



BIM4Ren

TRAINING

Digital Twins for nZEB Renovation

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www.iesve.com



This project has received funding from the H2020 programme under Grant Agreement No. 820773

IES

Digital Twin key concepts

- Compliance vs performance
- Model calibration
- Worked example

Strategies towards net zero

- Operational improvements
- Shallow retrofit
- Deep renovation
- Integration of RES (towards PEB)

Choosing a renovation scenario

- Optimisation
- LCA + LCC
- Multicriteria scenario comparison



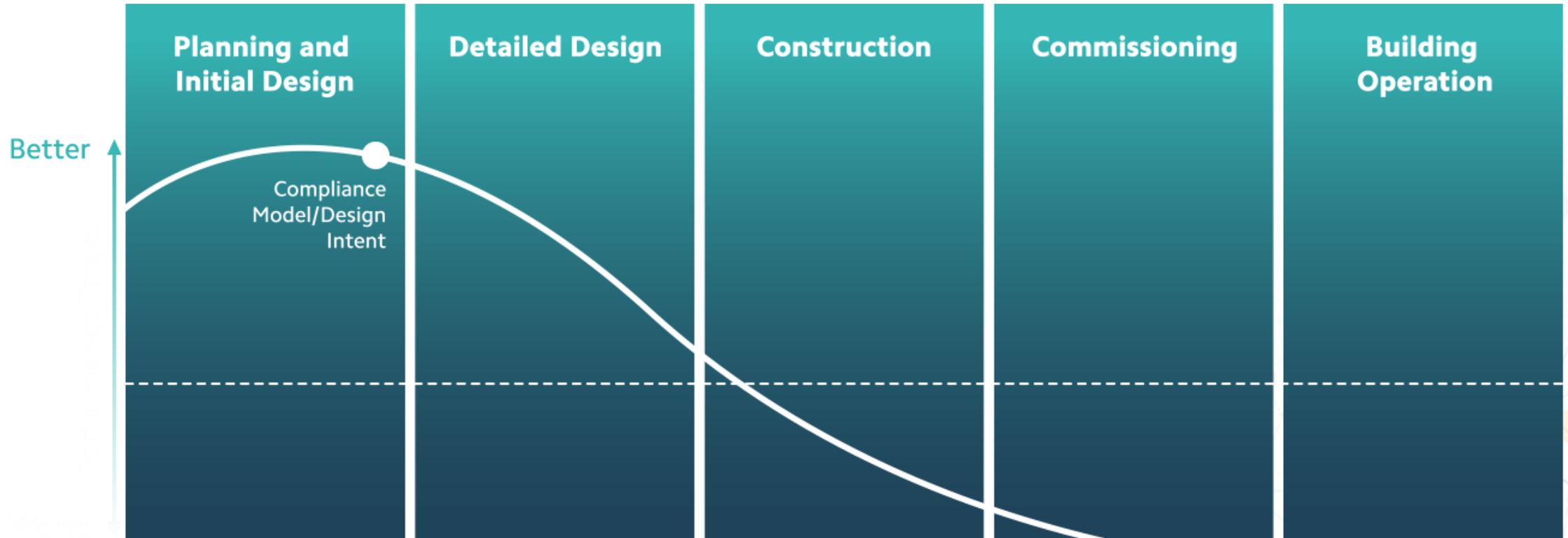
Digital Twins for renovation

Closing the performance gap



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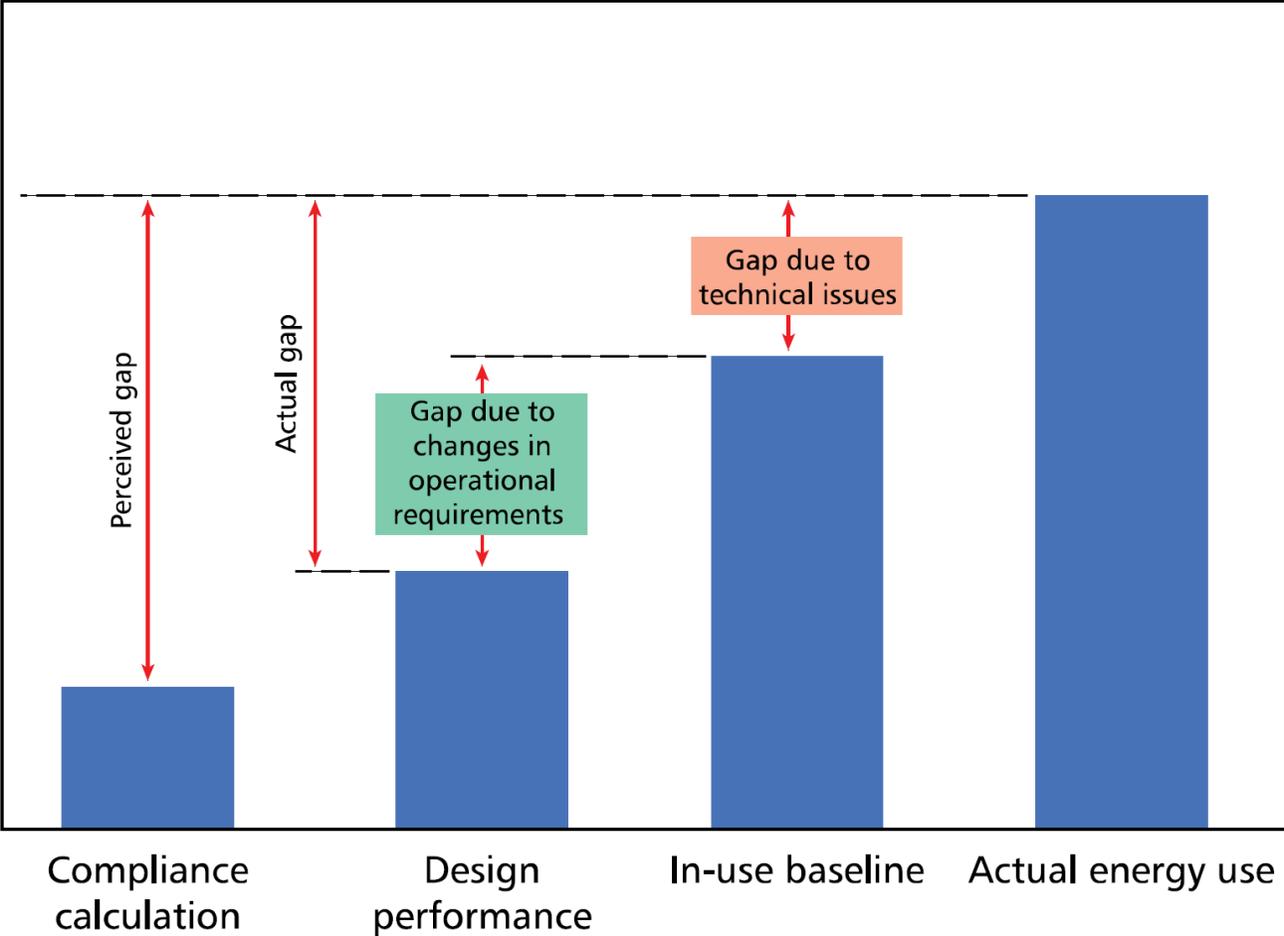
The problem with buildings



Buildings don't perform to their design intent and typically perform worse than even the minimal targets



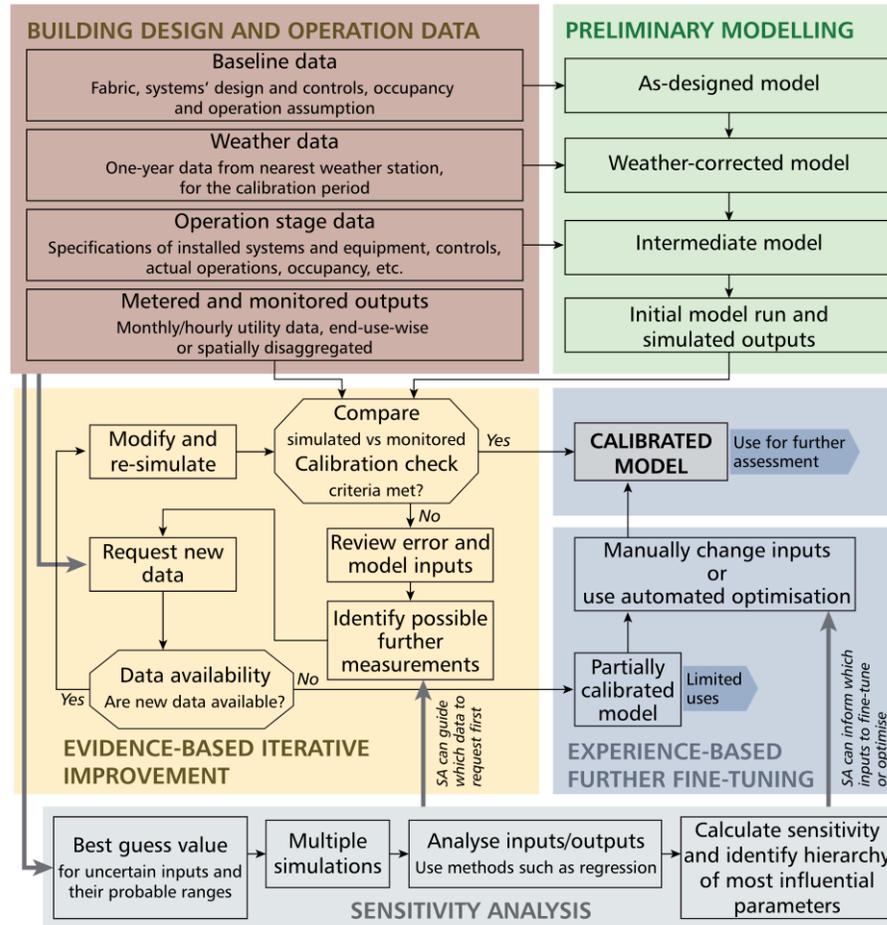
Compliance is not performance



Source: CIBSE TM63:2020 Building performance modelling and calibration for energy in-use



Model calibration for accuracy

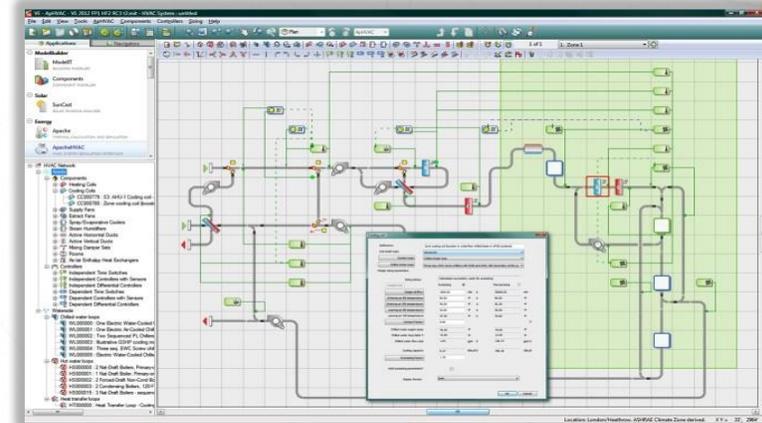
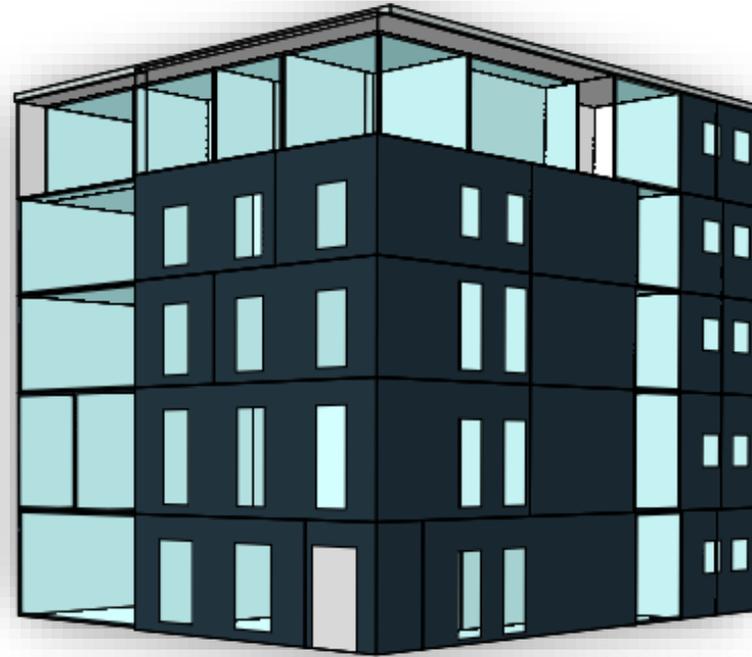


- TM63 (2020) Methodology
- Guidance for energy model calibration
- Evidence and experience based approach

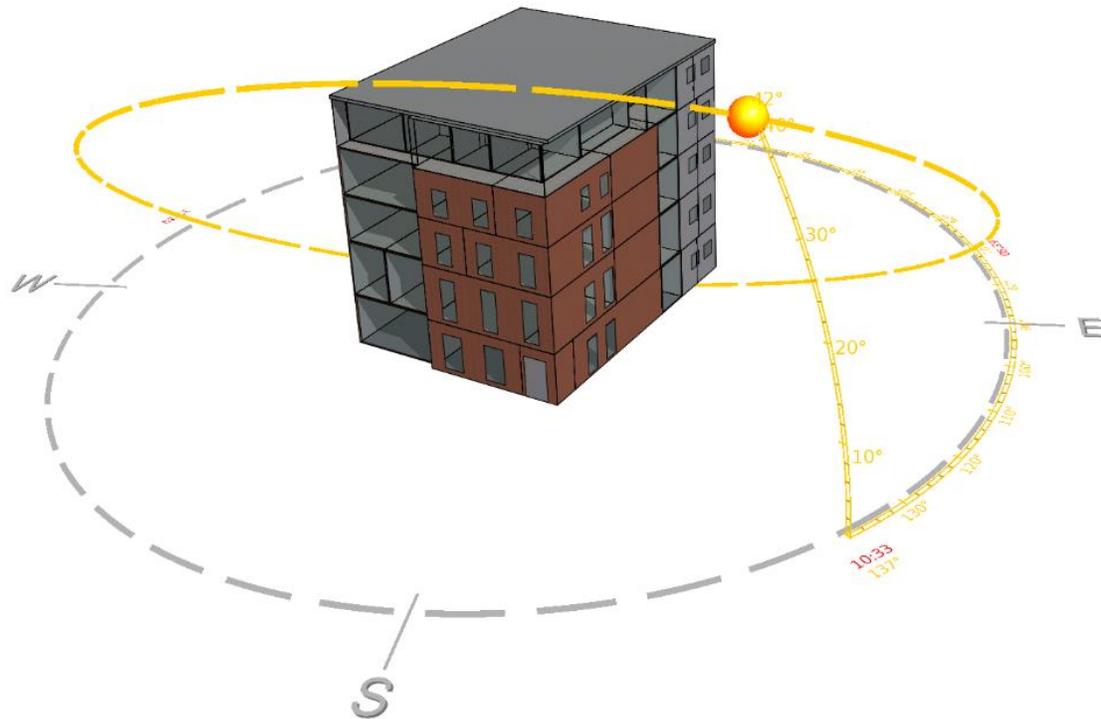
Source: CIBSE TM63:2020 Building performance modelling and calibration for energy in-use



Worked example



Building Location & Climate Analysis



Site Data

Location: *Example St., Shannon, Ireland*

Latitude: **.661392

Longitude: -*.630491

Orientation: 202° clockwise from North

Weather Station: Shannon Airport, IE

Cooling Degree Days: 0

Heating Degree Days: 3374

Yearly Global Solar Radiation: 944 kWh/m²



Model Inputs – Building Envelope

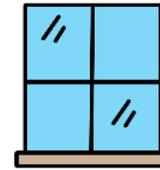


- Input
- Source
- Assumption



External walls

- Solid wall (40 – 60 cm); U-value: 1.97 W/m²K
- Site visit & SEAI average values by location and construction date



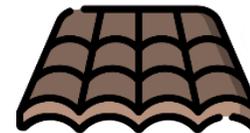
External windows

- Single/Double glazing; U-value: 2.7-3.8 W/m²K
- Site visit & SEAI average values by location and construction date



Ground exposed floor

- Cast concrete (100 cm); U-Value: 0.89 W/m²K
- SEAI average values by location and constr. date



Roof

- Concrete deck; U-value: 2.3 W/m²K
- Average SEAI average values by location and construction date

Model Inputs - Systems

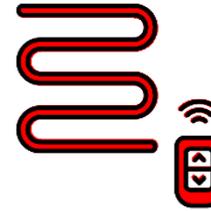


- Input
- Source
- Assumption



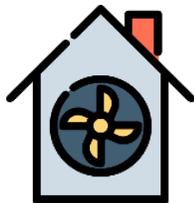
Lighting

- Fluorescent bulbs (~95%) & LED bulbs (~5%)
- Site visit & CIBSE guidelines by space type



