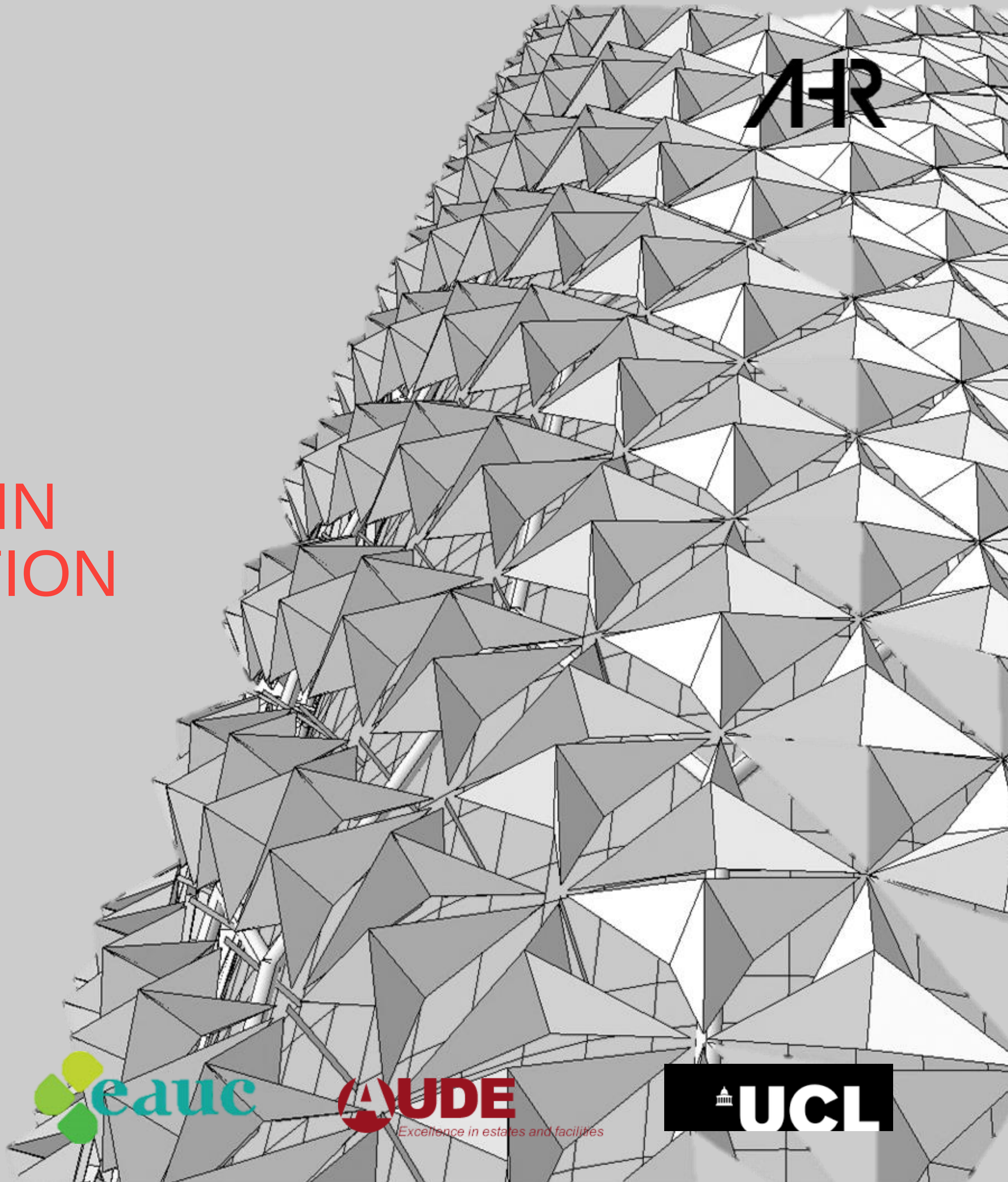
13.04.2016

BETTER BUILDING PERFORMANCE IN HIGHER EDUCATION

DR JUDIT KIMPIAN
TAMSIN TWEDDELL
DR SUNG-MIN HONG
DR DAVID HAWKINS
DR ESFAND BURMAN



MAX FORDHAM

eauc

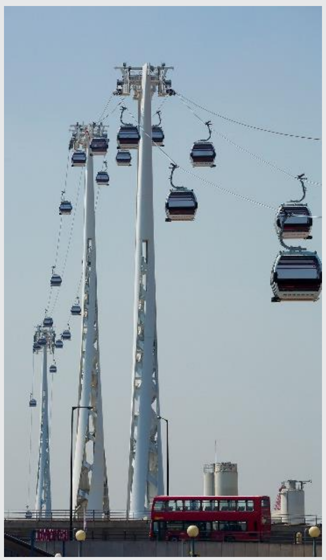
AUDE
Excellence in estates and facilities

UCL

AHR








Specialisms include:

- Architecture
- Building Consultancy
- Advance Design
- Interior Design
- Urban Design & Masterplanning
- Landscape Design

5TH

LARGEST ARCHITECTURAL EMPLOYER IN THE UNITED KINGOM

45

AHR PROJECTS THAT HAVE GAINED A SUSTAINABILITY ACCREDITATION, SUCH AS BREEAM, LEED, PASSIVHAUS

429

EMPLOYERS CURRENTLY WORKING IN OVER TWENTY COUNTRIES

13

INTERNATIONAL OFFICES SERVICING THE REGIONAL NEEDS OF EASTERN EUROPE, THE MIDDLE EAST, NORTH AFRICA AND THE INDIAN SUB CONTINENT

OVER 13,000 PROJECTS COMPLETED ACROSS ALL SERVICES WITHIN THE LAST TEN YEARS

32m

2014 TURNOVER (GBP)

AHR OFFICES

EUROPE
- London
- Birmingham
- Bristol
- Glasgow
- Huddersfield
- Leeds
- Manchester
- Moscow
- Shrewsbury
- Warsaw

ASIA
- Almaty
- Karachi [Associated Office]

MIDDLE EAST
- Dubai

1. DUBLIN INSTITUTE OF TECHNOLOGY
DUBLIN

2. UNIVERSITY OF HUDDERSFIELD
OASTLER BUILDING

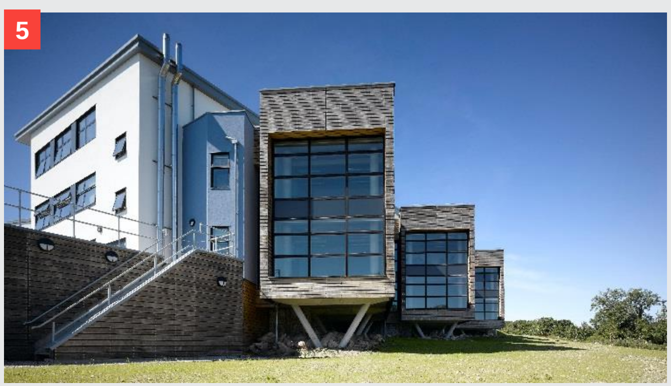
3. UNIVERSITY OF YORK
BIO-MEDICINE BUILDING

