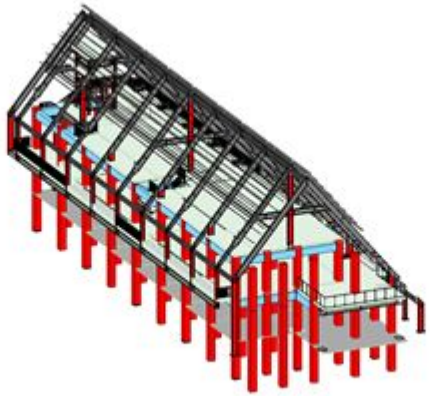
# 循環建築分析

## Steel Structure

**The original design**
Column size :BOX 500*500 mm
Span of x-axis : 1080 cm
Span of y-axis : 750 cm
Roof: c-shape purlin

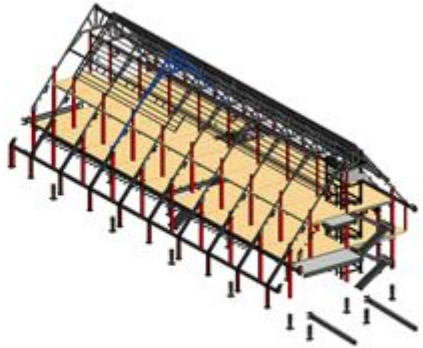
## RC Structure

**Aim on  a cheaper option**
Column size: 900*900 mm
span of x-axis : 1080 cm
span of y-axis : 750 cm
roof: c-shape purlin



## Timber  Structure

**For a more sustainable material**
column size: 610*610 mm
span of x-axis : 540 cm
span of y-axis : 750 cm
roof: wood purlin