Heating System

- Underfloor heating
- Site Visit



Ventilation System

- Mechanical/natural ventilation
- Site Visit



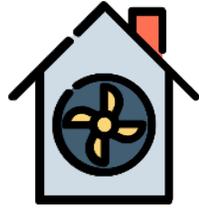
Heating Source

- 2 Gas Boilers (DHW & Space heating)
- Site Visit

Model Inputs – Building Operation

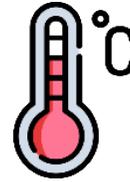


- Input
- Source
- Assumption



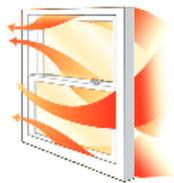
Ventilation rate

- Default air changes / hour
- *CIBSE standards per space type & No. of people*



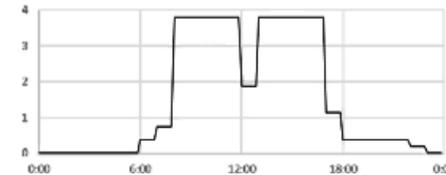
Thermal set points & Schedule

- Heating: 23°C; Cooling: N/A
- *Site Visit*



Infiltrations & Heat losses

- 0.21 air changes / hour
- *Construction year*



Profiles of use

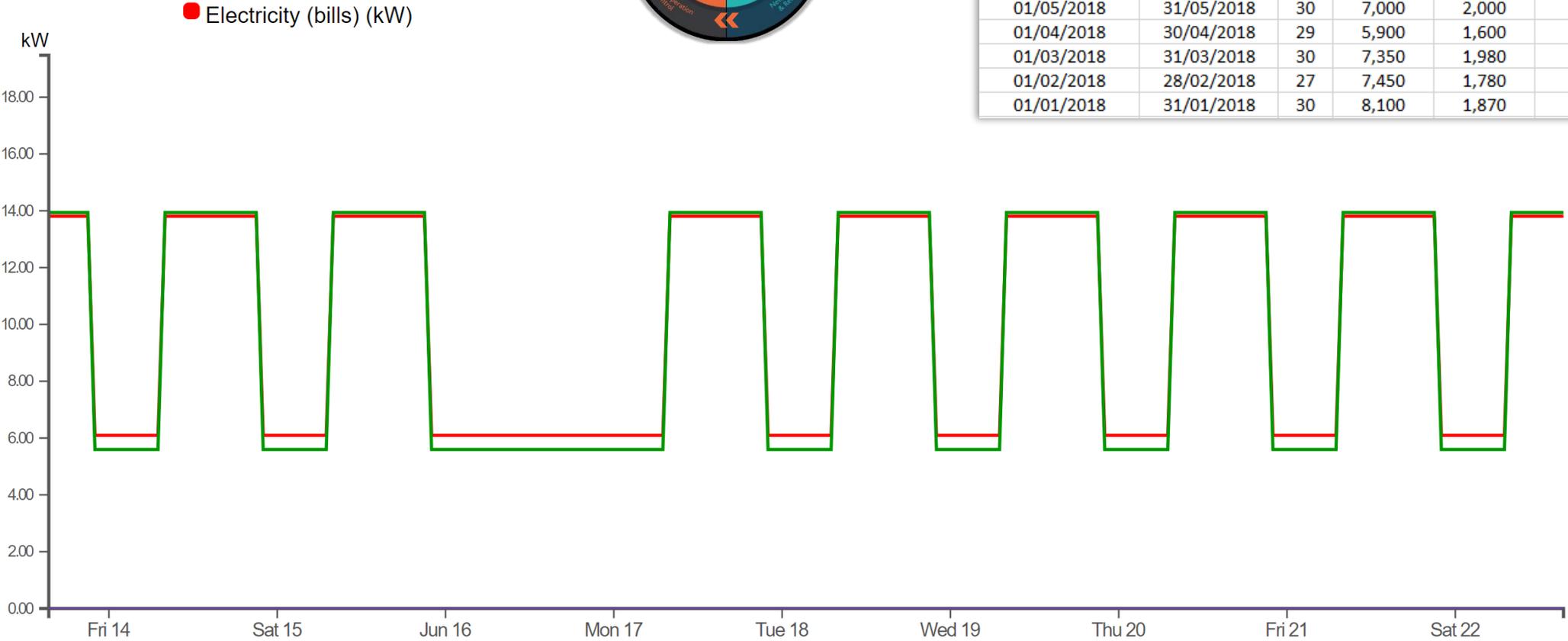
- Weekly (Mon-Sat): 8:00 – 22:00 (morning peak occupancy)
- Thursday evening: event in Hall room > peak of occupancy
- Sundays: closed
- *Site Visit*

Calibration: Electricity consumption



CSV ←

Period start	Period end	Days	kWh Day	kWh night	Total kWh
01/10/2018	31/10/2018	30	6,000	2,000	8,000
01/09/2018	30/09/2018	29	6,000	2,400	8,400
01/08/2018	31/08/2018	30	5,560	1,600	7,160
01/07/2018	31/07/2018	30	5,900	1,500	7,400
01/06/2018	30/06/2018	29	5,600	1,450	7,050
01/05/2018	31/05/2018	30	7,000	2,000	9,000
01/04/2018	30/04/2018	29	5,900	1,600	7,500
01/03/2018	31/03/2018	30	7,350	1,980	9,330
01/02/2018	28/02/2018	27	7,450	1,780	9,230
01/01/2018	31/01/2018	30	8,100	1,870	9,970



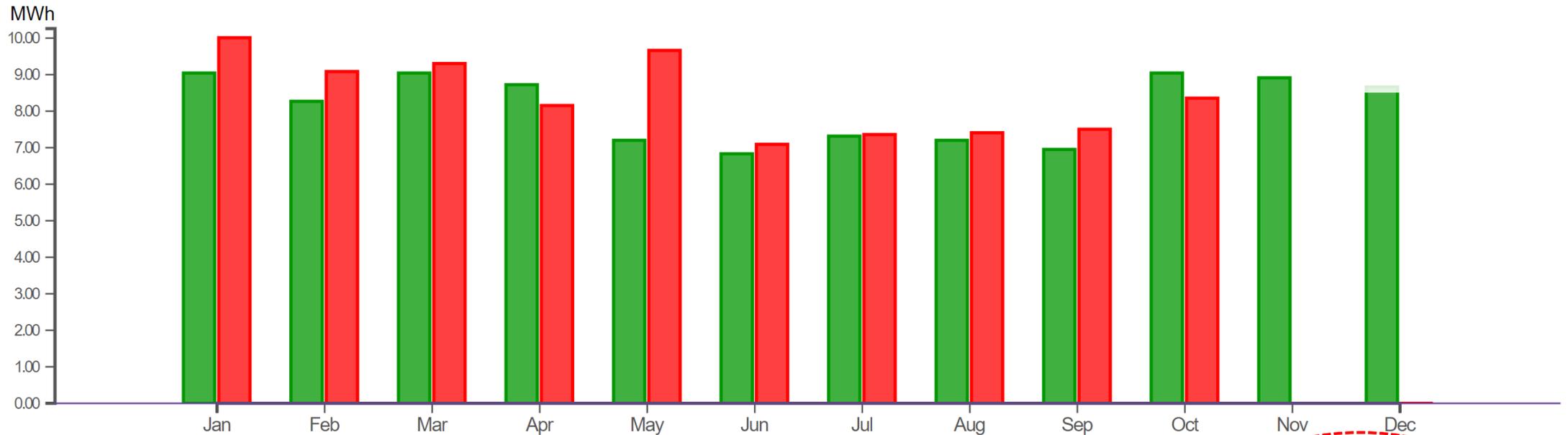
June 14th – June 22nd



Accuracy of the Model



● Electricity (bills) (MWh)
● Total electricity (MWh)

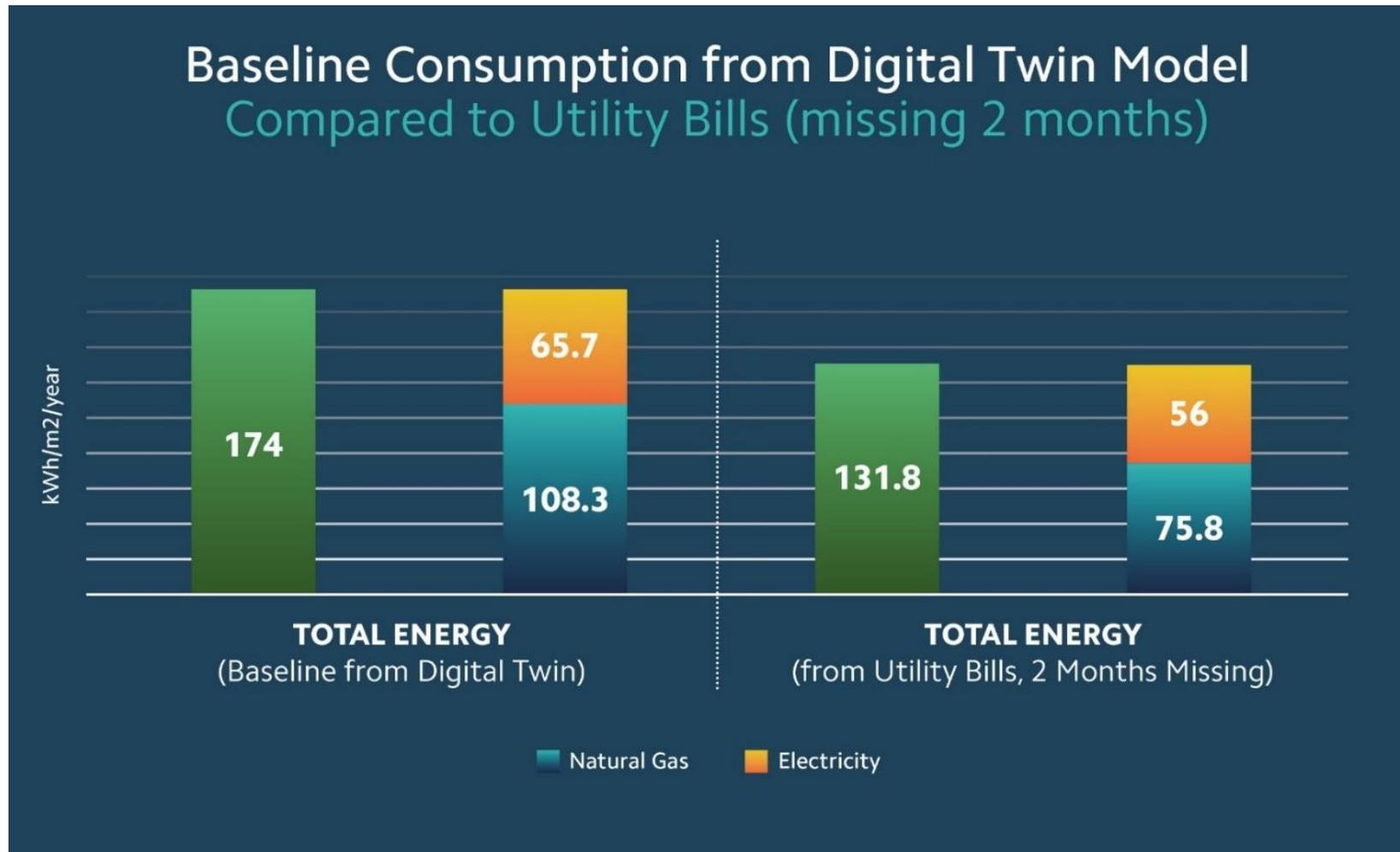


Monthly total	2019-01-01	2019-02-01	2019-03-01	2019-04-01	2019-05-01	2019-06-01	2019-07-01	2019-08-01	2019-09-01	2019-10-01	2019-11-01	2019-12-01
Total electricity (MWh)	9.0487	8.2700	9.0487	8.7265	7.2000	6.8321	7.3167	7.2000	6.9489	9.0487	8.9144	8.6730
Electricity (bills) (MWh)	10.0112	9.0854	9.3038	8.1570	9.6660	7.0905	7.3589	7.4080	7.5035	8.3595	0.0000	0.0000