4. UNIVERSITY OF WEST ENGLAND

5. FALMOUTH COLLEGE
TREMOUGH INNOVATION CENTRE

6. UNIVERSITY OF BIRMINGHAM
MASON HALL

7. THURROCK LEARNING CAMPUS
ESSEX, UK



1. UNIVERSITY OF LEICESTER
SCHOOL OF MUSEUM STUDIES

2. PLYMOUTH UNIVERSITY
POOL INNOVATION CENTRE

3. UNIVERSITIES OF BATH, BRISTOL & THE WEST OF ENGLAND BBSP ONE

4. UNIVERSITY OF BIRMINGHAM
SHACKLETON HALL

5. UNIVERSITY OF GLASGOW
LAB REFURBISHMENT TO BOYD ORR BUILDING

6. THURROCK LEARNING CAMPUS
ESSEX, UK

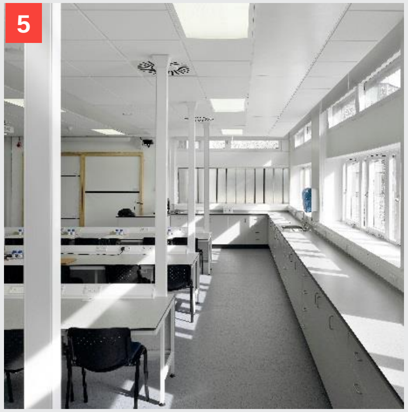
7. CONNELL COLLEGE
MANCHESTER, UK

1


3


2


4

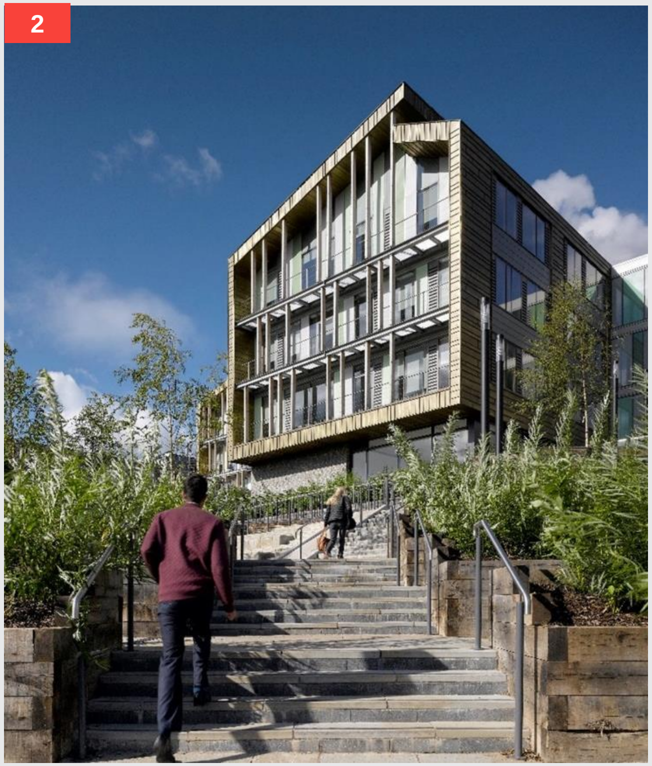

5


6


7

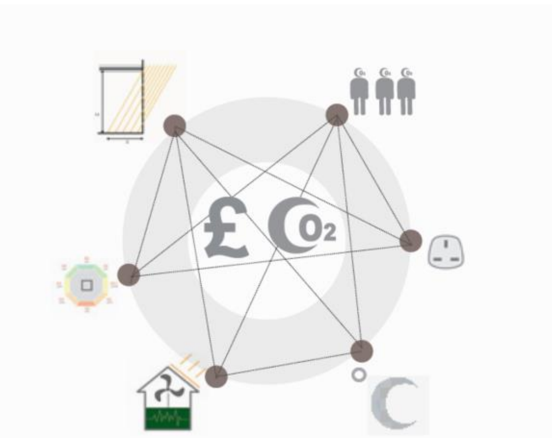

1. **MASDAR INSTITUTE OF SCIENCE AND TECHNOLOGY**
   2010
2. **KEYNSHAM CIVIC CENTRE AND ONE STOP SHOP**
   2014
3. **LOXFORD SCHOOL OF SCIENCE AND TECHNOLOGY**
   2012