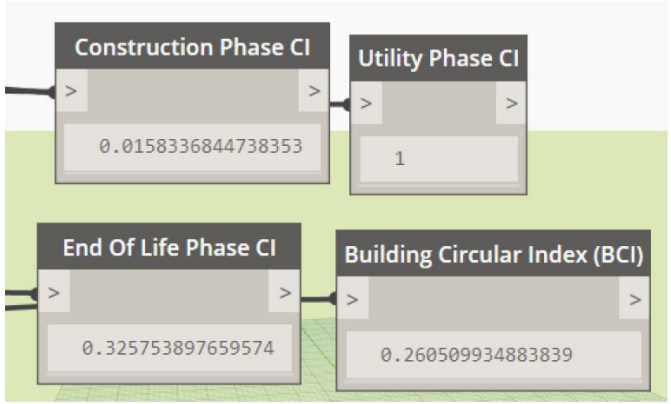


# 循環建築分析

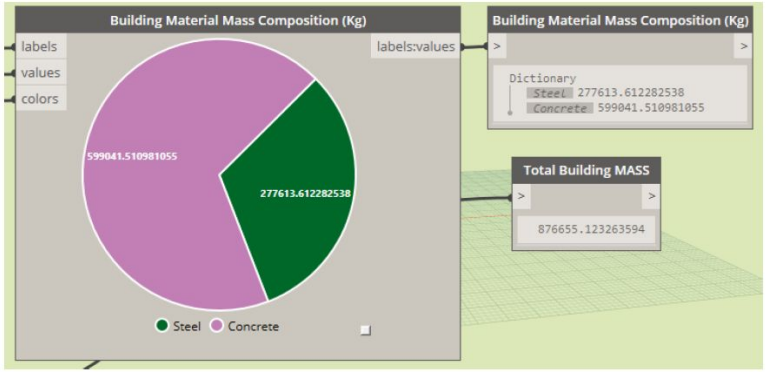
BCI = 0.26

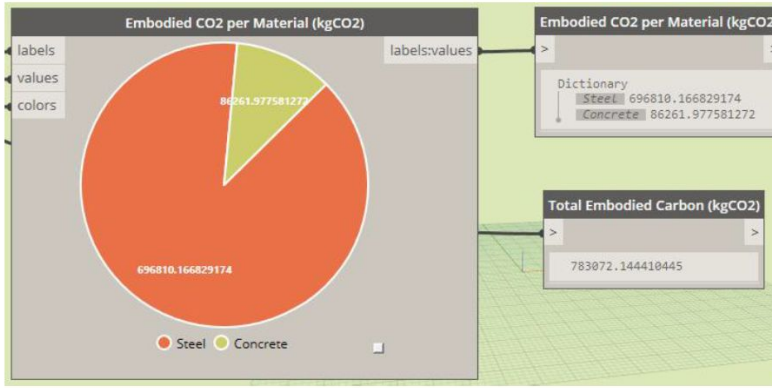
Building Mass = 877 T

Embodied Carbon = 783 TCO2

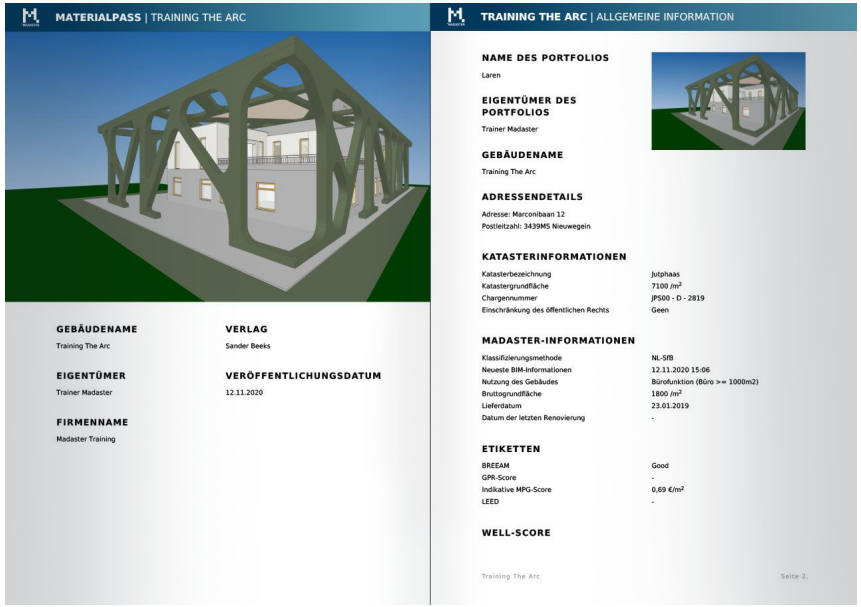



| Material | Weight Density (kg/m3) or (kg/m2) | Embodied CO2 (kgCO2/kg) | Fr | Frr | Fu | Cr | Cu | Ef | Ec | L | Lav |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Concrete | 2400 | 0.144 | 0 | 0 | 0 | 0.2 | 0 | 0.75 | 0.75 | 1 | 1 |
| Steel | 7850 | 2.510 | 0.05 | 0 | 0 | 0.94 | 0 | 0.75 | 0.75 | 1 | 1 |



# 循環城市建構



MATERIALPASS | TRAINING THE ARC

GEBÄUDENAME
Training The Arc

VERLAG
Sander Beeks

EIGENTÜMER
Trainer Madaster

VERÖFFENTLICHUNGSDATUM
12.11.2020

FIRMENNAME
Madaster Training

TRAINING THE ARC | ALLGEMEINE INFORMATION

NAME DES PORTFOLIOS
Laren

EIGENTÜMER DES PORTFOLIOS
Trainer Madaster

GEBÄUDENAME
Training The Arc

ADRESSENDETAILS
Adresse: Marconibaan 12
Postleitzahl: 3439MS Nieuwegein

KATASTERINFORMATIONEN

| | |
|---|---|
| Katasterbezeichnung | Jutphaas |
| Katastergrundfläche | 7100 /m² |
| Chargennummer | JPS00 - D - 2819 |
| Einschränkung des öffentlichen Rechts | Geen |

MADASTER-INFORMATIONEN

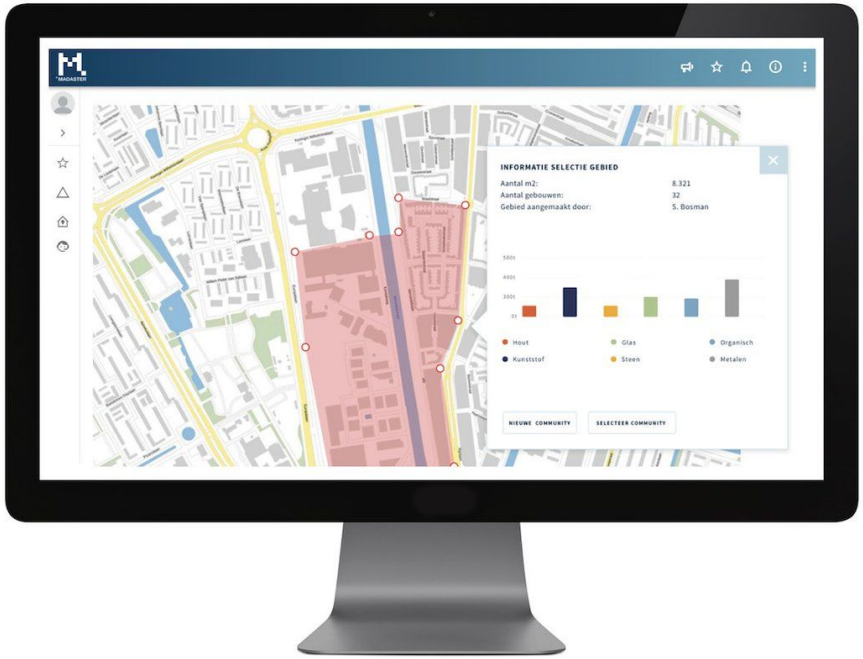
| | |
|---|---|
| Klassifizierungsmethode | NL-SfB |
| Neueste BIM-Informationen | 12.11.2020 15:06 |
| Nutzung des Gebäudes | Bürofunktion (Büro >= 1000m2) |
| Bruttogrundfläche | 1800 /m² |
| Lieferdatum | 23.01.2019 |
| Datum der letzten Renovierung | - |

ETIKETTEN

| | |
|---|---|
| BREEAM | Good |
| GPR-Score | - |
| Indikative MPG-Score | 0,69 €/m² |
| LEED | - |

WELL-SCORE

Training The Arc Seite 2.



# 結語-
# 永續 X 生命週期 X BIM

圖表來源：BSI 英國標準協會 2021 年 6 月

# 感謝聆聽
# 懇請賜教

BIM
Research Center for Building & Infrastructure Information Modeling and Management

bsi.