missing bills



Accuracy of the Model



-2.1% compared to the extrapolated bills



Create Scenario

Simulation Settings

★ MODEL: Sample Model

★ SCENARIO NAME: Scenario Name

★ SCENARIO DESCRIPTION: Scenario Description

★ START DATE: 01-01-2022

★ END DATE: 01-02-2022

★ TIME STEP: 10 Minutes

★ PRECONDITIONING PERIOD: 10 Days

★ REPORTING INTERVALS: 10 Minutes

★ WEATHER SOURCE: Get weather from ISCAN

★ ISCAN SCENARIOS: Measured Data

PARAMETERS 2

MODEL OUTPUTS 3

Parameter Types

★ PARAMETER TYPES: Parameter Types

Add Parameter Type

PARAMETER TYPES

★ PARAMETER DESCRIPTION: Room Gain

Parameter Description

★ ROOM SCHEME: Room Scheme

★ ROOM GROUP: Room Groups

★ ROOM ID'S: Selected ID's

★ GAIN: Tungsten

★ KIND: Sensible

★ VALUE / SCALE: Value

★ VALUE: e.g. 18 °C

★ RANGE (MIN - MAX): e.g. 21 °C, e.g. 23 °C

PARAMETER TYPES

★ PARAMETER DESCRIPTION: Room Setpoint

Parameter Description

★ ROOM SCHEME: Room Scheme

★ ROOM GROUP: Room Groups

★ ROOM ID'S: Selected ID's

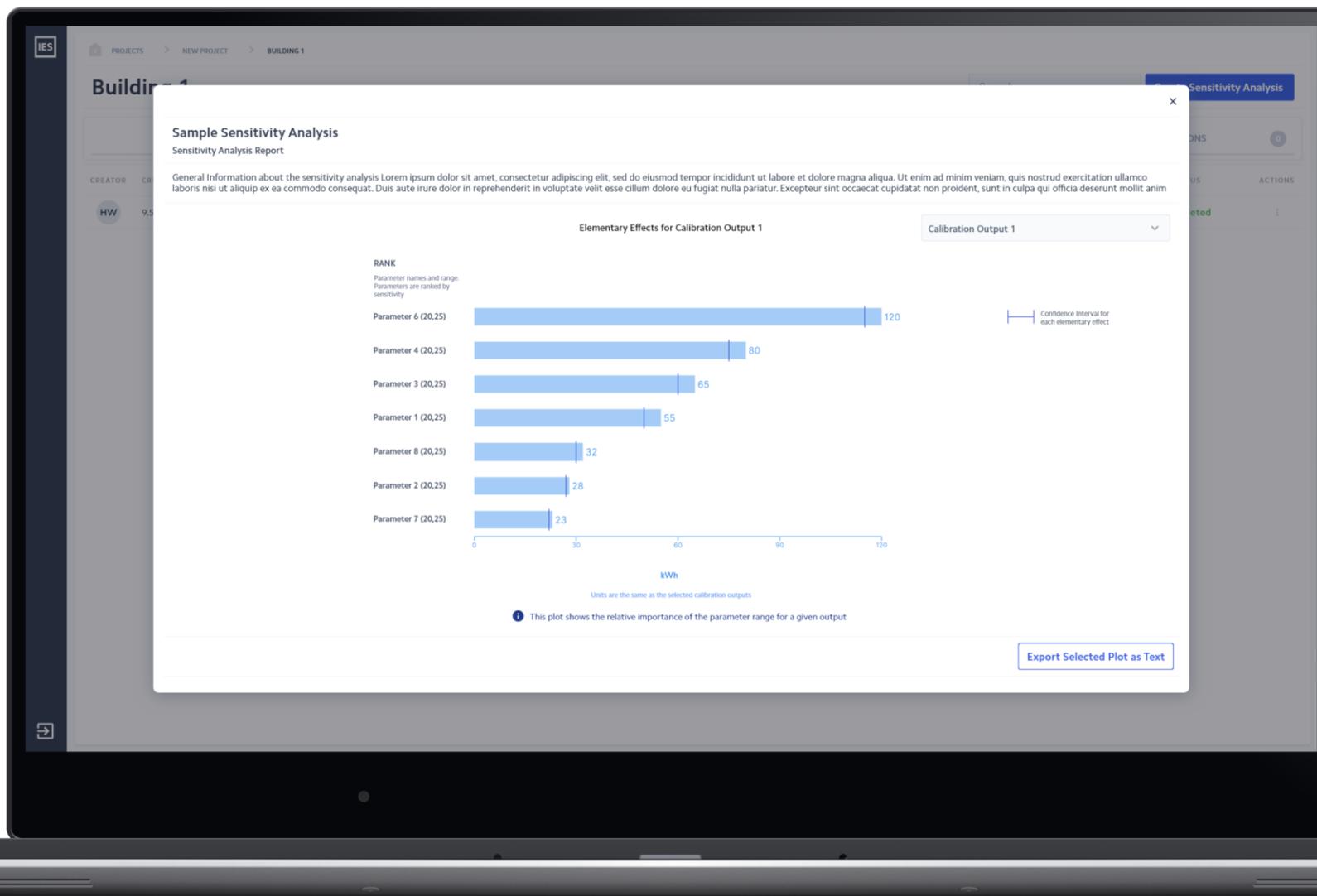
★ SETPOINT TYPE: Heating

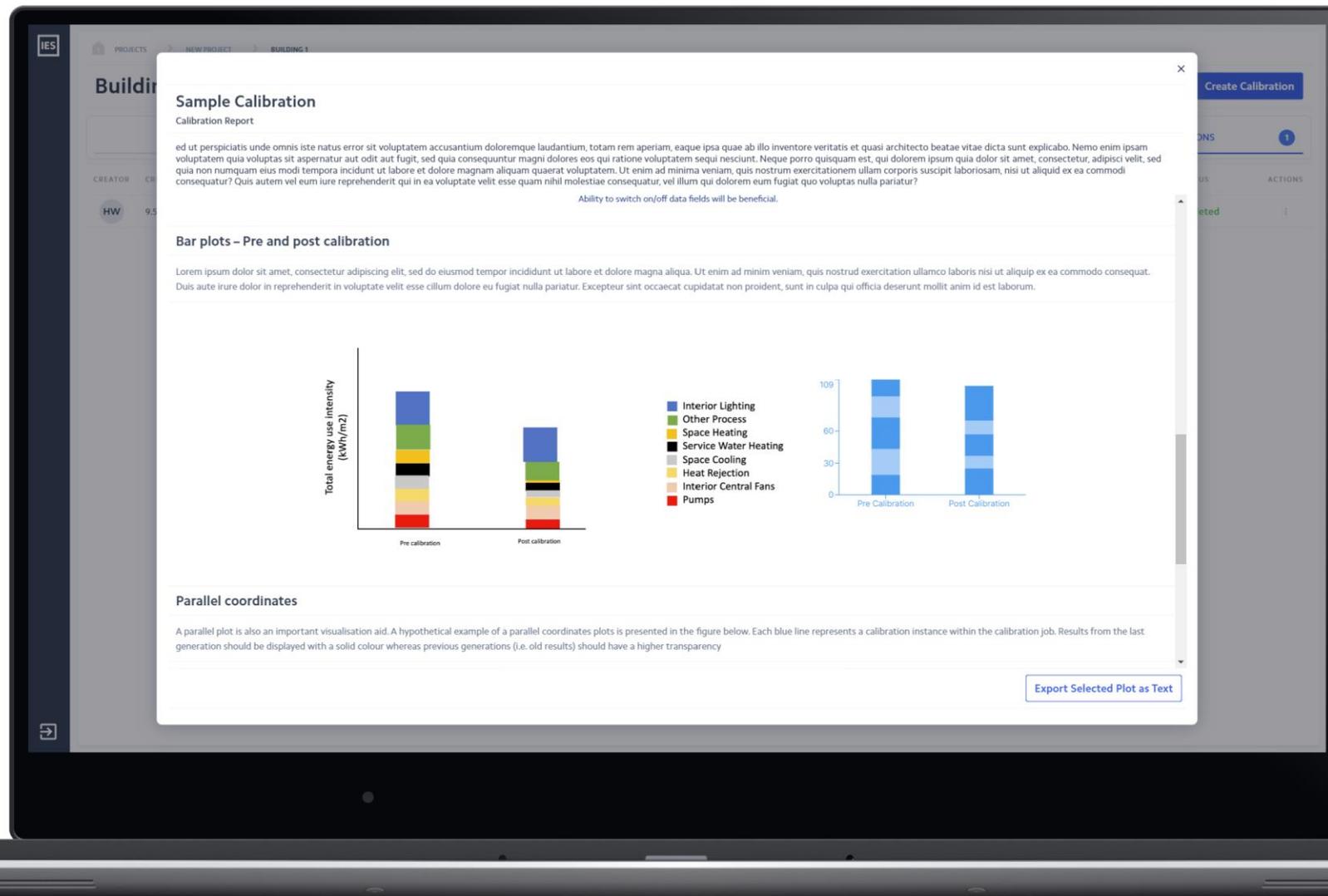
★ VALUE / SCALE: Value

★ VALUE: e.g. 18 °C

★ RANGE (MIN - MAX): e.g. 21 °C, e.g. 23 °C

Cancel Save & Continue Create Scenario





Sample Calibration

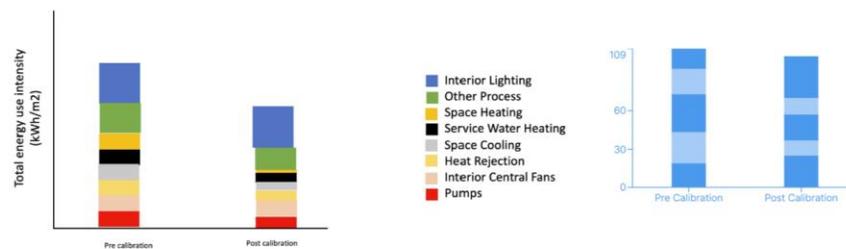
Calibration Report

ed ut perspiciatis unde omnis iste natus error sit voluptatem accusantium doloremque laudantium, totam rem aperiam, eaque ipsa quae ab illo inventore veritatis et quasi architecto beatae vitae dicta sunt explicabo. Nemo enim ipsam voluptatem quia voluptas sit aspernatur aut odit aut fugit, sed quia consequuntur magni dolores eos qui ratione voluptatem sequi nesciunt. Neque porro quisquam est, qui dolorem ipsum quia dolor sit amet, consectetur, adipisci velit, sed quia non numquam eius modi tempora incidunt ut labore et dolore magnam aliquam quaerat voluptatem. Ut enim ad minima veniam, quis nostrum exercitationem ullam corporis suscipit laboriosam, nisi ut aliquid ex ea commodi consequatur? Quis autem vel eum iure reprehenderit qui in ea voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

Ability to switch on/off data fields will be beneficial.

Bar plots - Pre and post calibration

>Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.



Parallel coordinates

A parallel plot is also an important visualisation aid. A hypothetical example of a parallel coordinates plots is presented in the figure below. Each blue line represents a calibration instance within the calibration job. Results from the last generation should be displayed with a solid colour whereas previous generations (i.e. old results) should have a higher transparency

Export Selected Plot as Text



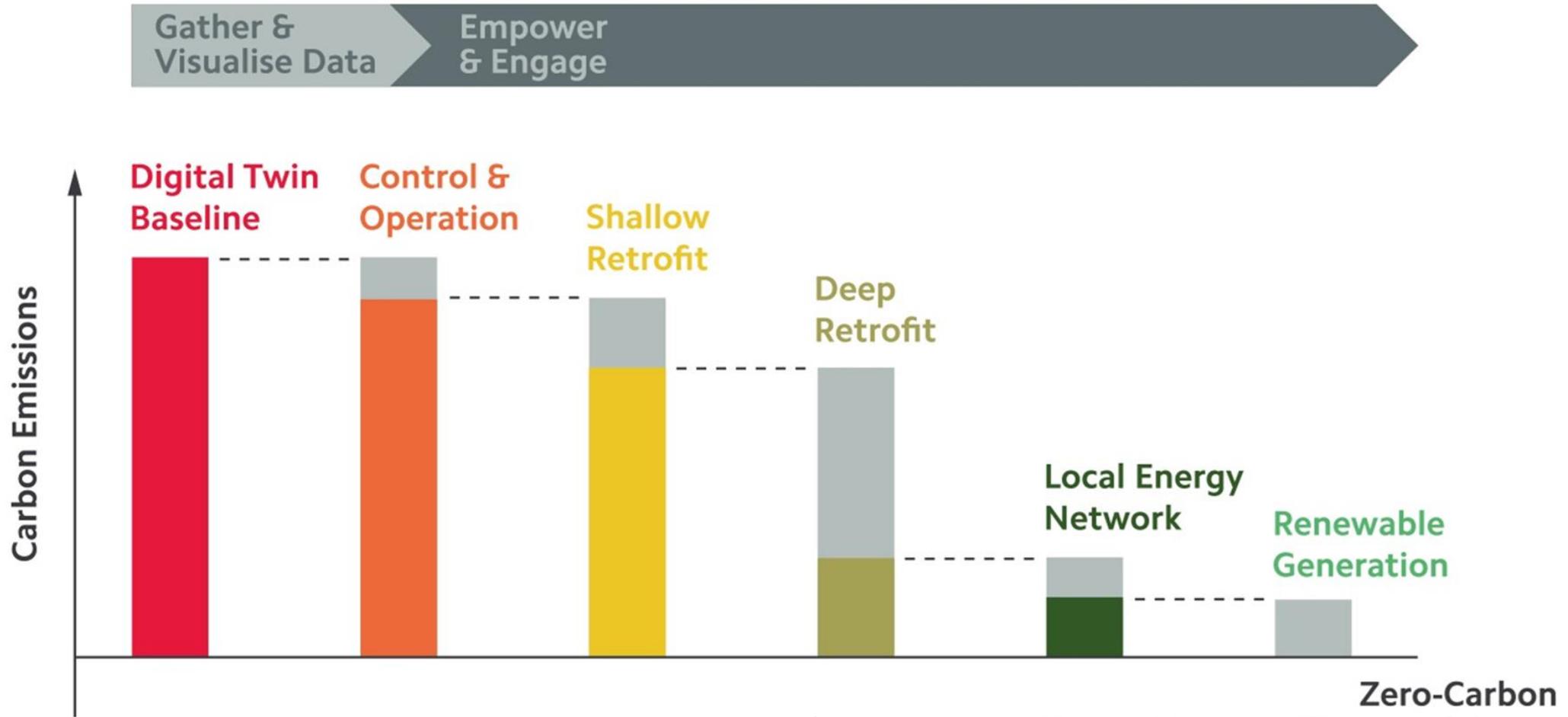
Strategies towards neat zero

Using a Digital Twin to roadmap building decarbonisation



This project has received funding from the H2020 programme under Grant Agreement No. 820773

Digital Twin for nZEB renovation



Evaluate the impact of different renewable energy generators to **achieve operational zero carbon**



**AREA OF INTEREST –
RESIDENTIAL BUILDING ON LOWER HARSTONGE STREET**

- POTENTIAL ENERGY EFFICIENCY STRATEGIES

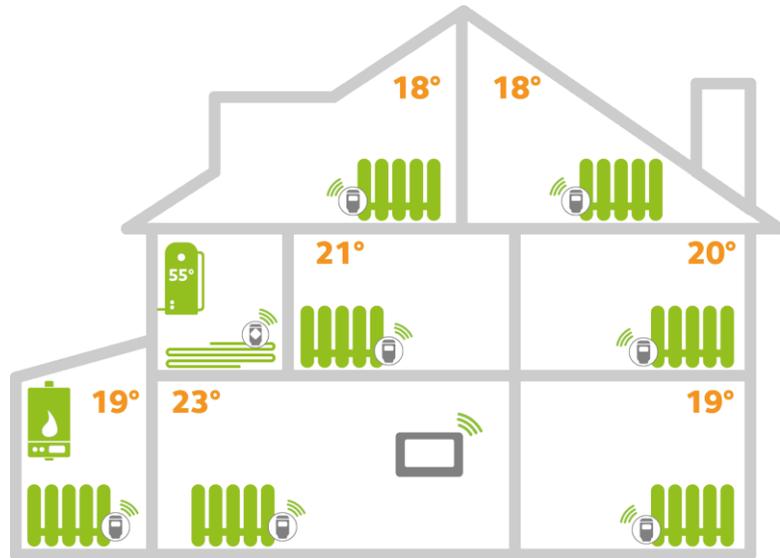
- OPERATIONAL MEASURES

- HEATING CONTROL UPGRADES AND ZONING: 15% SAVING



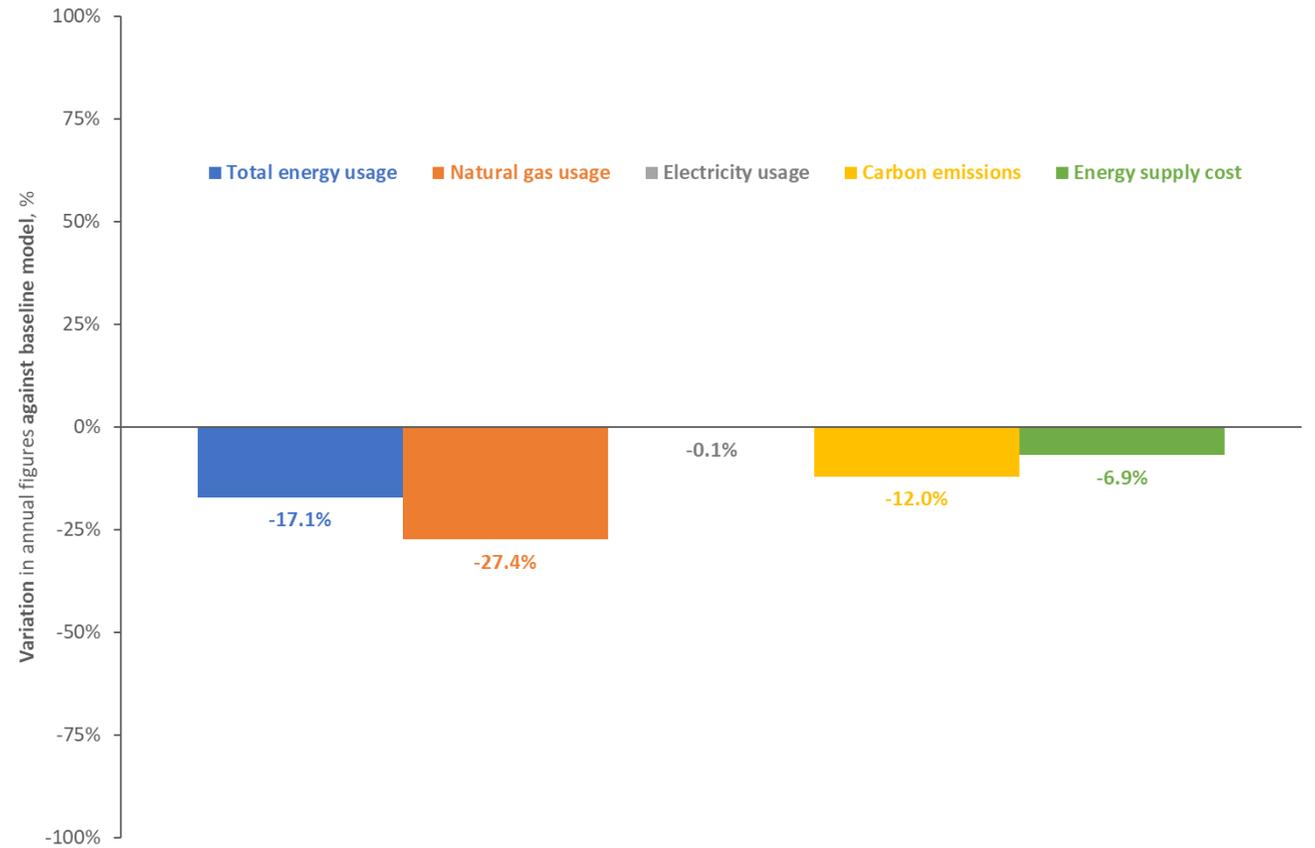
Operational Measures

1. Zone heating controls



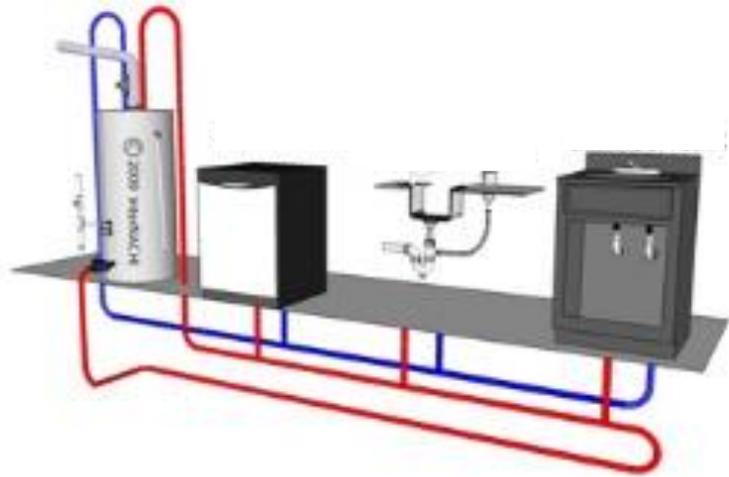
Heating control improvements:

- Individual room thermostats and HSP based on activity and occupancy
- Setback value of 16° C for unoccupied rooms