2

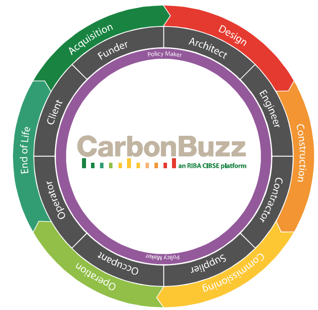


1

3



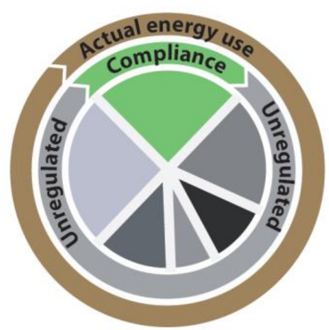
Virtual Information Modelling



Carbon Management in Design and Construction Practice

Climate Change Adaptation

Life Cycle Extension vs. replacement of Existing Building

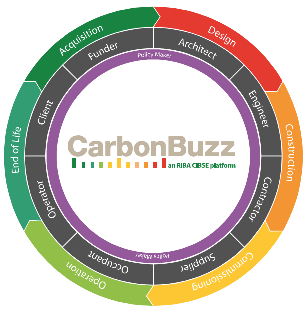


Predicted vs Operational Performance of Buildings

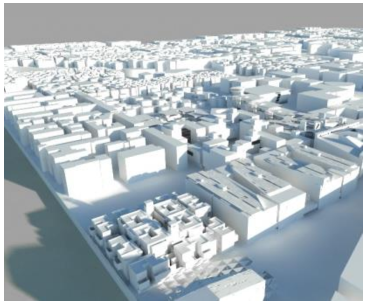
TSB Metadata project

Over 20 academic papers, UKGBC, AJ100, GreenBuild, CIBSE awards recognition

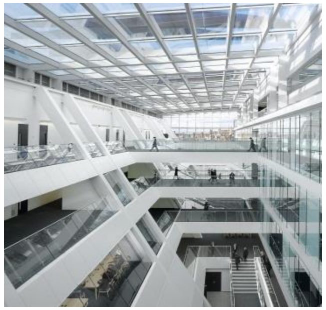
ARCHITECTURAL FEEDBACK LOOPS



Policy



Masterplan



Building

Component

Product

RESOURCE EFFICIENT BUILDINGS

A resource efficient way of providing…

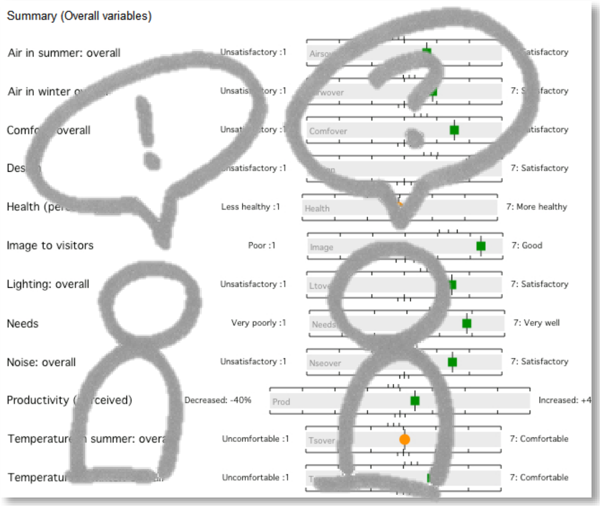
Source: Artist Maria Arceo

… a healthy, comfortable, safe, environment over a building's life span

MEASURING BUILDING PERFORMANCE

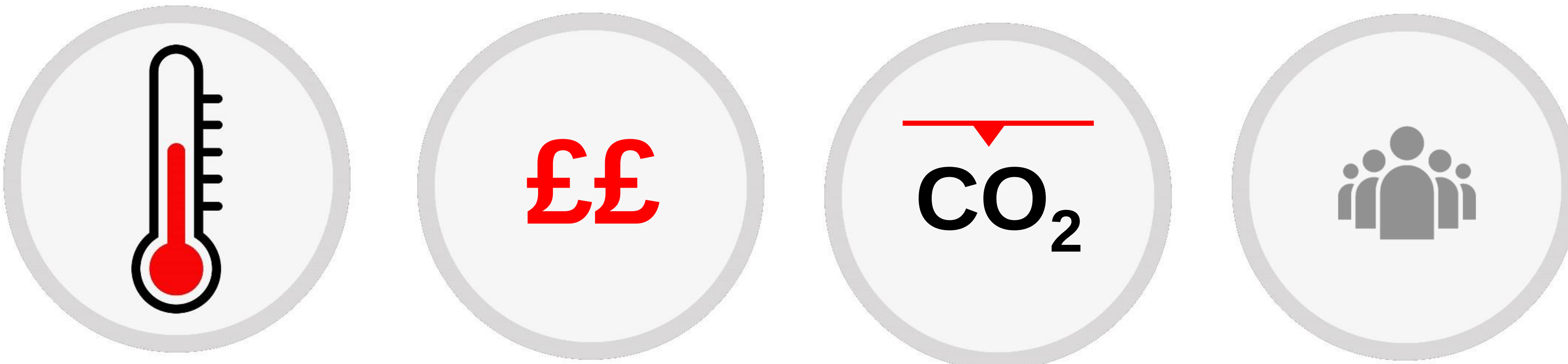
Meters and submeters reconciled

Data logging for IEQ
^{o}C CO_2 %RH   VOC



Occupier Survey and interviews

DRIVERS FOR BETTER BUILDING PERFORMANCE



Climate change

Capital and whole life cost

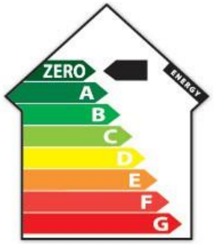
Regulatory targets

Occupant experience

REGULATORY CONTEXT

EPBD

Energy Performance of Buildings Directive



Energy Efficiency Directive

NZEB

3%

EED Public stock refurbishment target

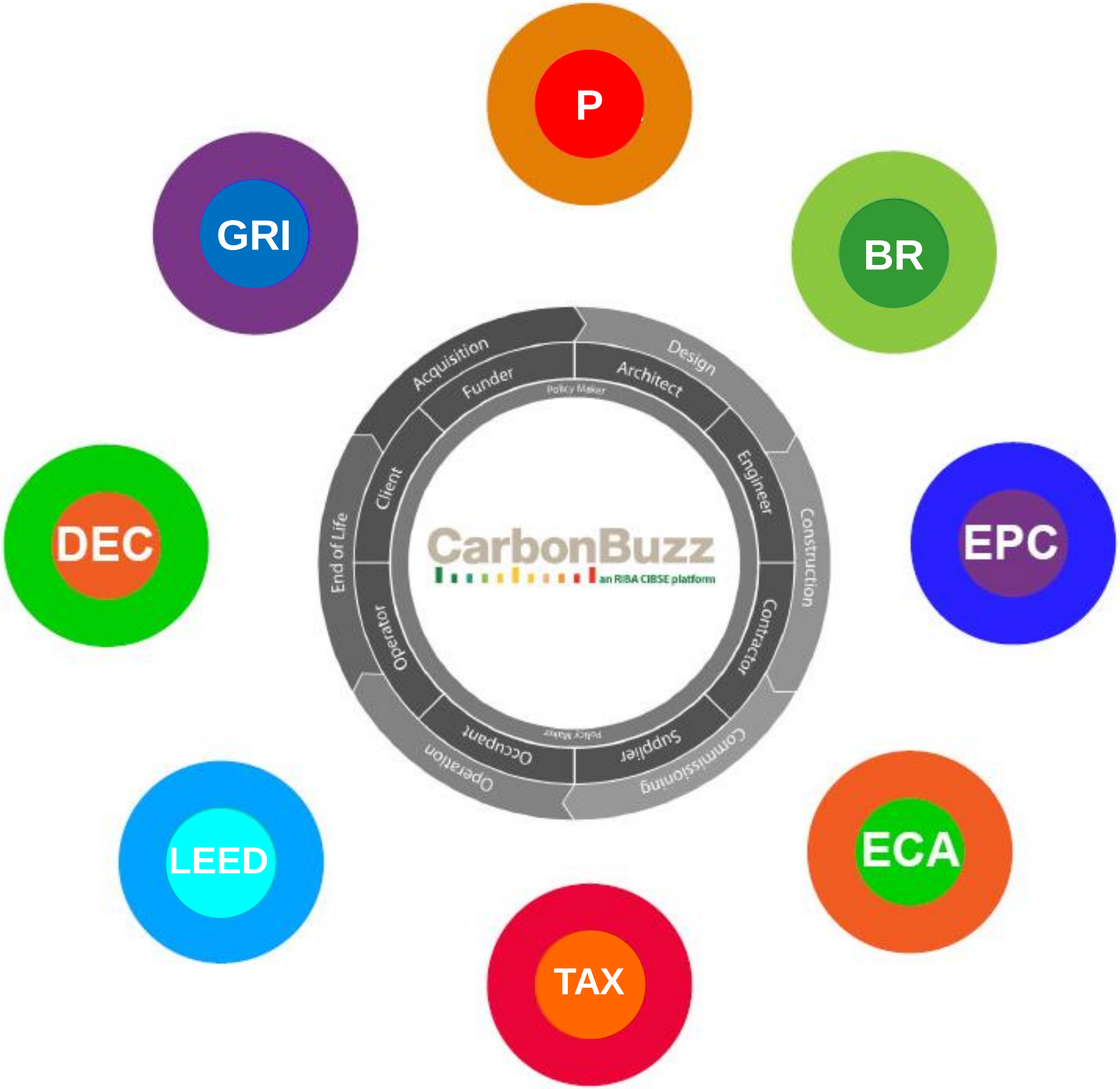
Minimum Energy Efficiency Target

ESOS

energy savings opportunities scheme

Energy Savings Opportunities Scheme

DISCREPANCY OF ENERGY REPORTING METRICS



COMPARING APPLES AND PEARS…

COMPLIANCE VS PREDICTING MEASURED ENERGY USE

EPC

As Built Building & System Properties

+ All equipment

Appliance
IT
Lifts
External lights
Special equipment
Etc. see list in CB
Controls

+ As built Factors

Actual system and fabric performance inc controls
Commissioning
Metering
Energy management setup

+ Management Factors

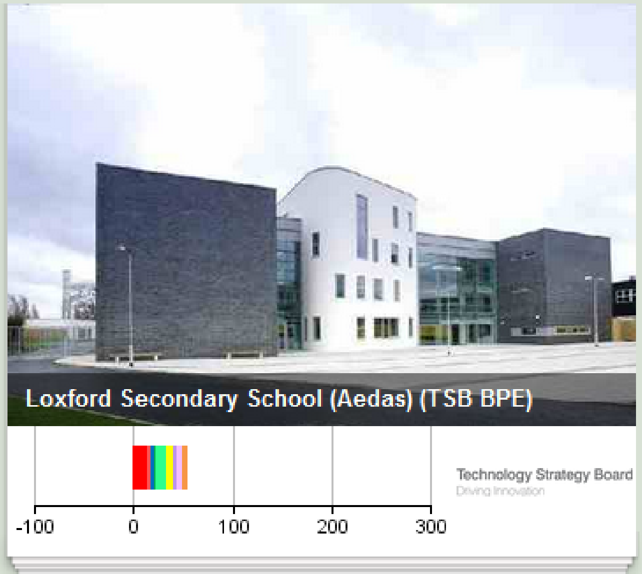
Hours
Occupancy
Zoning, set points, schedules
FM regime
Maintenance
Occupant engagement
Actual weather & climate

CarbonBuzz an RIBA CIBSE platform

Collaborative
Anonymous
Real

Sign up or Login

Home | Performance gap | Evidence | What you can do | Case studies | Partners



Get REAL about building energy consumption

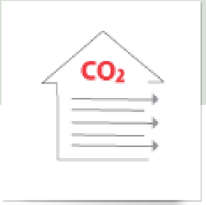
Our figures show that on average, buildings consume between 1.5 and 2.5 times predicted values

CarbonBuzz will help you close the gap between calculations and actual building performance