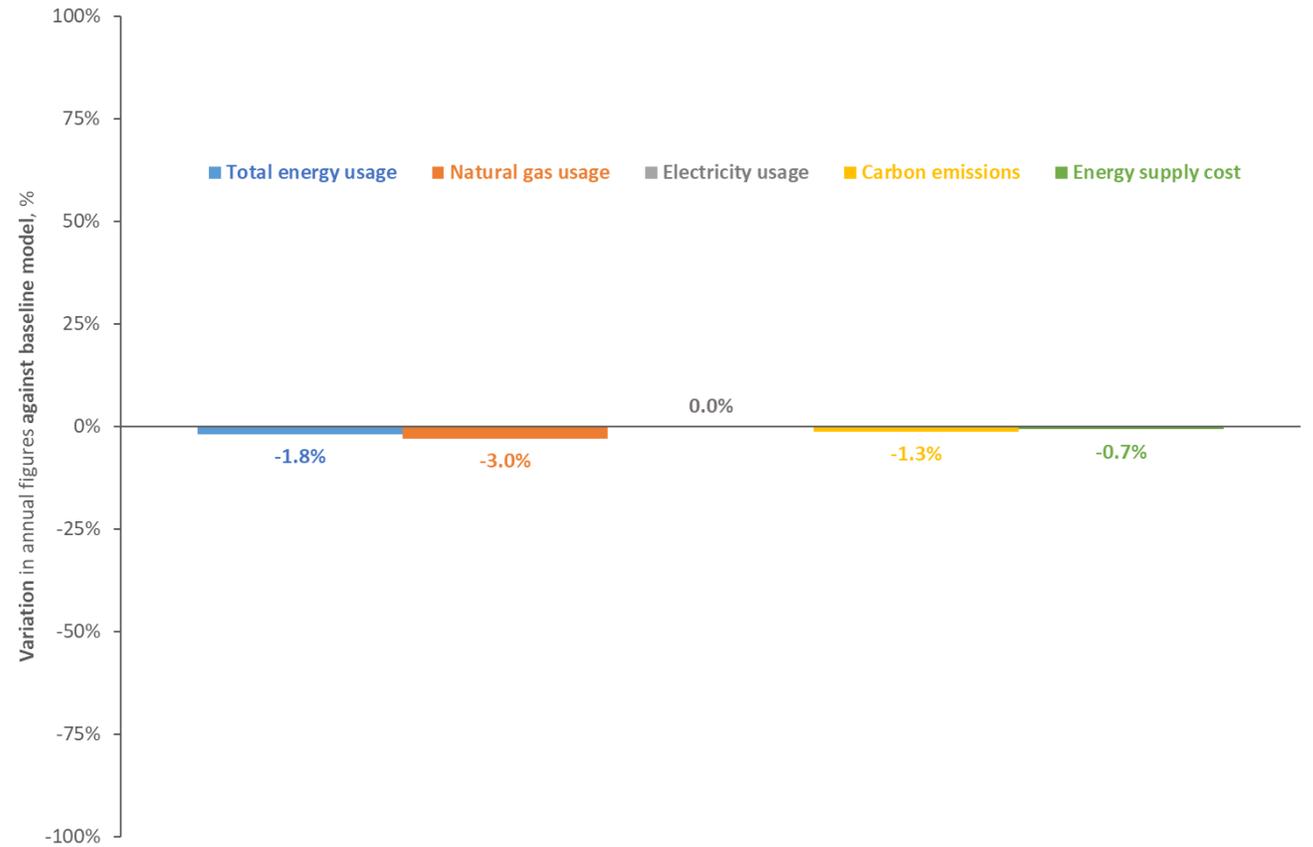


Operational Measures

2. DHW supply T reduction

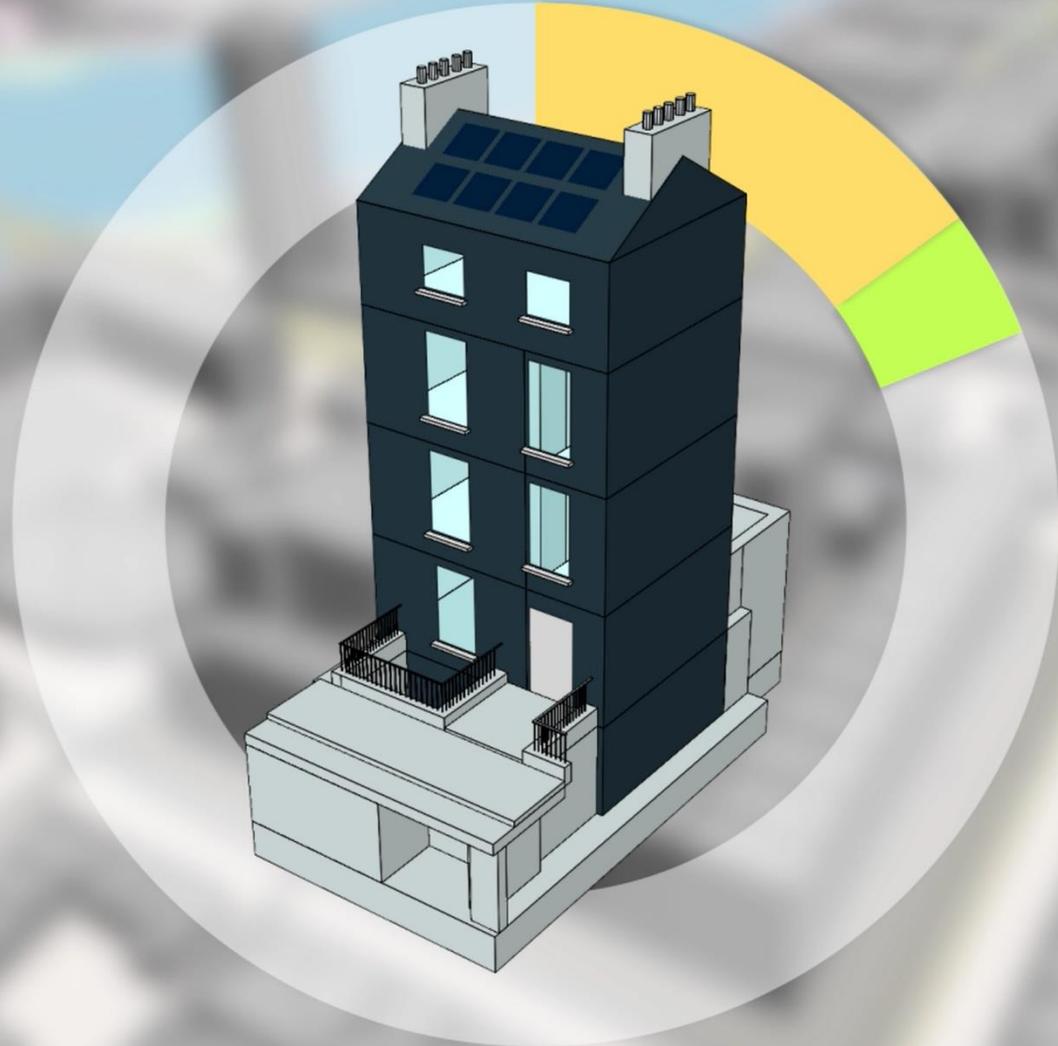


Supply T: 60 ° C → Supply T: 45 ° C*



*constrained by Legionellae bacteria regulation

**AREA OF INTEREST –
RESIDENTIAL BUILDING ON LOWER HARSTONGE STREET**



- POTENTIAL ENERGY EFFICIENCY STRATEGIES

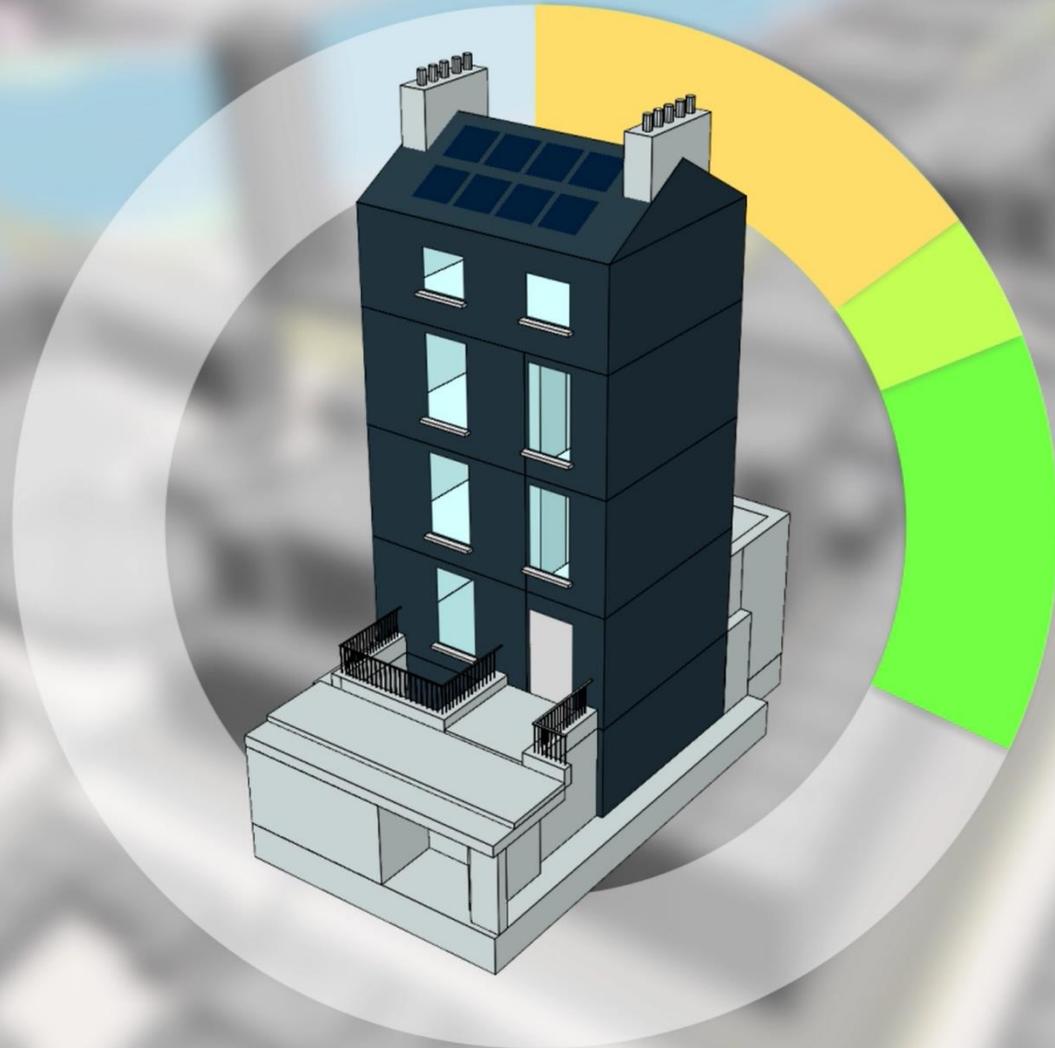
- OPERATIONAL MEASURES

- HEATING CONTROL UPGRADES AND ZONING: 15% SAVING

- SHALLOW RETROFIT MEASURES (I.E. LOW COST)

- WINDOW SEALS REPLACEMENT: 4% SAVING

**AREA OF INTEREST –
RESIDENTIAL BUILDING ON LOWER HARSTONGE STREET**



- POTENTIAL ENERGY EFFICIENCY STRATEGIES

- OPERATIONAL MEASURES

- HEATING CONTROL UPGRADES AND ZONING: 15% SAVING

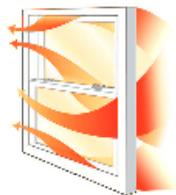
- SHALLOW RETROFIT MEASURES (I.E. LOW COST)

- WINDOW SEALS REPLACEMENT: 4% SAVING

- REPLACE THE OLD GAS BOILER WITH A NEW ONE: 13% SAVING

Shallow retrofit interventions

1. Improving airtightness*



Infiltration rate:
0.21 ac/h

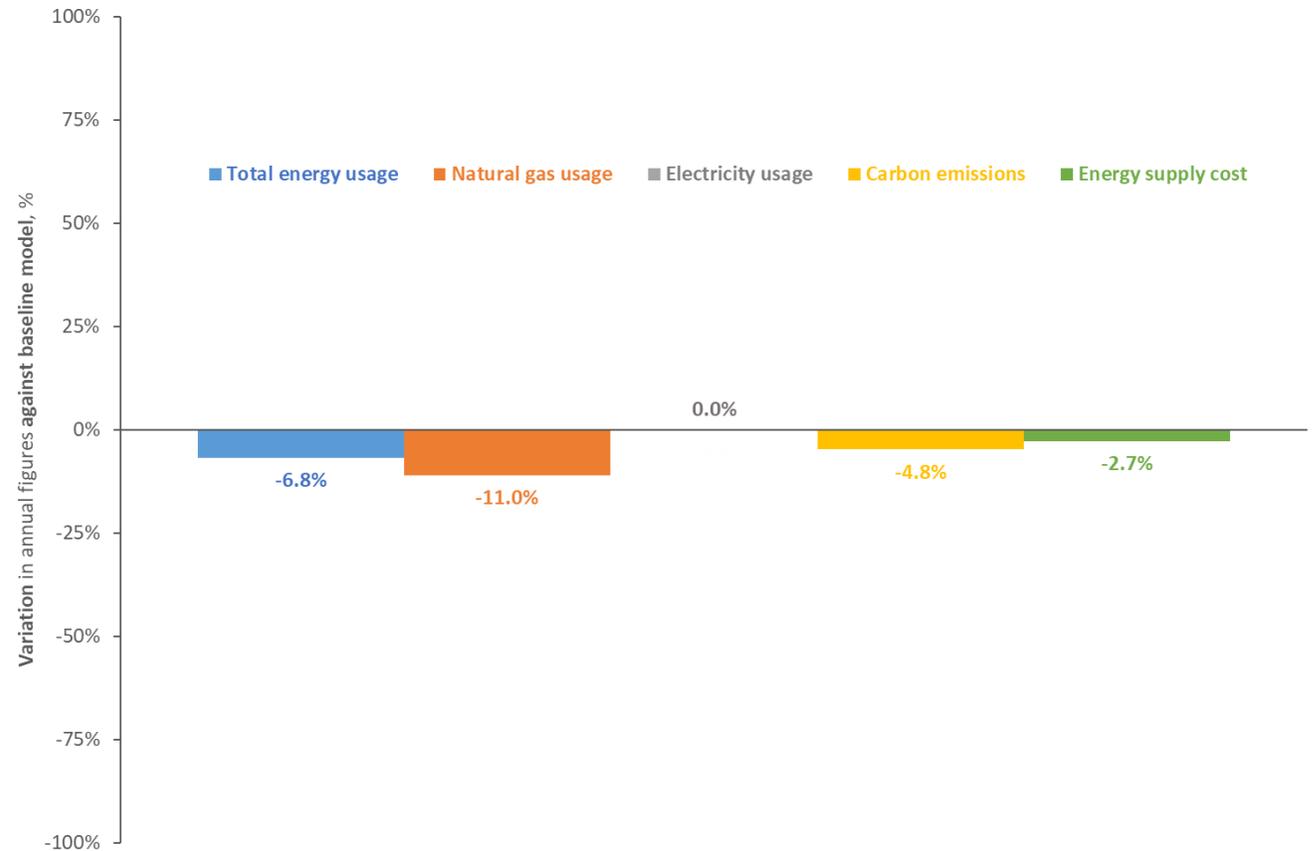


Infiltration rate:
0.07 ac/h

**

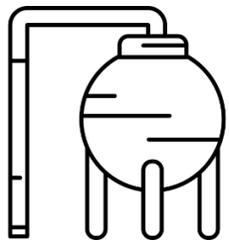
*sealing, weather-stripping, and use of door sweeps
[ASHRAE Fundamentals Chapter 16 and DHPLG, 2019]

**EPBD_ireland_2019_non-domestic_cost_optimal_report



Shallow retrofit interventions

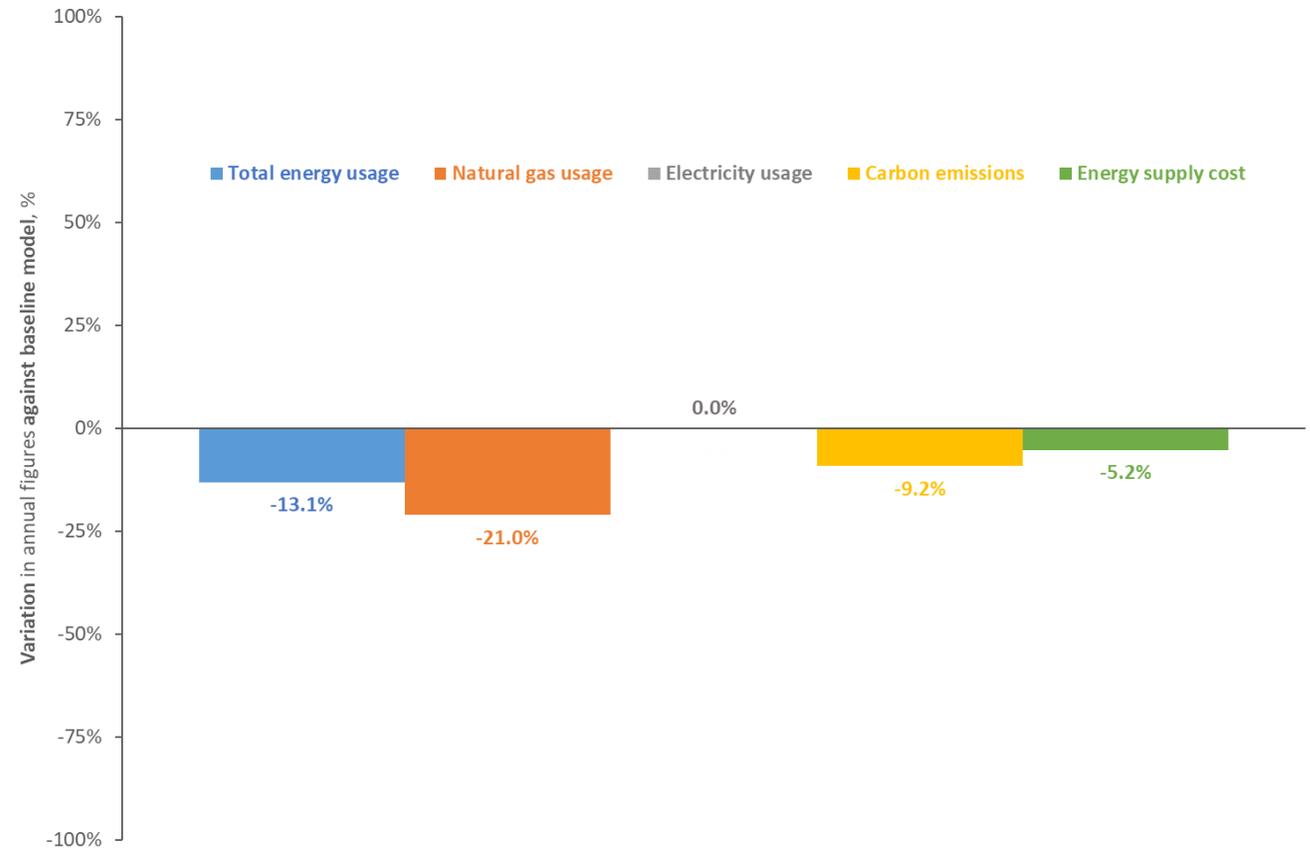
3. Boiler upgrade



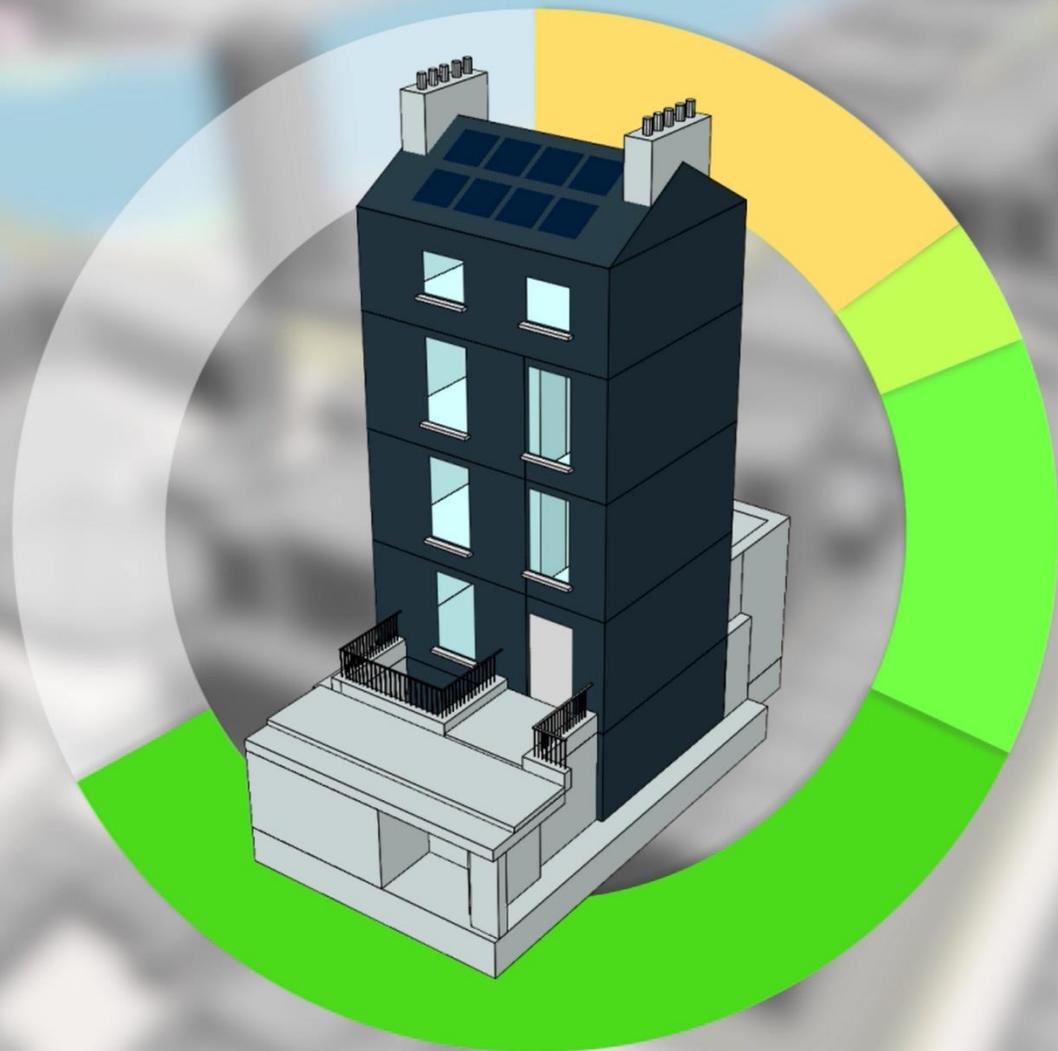
Baseline
sCOP: 0.75



New boiler
sCOP: 0.93



**AREA OF INTEREST –
RESIDENTIAL BUILDING ON LOWER HARSTONGE STREET**



- POTENTIAL ENERGY EFFICIENCY STRATEGIES

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- HEATING CONTROL UPGRADES AND ZONING: 15% SAVING

- SHALLOW RETROFIT MEASURES (I.E. LOW COST)