Get Started › or Find out more

Upload

Download template to gather data



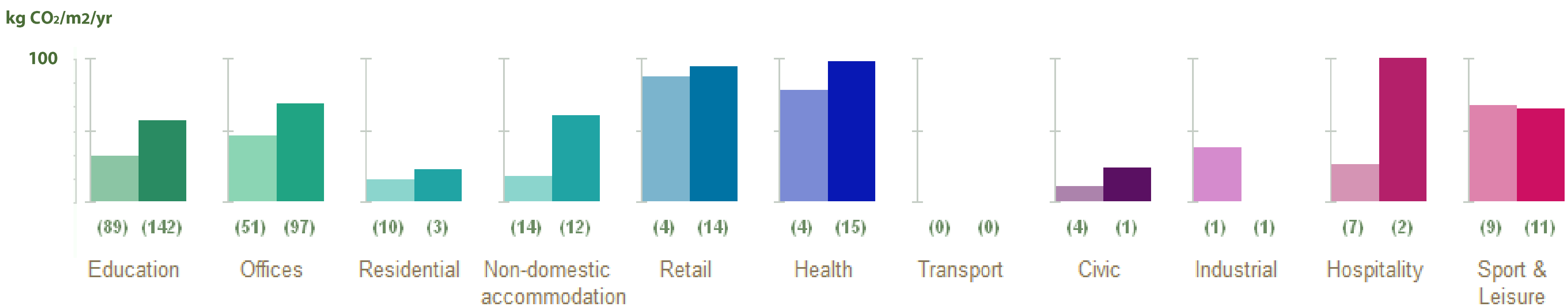
Share

Add users to your account

Compare

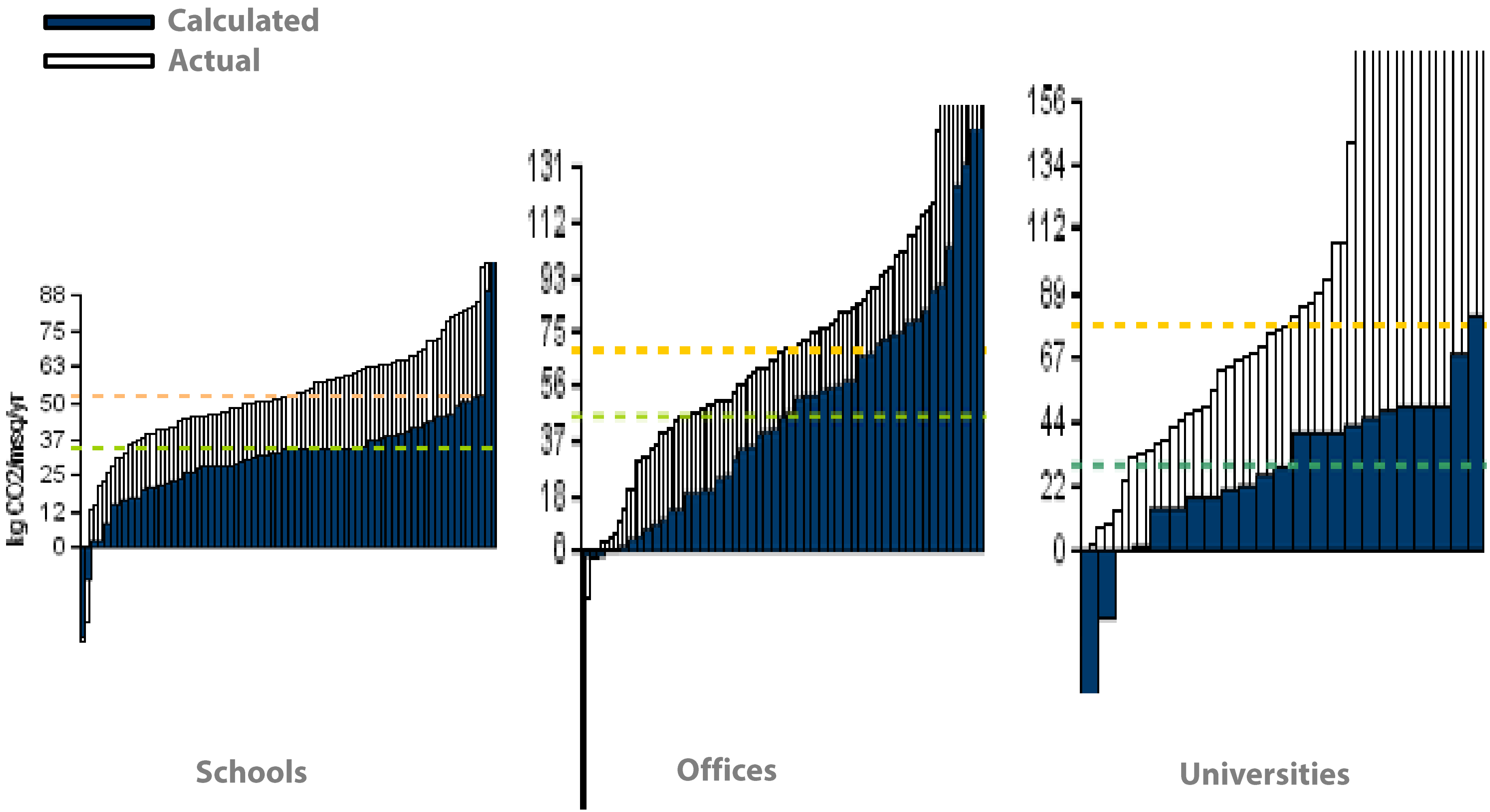
Compare your design estimate against

PERFORMANCE GAP | CALCULATED VS OPERATIONAL DATA MEDIANS



www.CarbonBuzz.org
an RIBA CIBSE platform

SECTOR BY SECTOR DATA | CALCULATED VS ACHIEVED PERFORMANCE



Schools

Heat: 1.48

Electricity: 1.9

Offices

Heat: 1.59

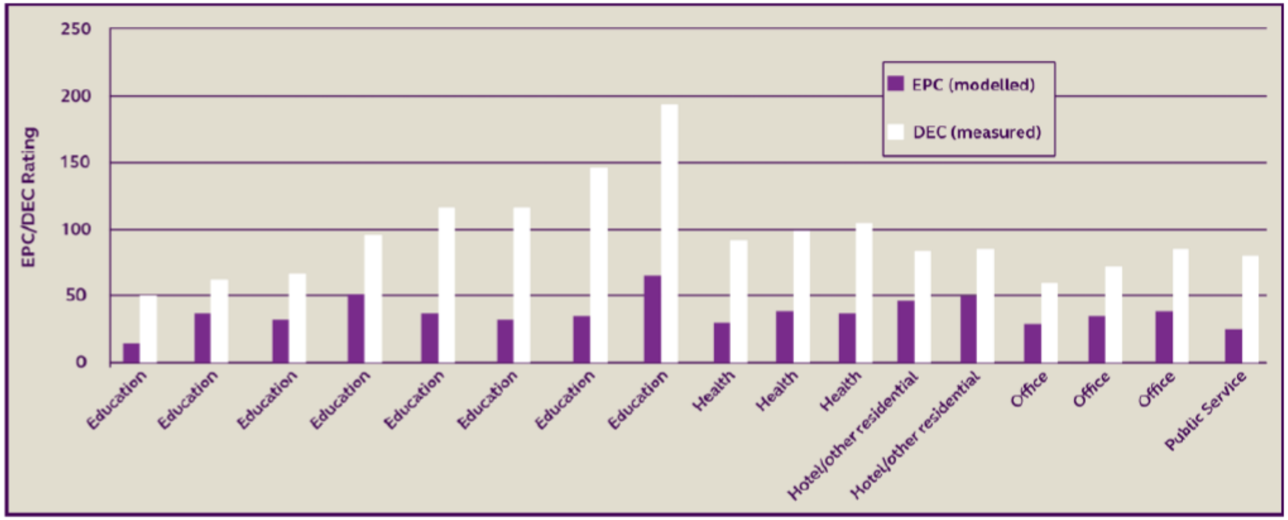
Electricity: 1.71

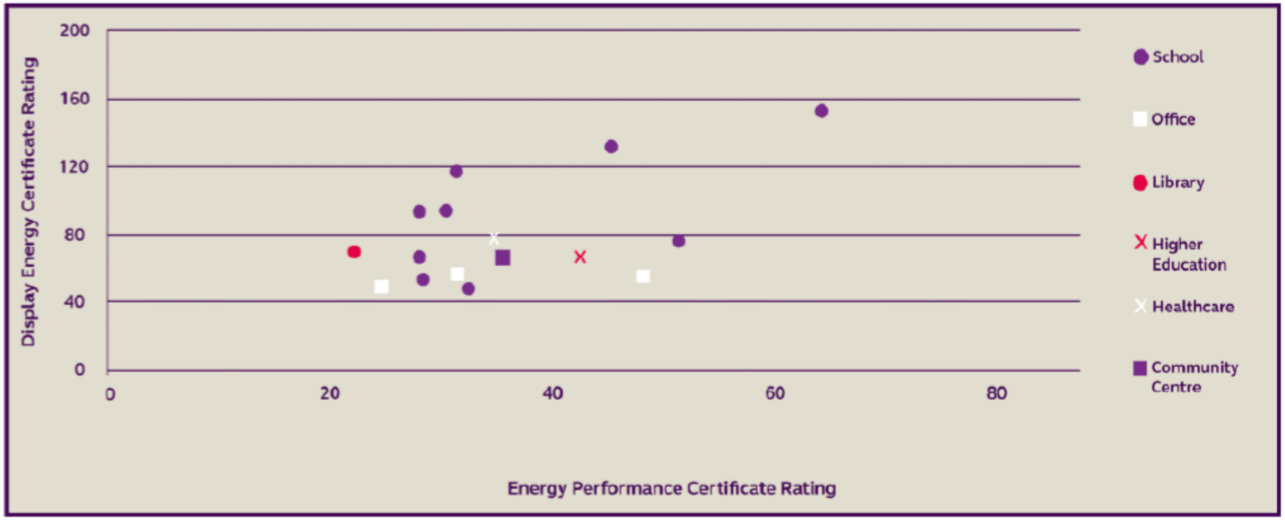
Universities

Heat: 1.2

Electricity: 2.3

ACTUAL VS DESIGN COMPARISON: QUOTIENTS

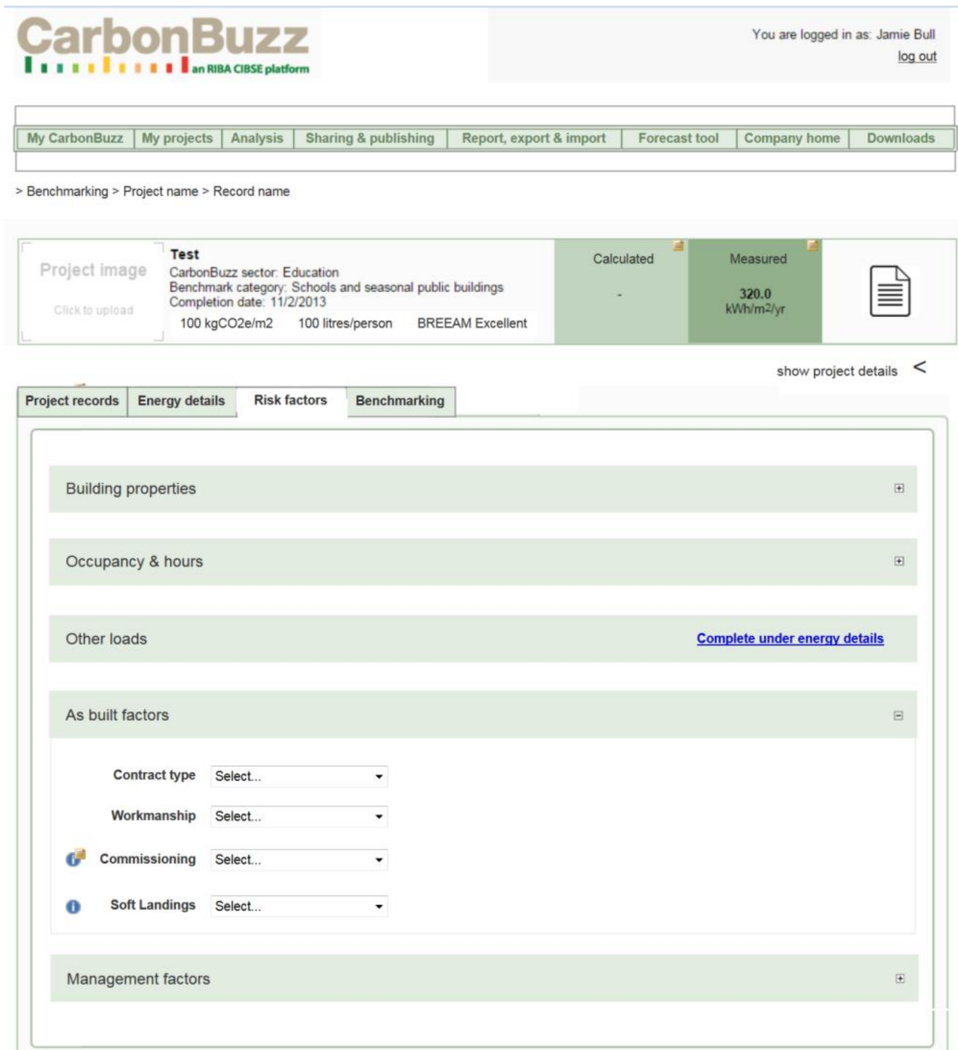




Source: Innovate UK, 2016. Building Performance Evaluation Programme: Findings from non-domestic projects, Getting the best from buildings

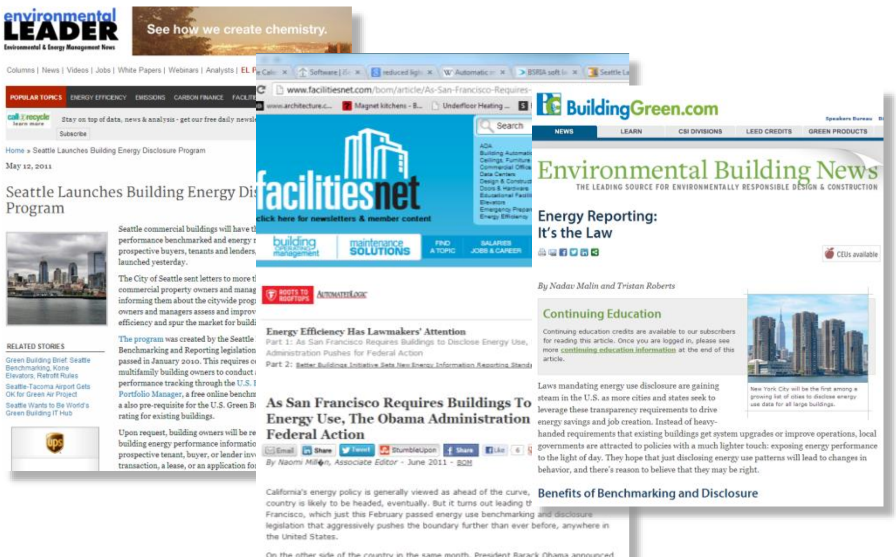
INNOVATE UK CARBONBUZZ FORECAST BETA

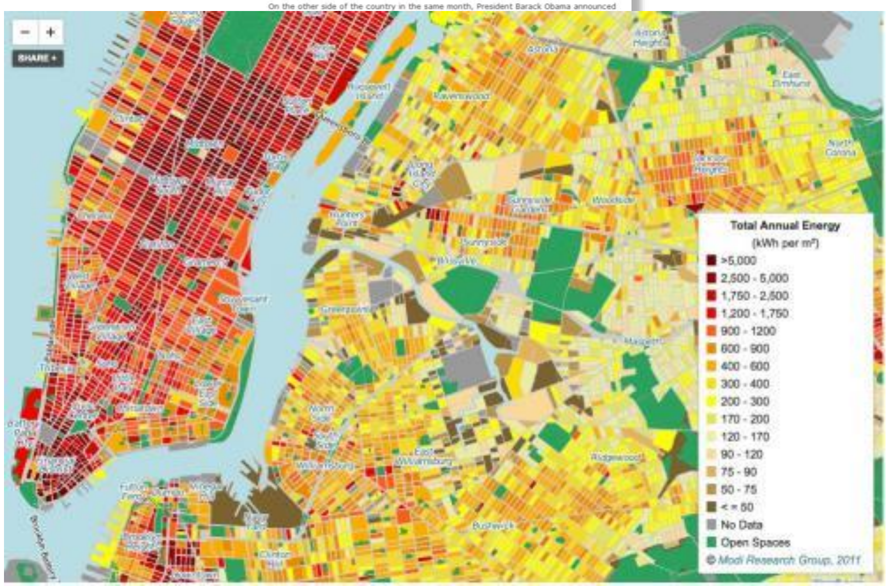
AHR|Aecom|CIBSE Automated tool to adjust EPCs to reflect risk factors