- WINDOW SEALS REPLACEMENT: 4% SAVING

- REPLACE THE OLD GAS BOILER WITH A NEW ONE: 13% SAVING

- DEEP RENOVATION (I.E. INCREASED COST)

- IMPROVING THE BUILDING ENVELOPE: 35% SAVING

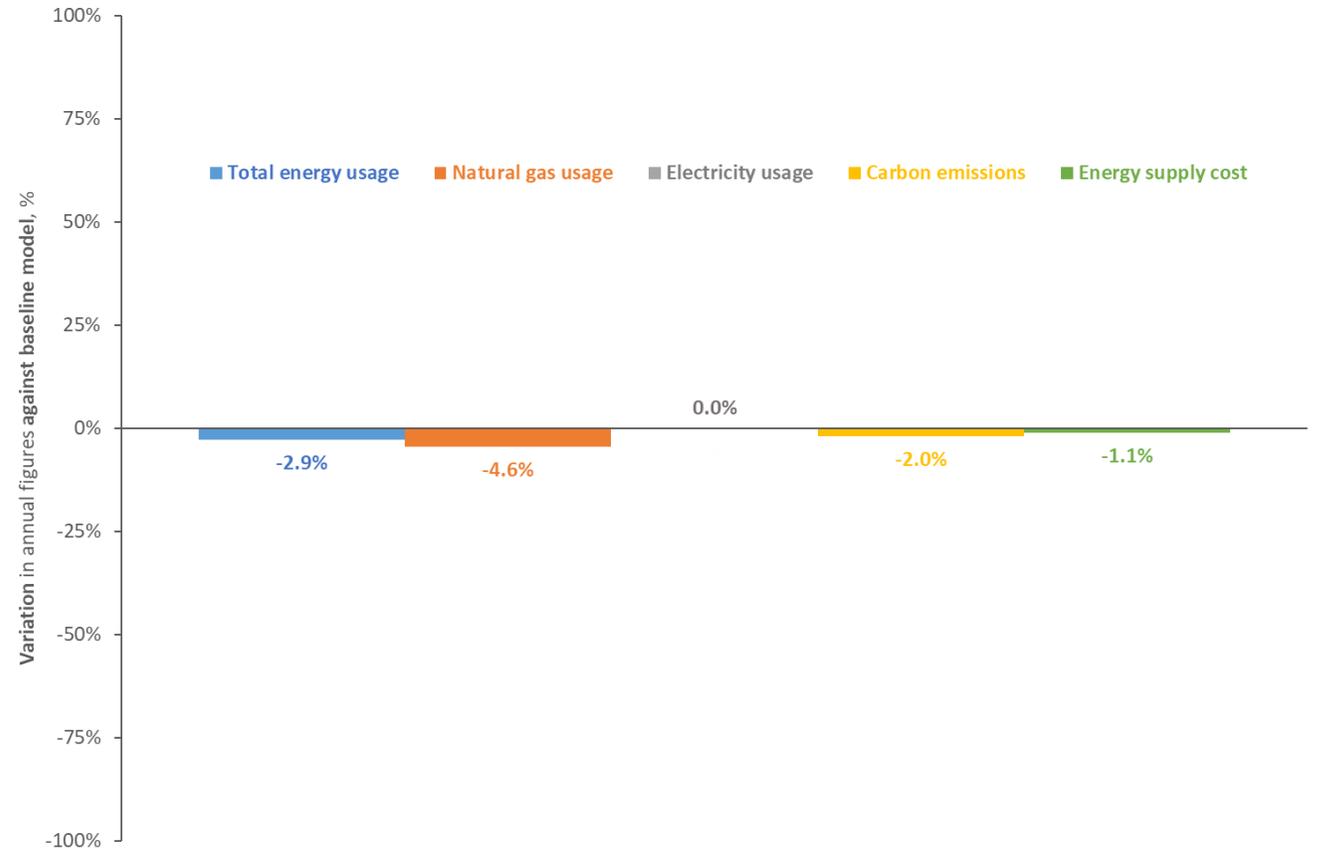
Deep renovation interventions

1. Roof insulation



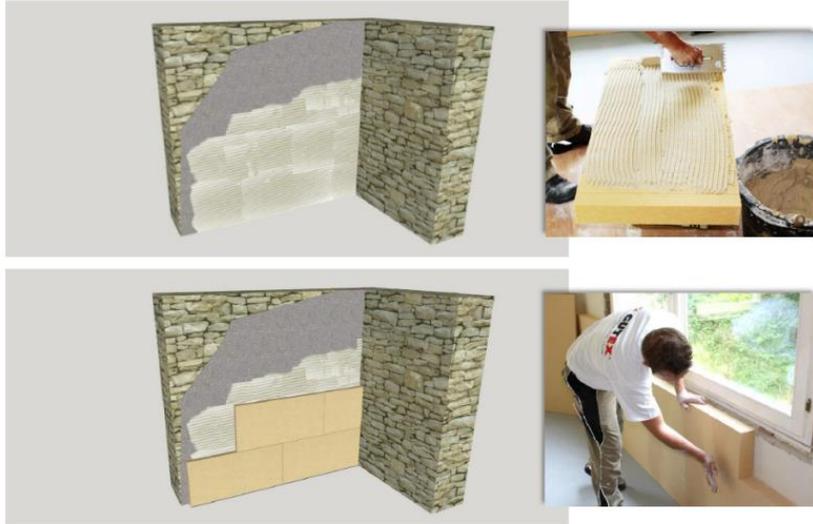
U-Value improvement:

- Baseline roof: 2.3 W/(m²)(K)
- Roof + aerogel insul. board: 0.6 W/(m²)(K)
- Air leakage reduced by 1/4



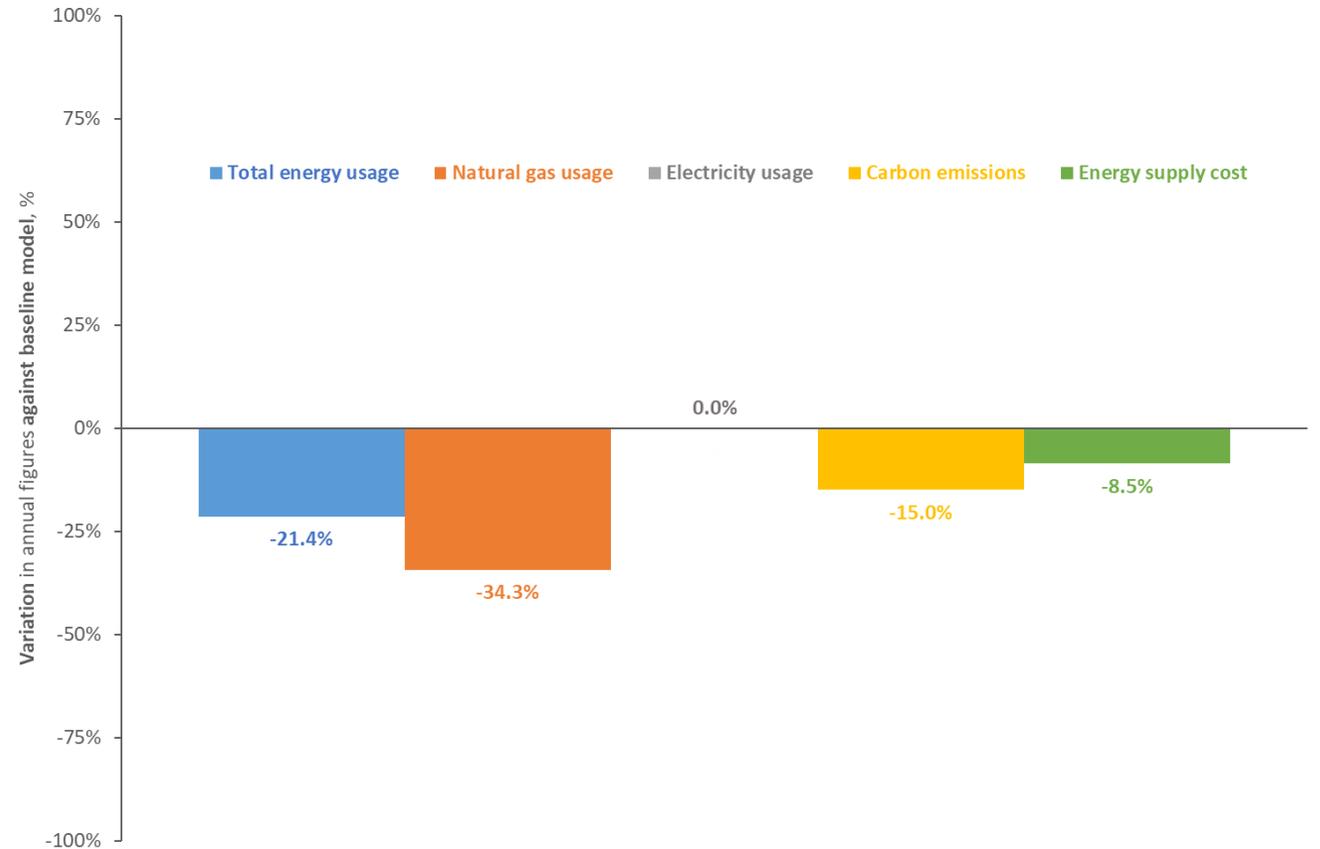
Deep renovation interventions

2. Internal wall insulation



U-Value improvement:

- Baseline solid wall: $1.97 \text{ W}/(\text{m}^2)(\text{K})$
- Solid wall + aerogel insulation board: $0.58 \text{ W}/(\text{m}^2)(\text{K})$



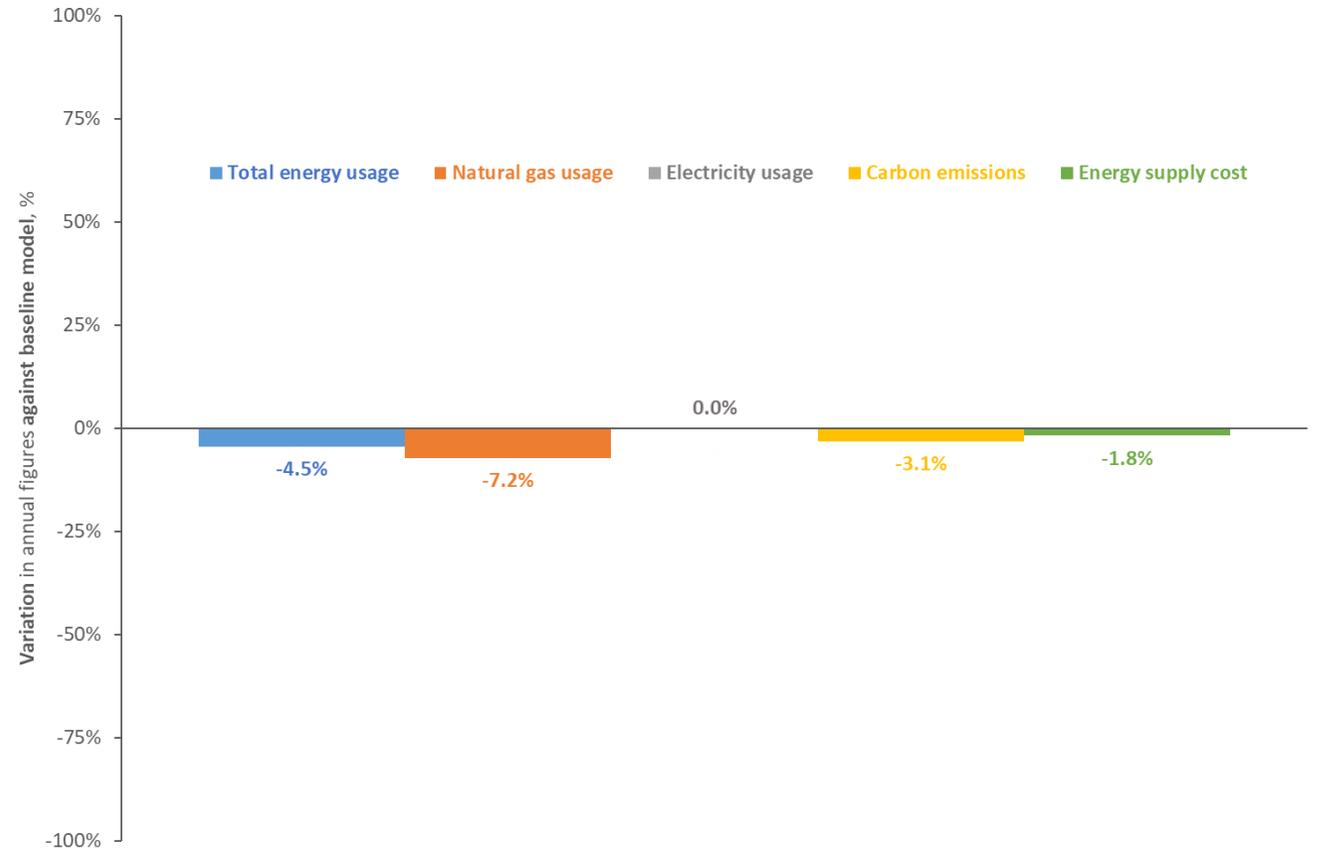
Deep renovation interventions

3. Ground floor insulation



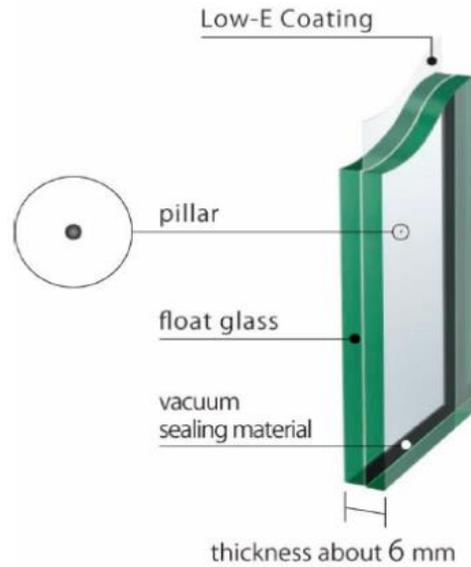
U-Value improvement:

- Ground Floor: $0.9 \text{ W}/(\text{m}^2)(\text{K})$
- Floating floor + aerogel insulation board: $0.28 \text{ W}/(\text{m}^2)(\text{K})$