EVOLVING REPORTING STANDARDS WITH MEASUREMENT AND VERIFICATION

ENERGY DISCLOSURE LED BY NORTH AMERICAN CITIES





Columbia university graphic

- Philadelphia
- New York City
- Chicago
- Seattle
- San Francisco
- Washington DC
- Austin, Texas

…

WELL BUILDING STANDARD

INTERNATIONAL WELL BUILDING INSTITUTE

INVESTMENT MODELS

Sale value	Resale value	Lifetime value
Developer	Owner/user	Government / Community
Net to Gross area Wall to floor area Weight Buildability	Life cycle cost Energy use CO2/msq Building maintenance Lifespan Environmental quality	Whole life cost Transport, economic and social infrastructure Landmark value Neighbourhood value
Explicit	Cumulative	Implicit

1. **What are the common KPIs reported on for new projects and refurbishments? (student survey, staff satisfaction, etc)**

2. **How is building performance currently planned for?**

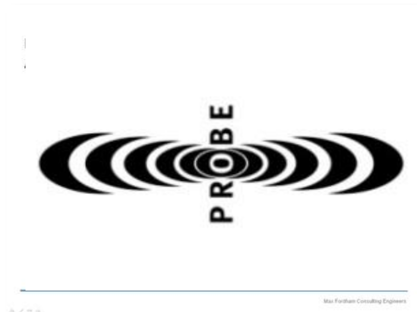
3. **How are KPIs incorporated into procurement? (POE, Soft Landings, Independent Commissioning, Passivhaus, etc)**

BREAKOUT SESSION 2

1. **What are typical use/occupancy scenarios for different HE building types?**
2. **With these in mind, how much influence does a building's architecture have on energy use?**
3. **How much influence do the users have on energy use?**
4. **How are learning and research environments changing (for example in response to new funding models, new technologies, social changes, research demands etc.)**
5. **What functionality would be required in buildings to cater for this?**