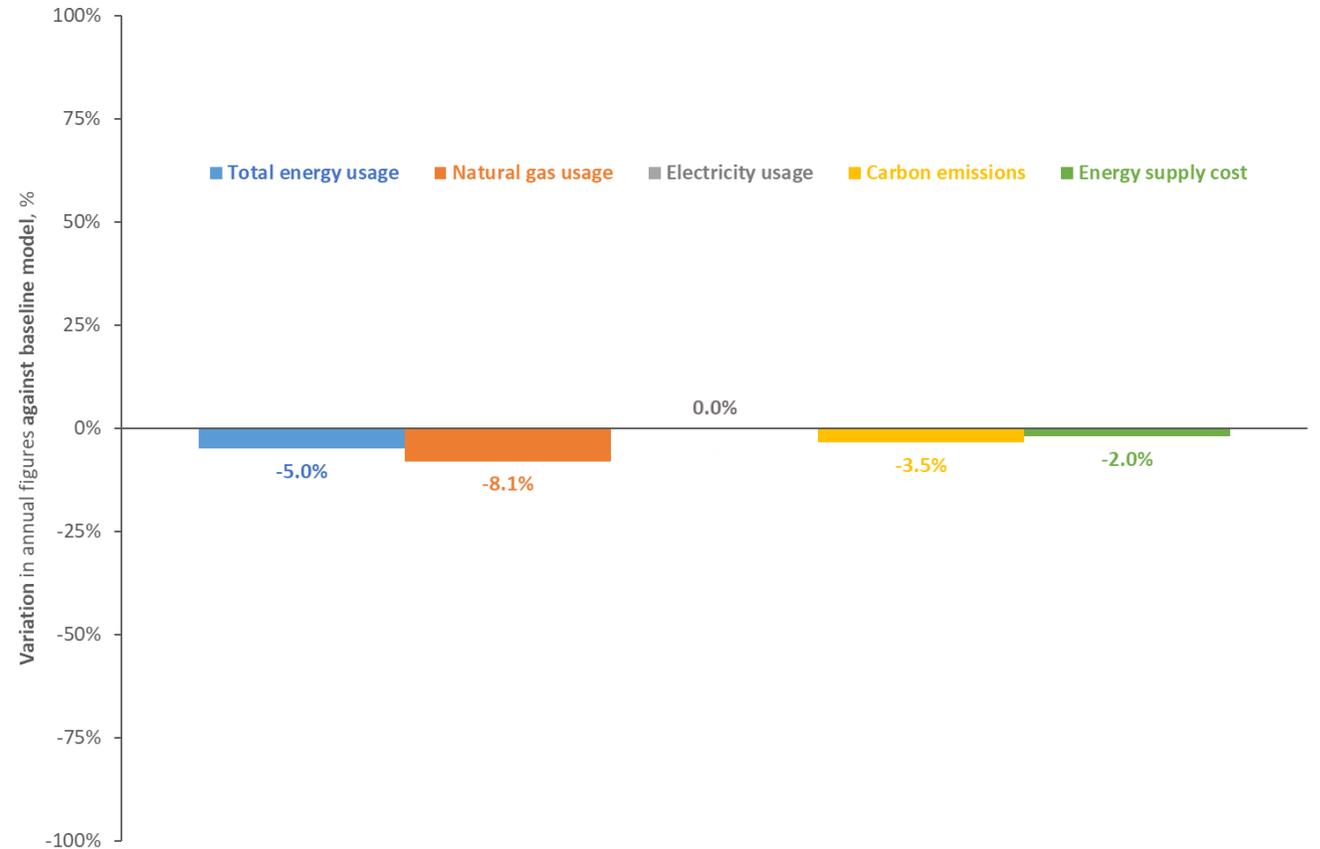
Deep renovation interventions

4. Windows retrofit

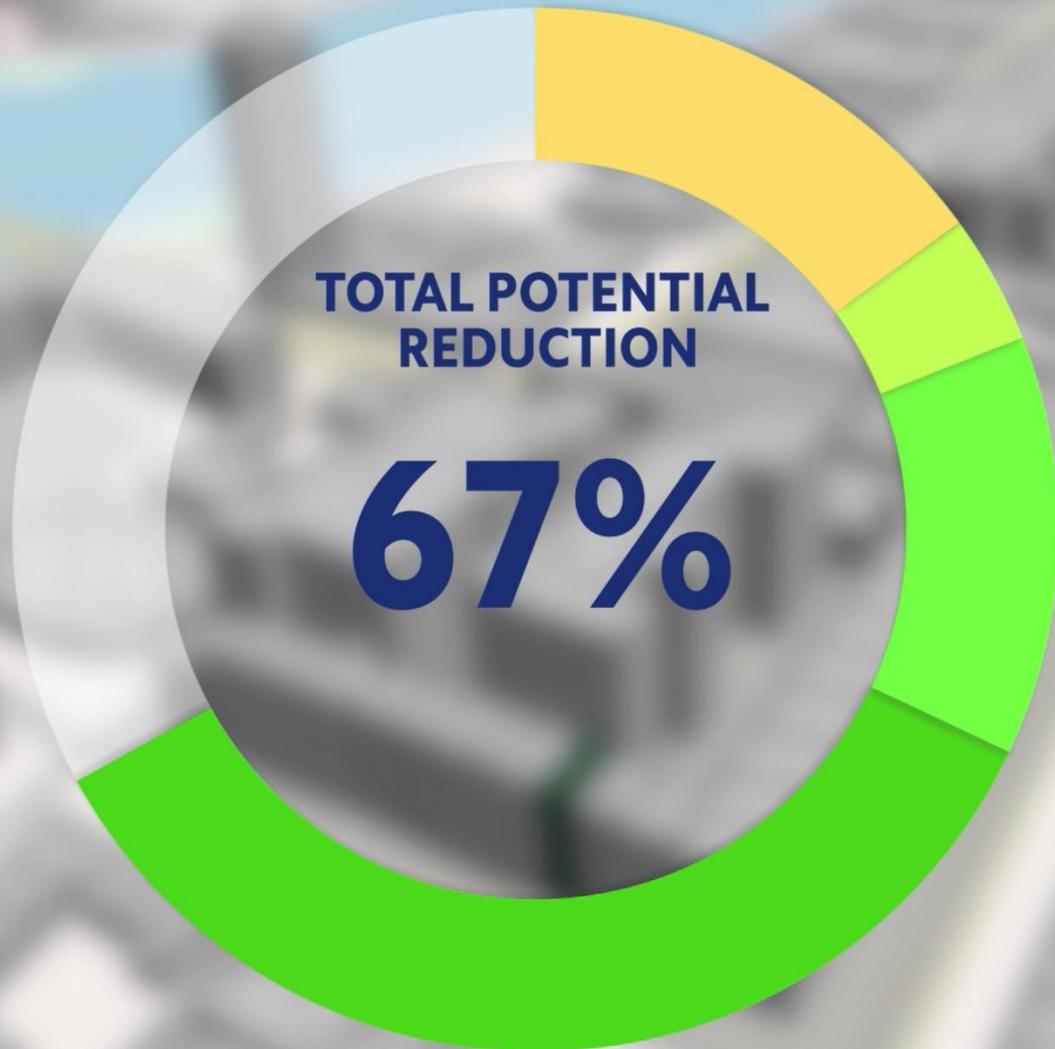


U-Value improvement:

- Old single glazing: $3.8 \text{ W}/(\text{m}^2)(\text{K})$
- New double glazing with air gap: $0.94 \text{ W}/(\text{m}^2)(\text{K})$



**AREA OF INTEREST –
RESIDENTIAL BUILDING ON LOWER HARSTONGE STREET**



- POTENTIAL ENERGY EFFICIENCY STRATEGIES

- OPERATIONAL MEASURES

- HEATING CONTROL UPGRADES AND ZONING: 15% SAVING

- SHALLOW RETROFIT MEASURES (I.E. LOW COST)

- WINDOW SEALS REPLACEMENT: 4% SAVING

- REPLACE THE OLD GAS BOILER WITH A NEW ONE: 13% SAVING

- DEEP RENOVATION (I.E. INCREASED COST)

- IMPROVING THE BUILDING ENVELOPE: 35% SAVING

Deep renovation interventions

5. Air-to-water heat pump for space heating and DHW

Outdoor units

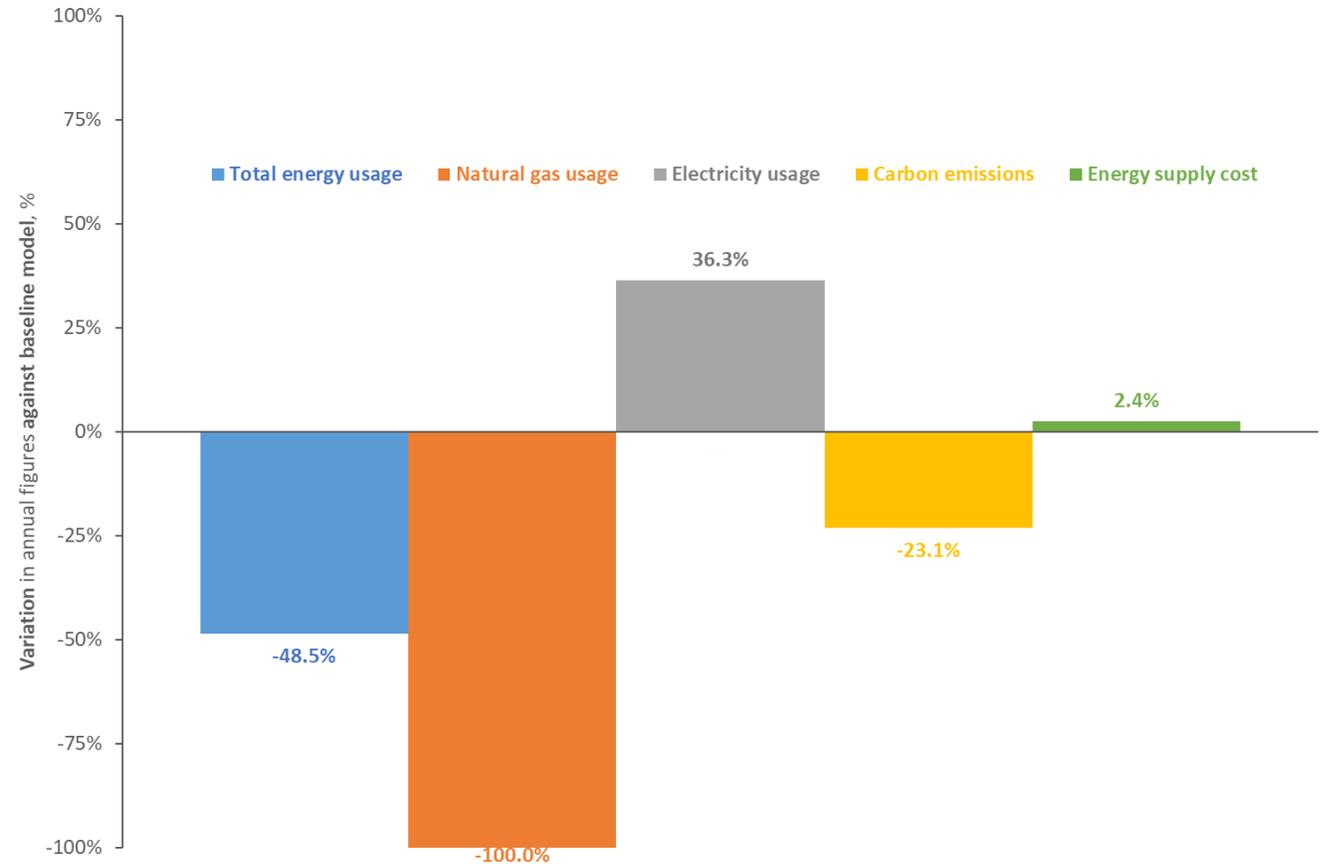


Indoor units



Improvements:

- Bring sCOP to 3.25
- Can be used for both space heating and DHW
- Enables installation of hot water storage tank



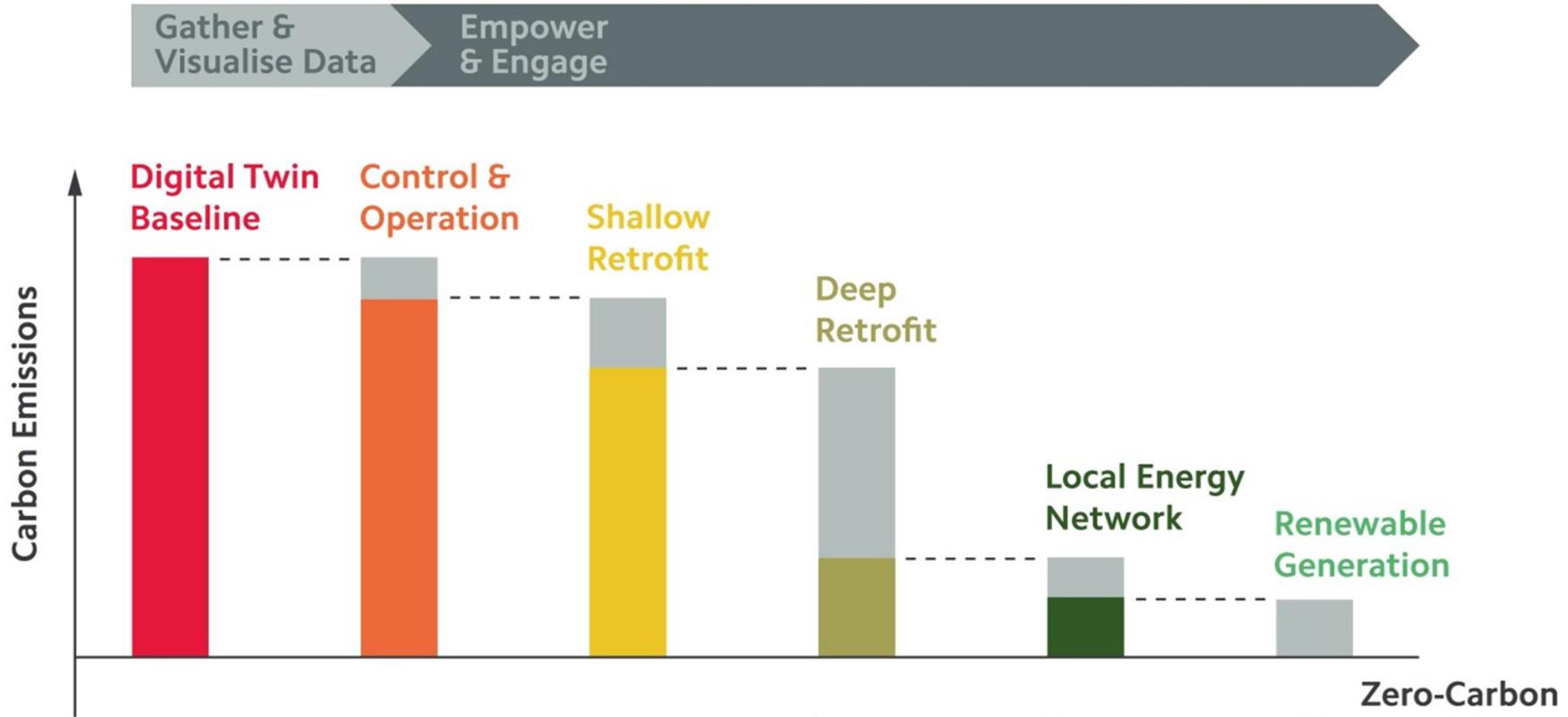


Choosing the optimal renovation



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Digital Twin for nZEB renovation



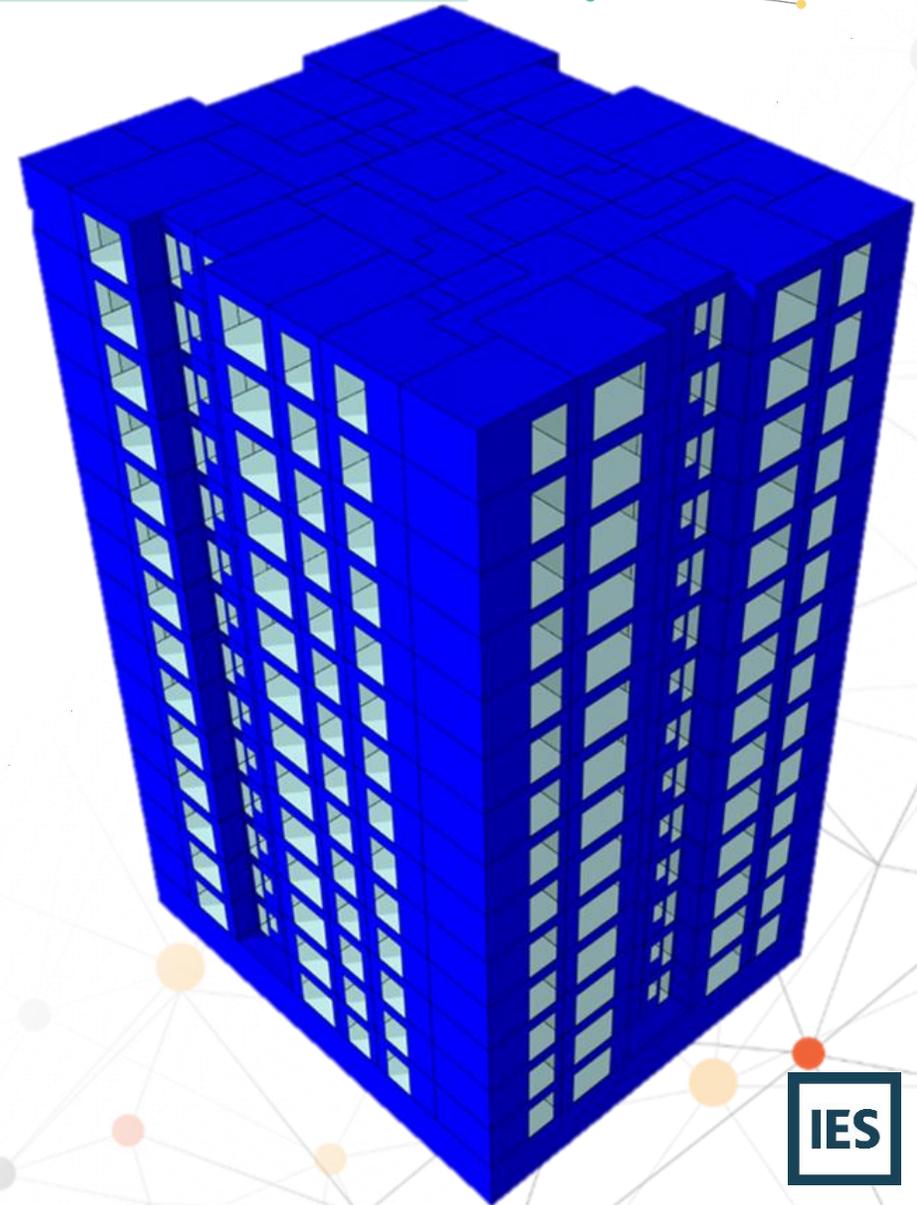
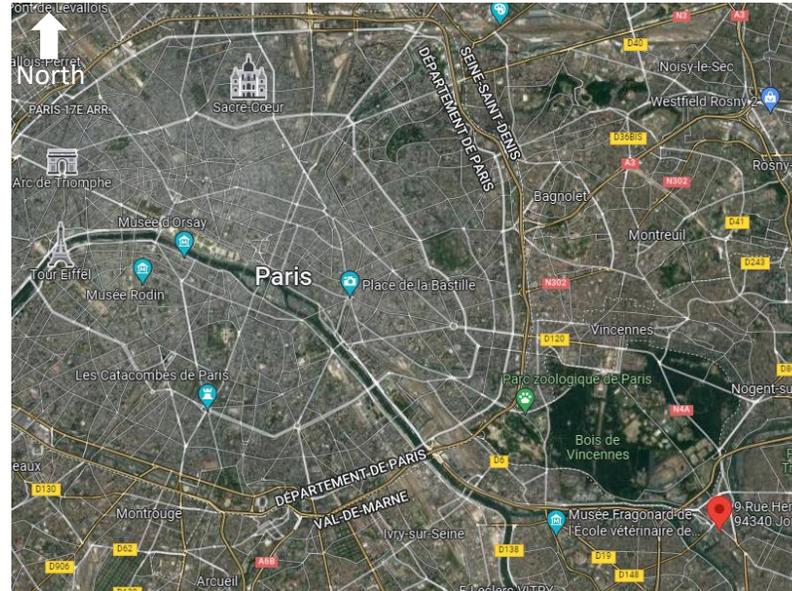
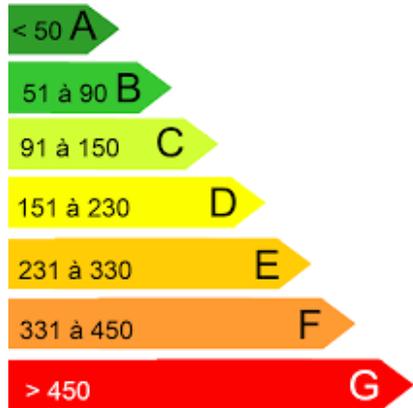
Evaluate the impact of different renewable energy generators to **achieve operational zero carbon**



Renovation Scenario Optimisation



- Residential Building
- Built in 1974
- 5645 m²
- 13 floors
- 83 flats



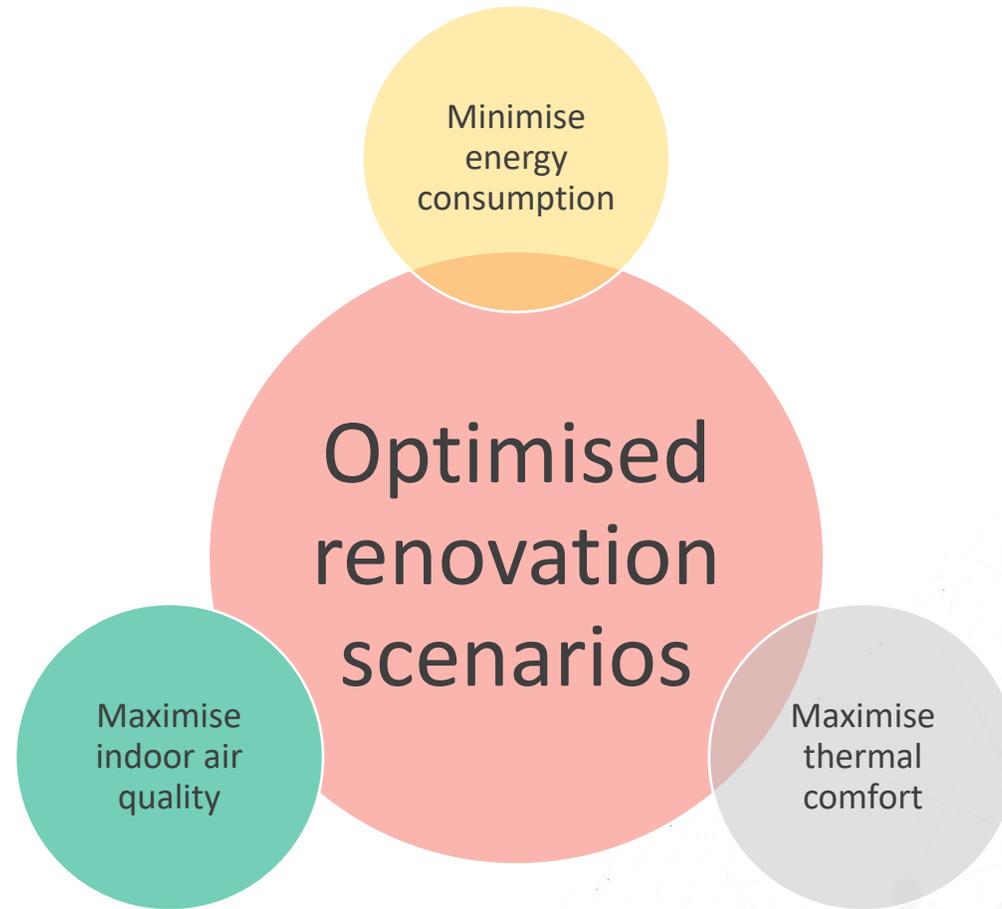
Baseline and proposed interventions



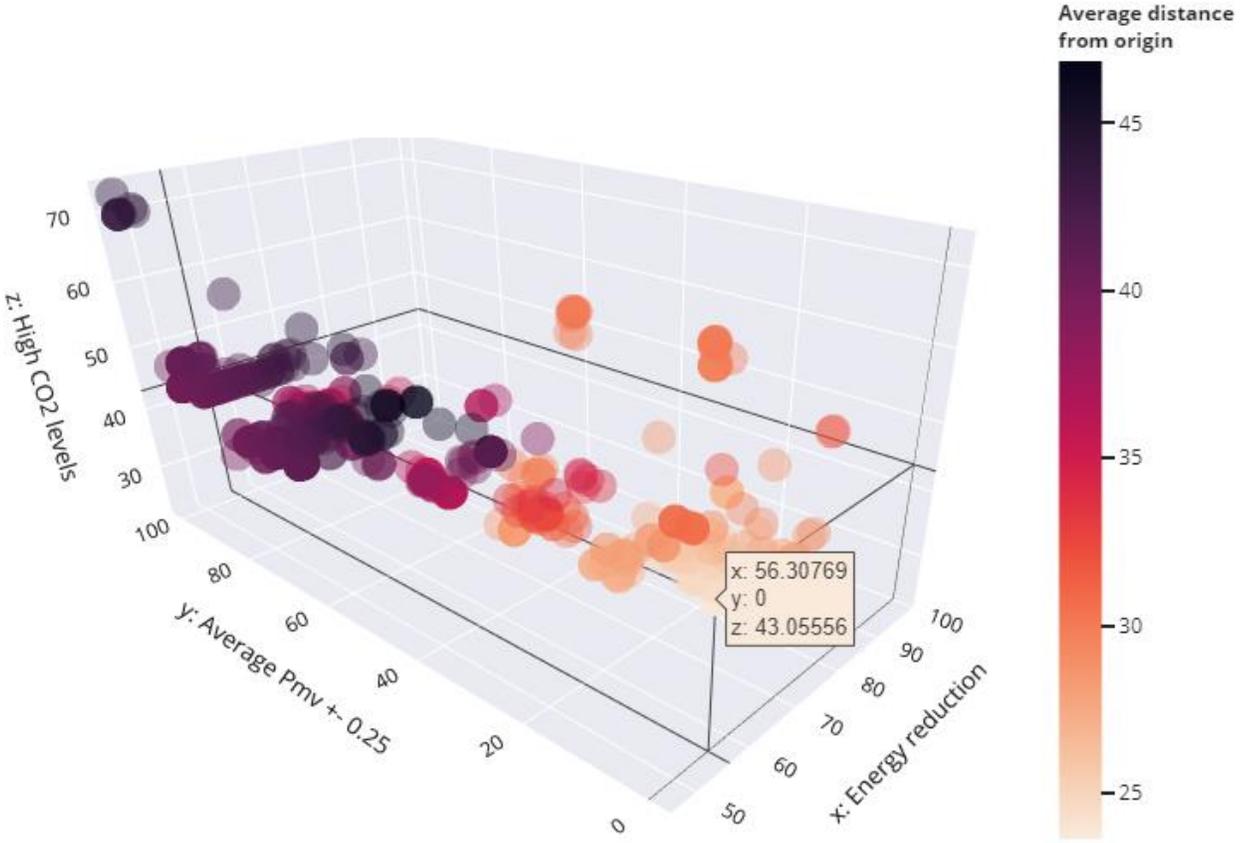
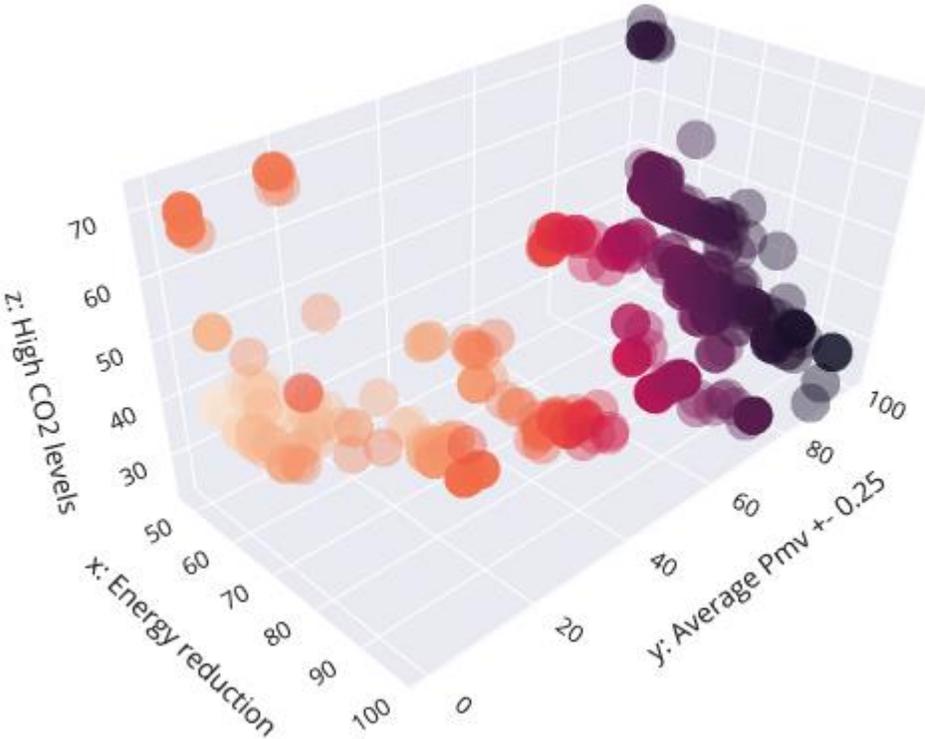
Area of intervention	Area of interest	Baseline	Retrofit	Range	Name	Notes
Envelope	Exterior wall	Concrete 15 cm + 5 cm insulation $U = 0.66 \text{ W.m}^2/\text{K}$	Mineral wool (rock) 14 cm ($\lambda=0.032 \text{ W/m.K}$) or equivalent $R = 4.4 \text{ m}^2\text{K/W}$	-	STD_WAL4	$U=0.26$
			Mineral wool (rock) 20 cm ($\lambda=0.032 \text{ W/m.K}$) or equivalent $R = 4.4 \text{ m}^2\text{K/W}$	-	STD_WAL5	$U=0.19$
			Mineral wool (rock) 25 cm ($\lambda=0.032 \text{ W/m.K}$) or equivalent $R = 4.4 \text{ m}^2\text{K/W}$	-	STD_WAL6	$U=0.15$
	Upper floor basement	Concrete 20 cm + 5 cm insulated woodwool panel $U = 3.22 \text{ W.m}^2/\text{K}$	Spray applied insulation 12 cm or equivalent $R \geq 3 \text{ m}^2.\text{K/W}$	-	STD_FLO3	$U=0.19$
			Spray applied insulation 16 cm or equivalent $R \geq 3 \text{ m}^2.\text{K/W}$	-	STD_FLO4	$U=0.14$
			Spray applied insulation 20 cm or equivalent $R \geq 3 \text{ m}^2.\text{K/W}$	-	STD_FLO5	$U=0.12$
	Roof	Concrete 20 cm + 4 cm polyurethane $U = 0.63 \text{ W.m}^2/\text{K}$	Polyurethane 12 cm ($\lambda=0.023 \text{ W/m.K}$) or equivalent $R \geq 5.2 \text{ m}^2.\text{K/W}$	-	STD_ROO1	$U=0.23$
			Polyurethane 16 cm ($\lambda=0.023 \text{ W/m.K}$) or equivalent $R \geq 5.2 \text{ m}^2.\text{K/W}$	-	STD_ROO2	$U=0.17$
			Polyurethane 20 cm ($\lambda=0.023 \text{ W/m.K}$) or equivalent $R \geq 5.2 \text{ m}^2.\text{K/W}$	-	STD_ROO3	$U=0.1448$
Glazing and doors	Windows	Double glazed $U_w = 2.8 \text{ W.m}^2/\text{K}$	Low-E Double Glazing $SC=0.6$	-	LWDB0045	$U=2.06$
			Low-E Triple Glazing $SC=0.65$	-	LWTR0005	$U=1.35$
	Landing door	Non-insulated door $U_d = 3.5 \text{ W.m}^2/\text{K}$	Wooden door insulated $U_d < 2.19 \text{ W/m}^2/\text{K}$	-	WDND0000	$U=2.19$
			Wooden Door 60 mm $U_d < 1.6 \text{ W/m}^2/\text{K}$	-	WDND0002	$U=1.6$
Air tightness	Air tightness	0.25 ach	Infiltration rate [ach]	[0.26 - 0.1]	-	-
Ventilation	Vent. rates	1.9 ach	Auxiliary ventilation [ach]	[1.5 - 2.5]	-	-
Lighting	Lighting	11 W/m ²	Efficient lighting [W/m ²]	[3-15]	-	-
Heating set point	Set-points	20 °C	Heating set point change [°C]	[18-22]	-	-
DHW	Fixtures	26 l/h	Reduction of DHW consumption. Improvement of fixtures [l/h]	[15-26]	-	-
System	Efficiency, Heat recovery, DHW supply T	$S_{EFF} = 0.9$ $HR=0\%$ $DHW_{ST} = 60 \text{ }^\circ\text{C}$	Seasonal efficiency 0.90, Heat recovery effectiveness 0.3, DHW Hot water supply temperature 58 °C	-	SYST0003	
			Seasonal efficiency 0.92, Heat recovery effectiveness 0.45, DHW Hot water supply temperature 55 °C	-	SYST0005	
			Seasonal efficiency 0.94, Heat recovery effectiveness 0.55, DHW Hot water supply temperature 53 °C	-	SYST0006	



Optimisation Objectives



Optimisation results



Set of best solutions



Ext Wall	Roof	Ground Floor	Ext Window	Int Door	Apache System	Infiltration	Auxiliary Vent	Lighting	Heating set-point	DHW Consumption	Energy reduction from baseline	PMV percentage of time discomfort	CO2 air quality improvement
-	-	-	-	-	-	[ach]	[ach]	[W/m2]	[C]	[l/h]	%	%	%
STD_WAL5	STD_ROO3	STD_FLO5	LWTR0005	WDND0002	SYST0005	0.10	2.18	4.2	21.4	15.29	43.8	0	57
STD_WAL5	STD_ROO3	STD_FLO5	LWTR0005	WDND0002	SYST0006	0.11	2.17	4.2	21.4	15.29	43.8	0	57
STD_WAL5	STD_ROO3	STD_FLO5	LWTR0005	WDND0002	SYST0006	0.11	2.17	4.2	21.4	15.29	43.8	0	57

Ext walls: Mineral wool (rock) 20 cm ($\lambda = 0.032$ W/m.K) or equivalent $R = 4.4$ m²K/W

Roof: Polyurethane 20 cm ($\lambda = 0.023$ W/m.K) or equivalent $R \geq 5.2$ m².K/W

Ground Floor: Spray applied insulation 20 cm or equivalent $R \geq 3$ m².K/W

Ext windows: Low-E Triple Glazing SC = 0.65

Doors: Wooden Door 60 mm $U_d < 1.6$ W/m²/K

System: Seasonal efficiency 0.92, heat recovery effectiveness 0.45, DHW hot water supply temperature 55 ° C

Air tightness: Infiltration rate 0.1 ach

Auxiliary ventilation: 2.18 ach

Lighting: Efficient lighting e.g led 4.2 W/m²

Heating set-point: 21 ° C

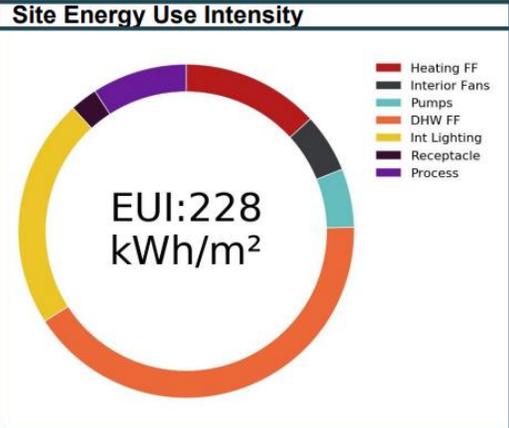
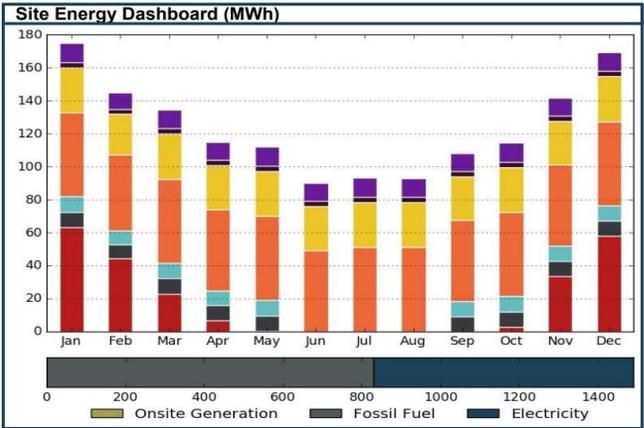
DHW consumption: Efficient fixtures 15.29 l/h



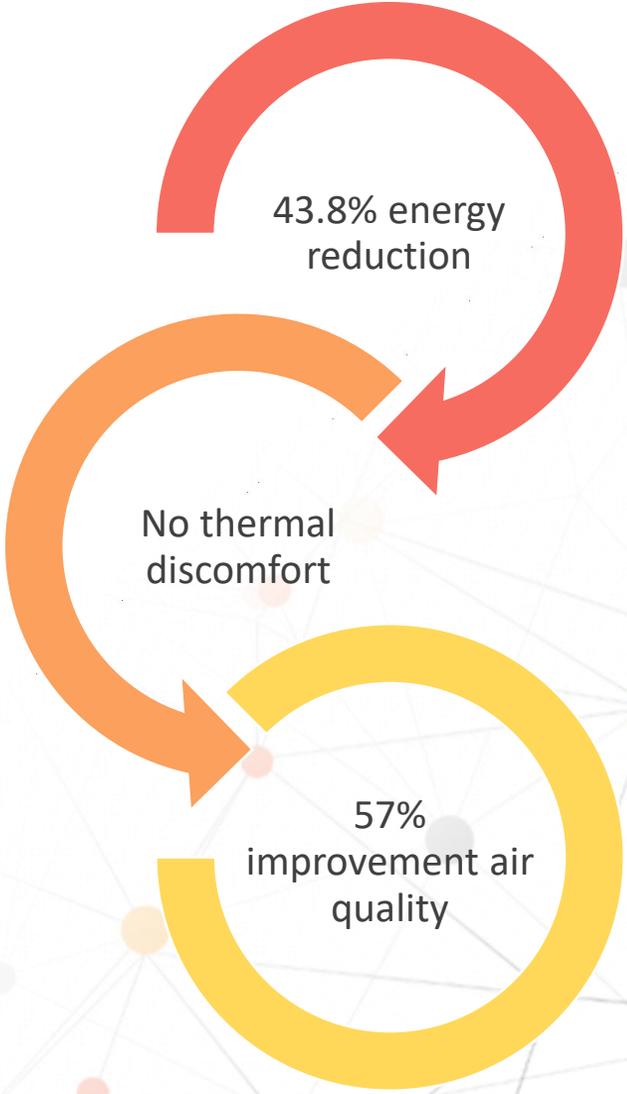
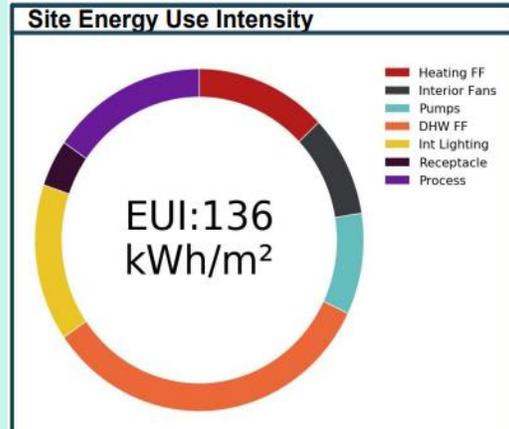
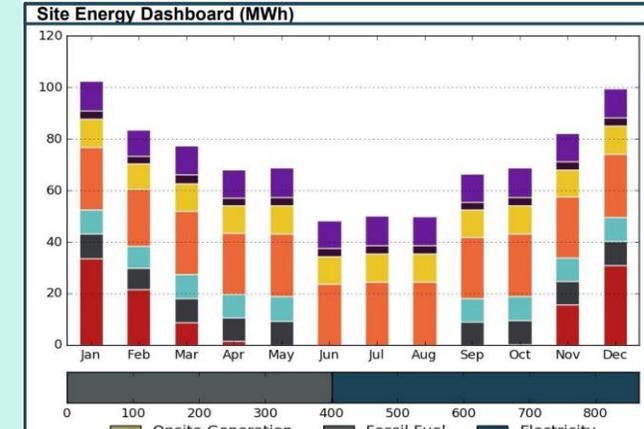
Optimal renovation scenario



Baseline



Optimal renovation scenario



Life Cycle Assessment + Costing



B-BEST –BIM4REN
Building Environmental
Sustainability Tracker



Renovation project
assessment

BIM Data



B-BEST
Life Cycle
Assessment

**Environmental
assessment of
renovation**

- Embodied material & energy footprint
- Embodied Carbon

Costing database + user
inputs on costs and benefits



B-BEST
Life Cycle
Costing

**Economic assessment
of renovation
(investment vs
energy savings)**

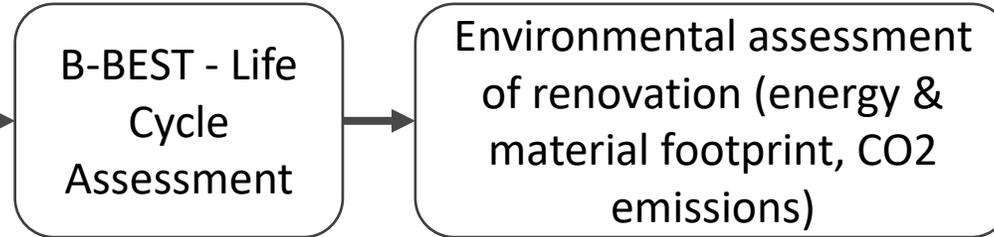
- Net Present Value
- Payback time



B-BEST – LCA module



LCA Module



1. Enter renovation details location, building, year

B-Best

LCA LCC

Select a Country * Italy

Select a Building Use * Residential

Select a Building Type *

Select Year 1970

Upload IFC API Documentation

CLOSE

2. Upload IFC file and check component info

B-Best

LCA LCC

Select a Country * Italy

Select a Building Use * Residential

Select a Building Type * Multi-Family House

Select Year 2002

```
{
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    "Doors": { ... } 5 items
    "Ground beam": { ... } 3 items
    "Piles": { ... } 3 items
    "Railing": { ... } 3 items
    "Slab": { ... } 6 items
    "Wall Standard Case": { ... } 3 items
    "Walls": { ... } 3 items
    "Windows": { ... } 5 items
  }
}
```

Upload IFC API Documentation

Export as JSON Export as CSV Download PDF

IFC File uploaded successfully

CLOSE

3. Download and check auto-generated Bill of Materials

Number	Item	Material	Number of Items	Total Volume	Total Area	Ecopoint ID	
10	2.1 Frame						
12	2.2 Roof structure						
13	2.3 Core and shear walls						
14	2.4 Staircases						
15							
16	Bill No.3 Floor						
17	Number	Item	Material	Number of Items	Total Volume	Total Area	Ecopoint ID
18	3.1 Floor	Concrete	1	9.6	71.2	[1474, 2810, 2854, 7687]	
19	3.2 Floor covering						
20							
21	Bill No.4 Roof						
22	Number	Item	Material	Number of Items	Total Volume	Total Area	Ecopoint ID
23	4.1 Roof cladding/coverings						
24	4.2 Roof flashing						
25							
26	Bill No.5 Walls, windows and doors						
27	Number	Item	Material	Number of Items	Total Volume	Total Area	Ecopoint ID
28	5.1 Walls	Stone	4	28.456	81.325		
29	5.2 External Wall cladding						
30	5.3 External Wall cladding systems						
31	5.4 Windows	Glass	4	0	8.024	[272, 688, 1448, 2322, 7071, 7501, 9103]	
32	5.5 Doors	Wood	1	0	0.856		
33							
34							
35							
36							

4. Obtain building energy & material footprint info (to be finalised)

B-BEST – LCA module



LCC
Module



B-BEST - Life Cycle Costing

Economic assessment of renovation (investment vs energy savings)

1. Enter renovation details - location, category, type, lifespan and surface area

Renovation Type

Select a Country *
France

Renovation Category *
Medium Renovation

Renovation Details *
MEP Retrofit

Renovation Lifespan *
10 years
15 years
25 years

Surface Area (m²) *

- 2. Enter renovation cost information**
- 3. Enter renovation energy savings (if applicable)**
- 4. Enter expected building value increase**

5. Obtain results of costs vs benefits



Populate your project with data

The screenshot displays the 'ATTRIBUTES PANEL' for a building project. It features a central 3D model of a building with several data input fields and an 'Upload' button. The data fields include:

- Name: Helix Building
- Building type: Office
- Object type: Building
- Electricity: 142.43 kWh / m2 year

Below the data fields is a bar chart showing electricity usage over time, with a '1year' filter selected. The x-axis shows months from Jan 18 to Jan 19, and the y-axis shows usage from 0.0 to 100. A 'Simulate' button is located at the bottom of the panel.

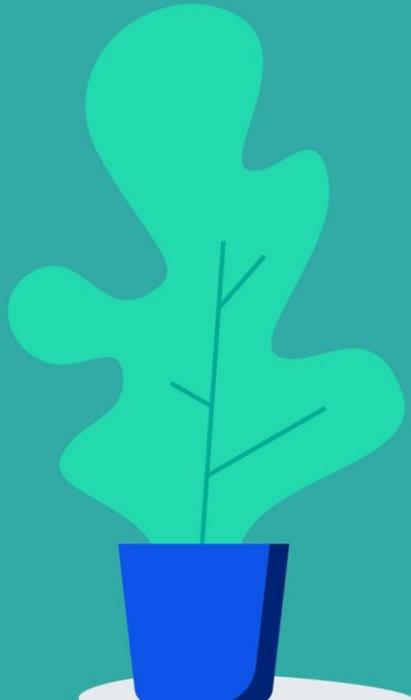
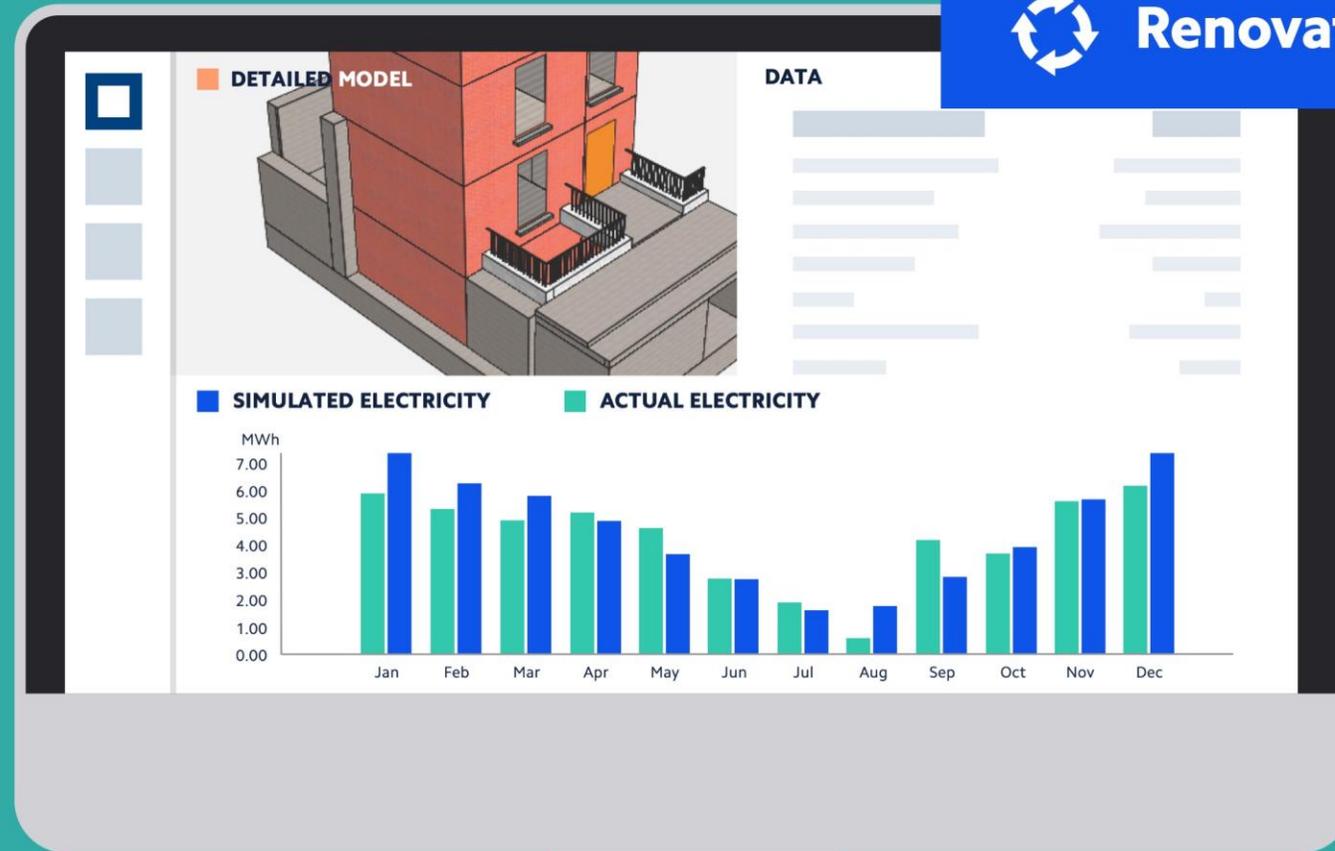
Four dashed arrows point from external icons to the central panel:

- Energy Bills** (Icon: document with dollar sign and lightbulb) points to the 'Filter attributes..' search bar.
- General Info** (Icon: document with list) points to the 'Upload' button.
- Utility Info** (Icon: building with water drop) points to the 'Electricity' data field.
- Construction details** (Icon: hard hat and blueprint) points to the 3D building model.

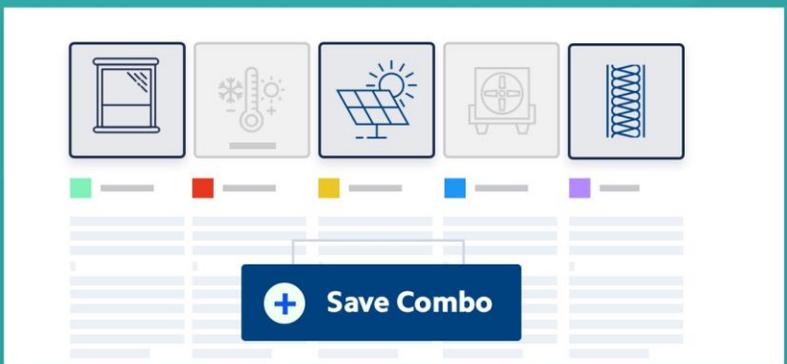
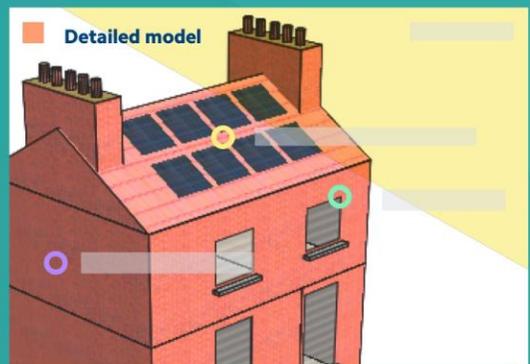
Model is updated with new datapoints



Renovate



Renovation Scenarios



Scenario 1

- + Change Windows
- + Change Setpoint

Scenario 2

- + Add Solar
- + Change Ventilation

Scenario 3

- + Change Setpoint
- + Change Ventilation

Scenario 4

- + Add Solar
- + Add Wall Insulation

 **Compare**

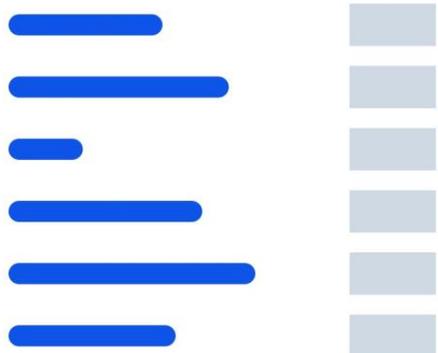


Make Decisions

Best for Comfort



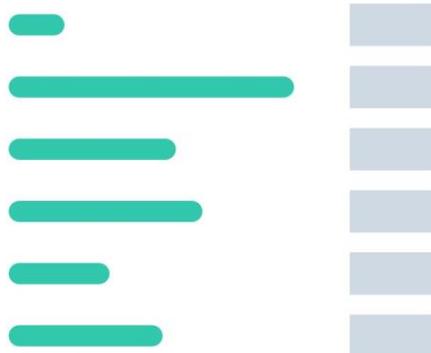
- + Change Windows
- + Change Setpoint



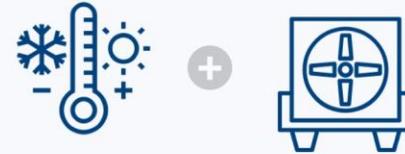
Best for Overall



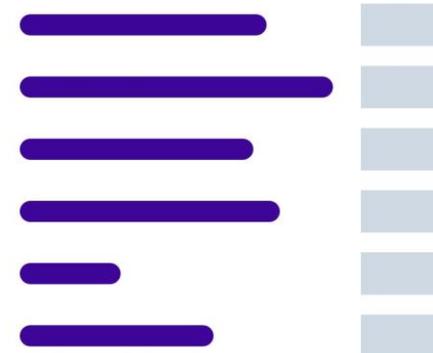
- + Add Solar
- + Change Ventilation



Higher Savings



- + Change Setpoint
- + Change Ventilation





Thank you for
your attention

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<http://bim4ren.eu/>



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