RECENT RESEARCH STUDIES

LCBA & LCBP



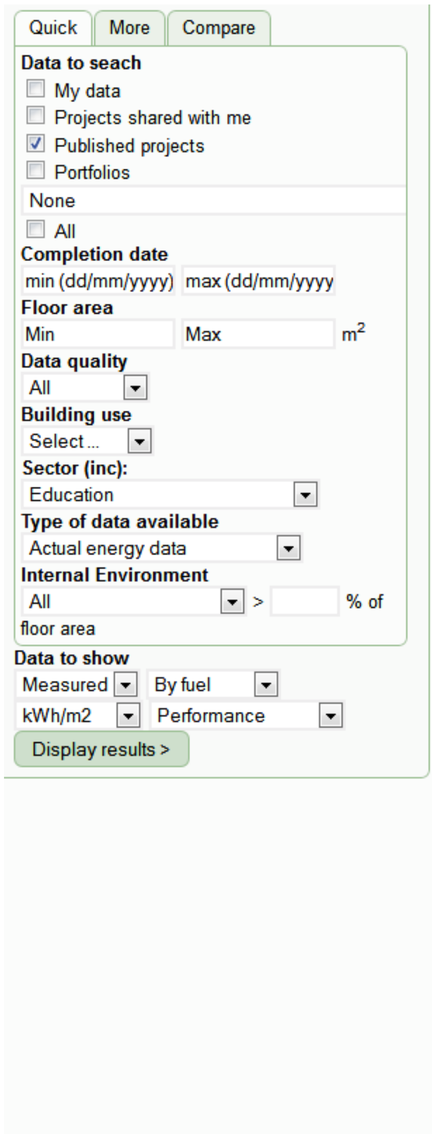
CARBON TRUST

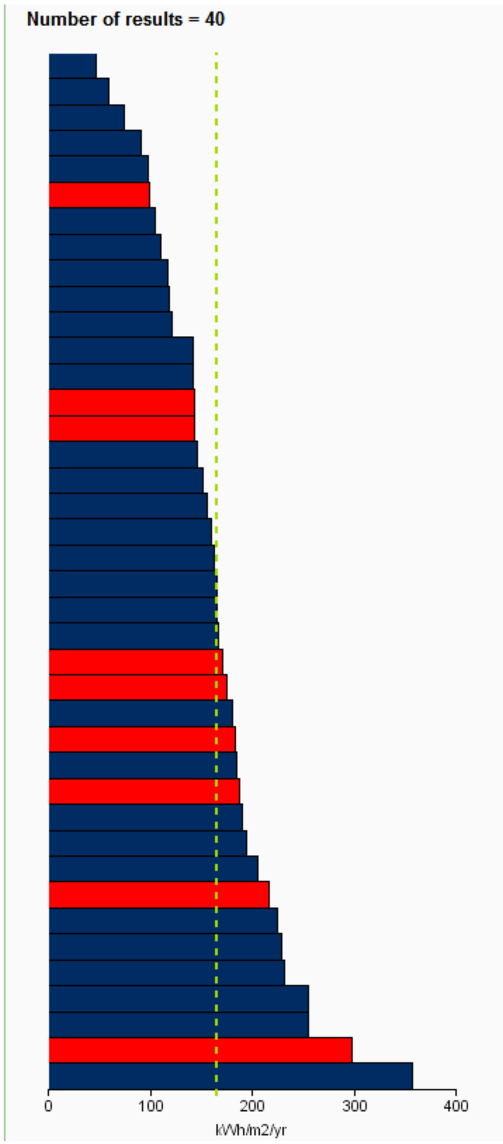
UBT
Usable Buildings Trust

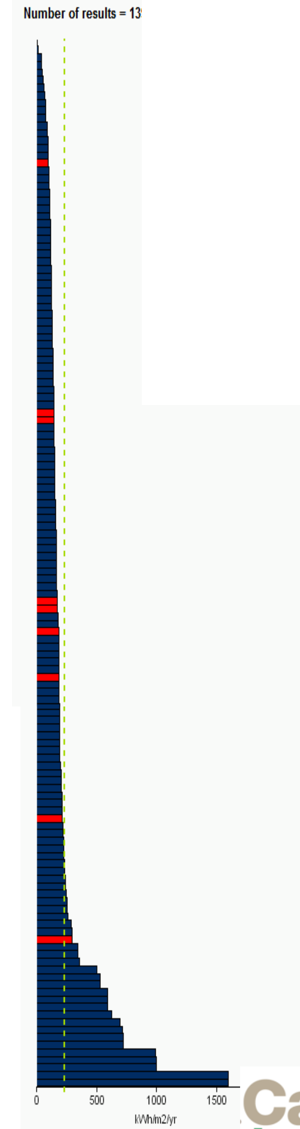
Innovate UK
Technology Strategy Board

AHR INNOVATE UK BUILDING PERFORMANCE EVALUATIONS

AHR BPE PROJECTS COMPARED TO PUBLISHED AND ANONYMISED PROJECTS

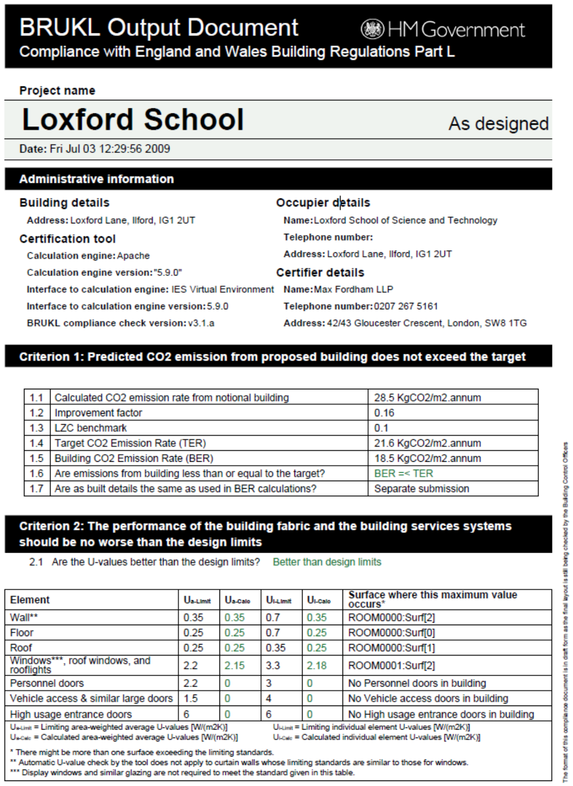






LOXFORD SCHOOL OF SCIENCE AND TECHNOLOGY

ENERGY LABELS: BRUKL / EPC / DEC



BRUKL Output Document

HM Government

Compliance with England and Wales Building Regulations Part L

Project name

Loxford School

As designed

Date: Fri Jul 03 12:29:56 2009

Administrative information

Building details

Address: Loxford Lane, Ilford, IG1 2UT

Certification tool

Calculation engine: Apache

Calculation engine version: "5.9.0"

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 5.9.0

BRUKL compliance check version: v3.1.a

Occupier details

Name: Loxford School of Science and Technology

Telephone number:

Address: Loxford Lane, Ilford, IG1 2UT

Certifier details

Name: Max Fordham LLP

Telephone number: 0207 267 5161

Address: 42/43 Gloucester Crescent, London, SW8 1TG

Criterion 1: Predicted CO2 emission from proposed building does not exceed the target

1.1	Calculated CO2 emission rate from notional building	28.5 KgCO2/m2.annum
1.2	Improvement factor	0.16
1.3	LZC benchmark	0.1
1.4	Target CO2 Emission Rate (TER)	21.6 KgCO2/m2.annum
1.5	Building CO2 Emission Rate (BER)	18.5 KgCO2/m2.annum
1.6	Are emissions from building less than or equal to the target?	BER =< TER
1.7	Are as built details the same as used in BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and the building services systems should be no worse than the design limits

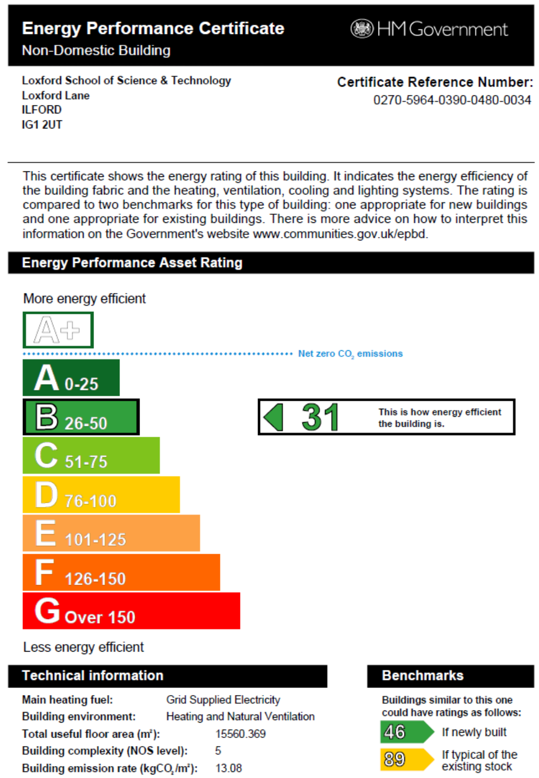
2.1 Are the U-values better than the design limits? Better than design limits

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Limit}$	$U_{i\text{-}Calc}$	Surface where this maximum value occurs*
Wall**	0.35	0.35	0.7	0.35	ROOM0000:Surf[2]
Floor	0.25	0.25	0.7	0.25	ROOM0000:Surf[0]
Roof	0.25	0.25	0.35	0.25	ROOM0000:Surf[1]
Windows***, roof windows, and rooflights	2.2	2.15	3.3	2.18	ROOM0001:Surf[2]
Personnel doors	2.2	0	3	0	No Personnel doors in building
Vehicle access & similar large doors	1.5	0	4	0	No Vehicle access doors in building
High usage entrance doors	6	0	6	0	No High usage entrance doors in building

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [W/(m2K)]
$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [W/(m2K)]
$U_{i\text{-}Limit}$ = Limiting individual element U-values [W/(m2K)]
$U_{i\text{-}Calc}$ = Calculated individual element U-values [W/(m2K)]

* There might be more than one surface exceeding the limiting standards.
** Automatic U-value check by the tool does not apply to curtain walls whose limiting standards are similar to those for windows.
*** Display windows and similar glazing are not required to meet the standard given in this table.

The format of this compliance document is in draft form as the final layout is still being checked by the Building Control Officers



Energy Performance Certificate

Non-Domestic Building

HM Government

Loxford School of Science & Technology
Loxford Lane
ILFORD
IG1 2UT

Certificate Reference Number:
0270-5964-0390-0480-0034

This certificate shows the energy rating of this building. It indicates the energy efficiency of the building fabric and the heating, ventilation, cooling and lighting systems. The rating is compared to two benchmarks for this type of building: one appropriate for new buildings and one appropriate for existing buildings. There is more advice on how to interpret this information on the Government's website www.communities.gov.uk/epbd.

Energy Performance Asset Rating

Technical information

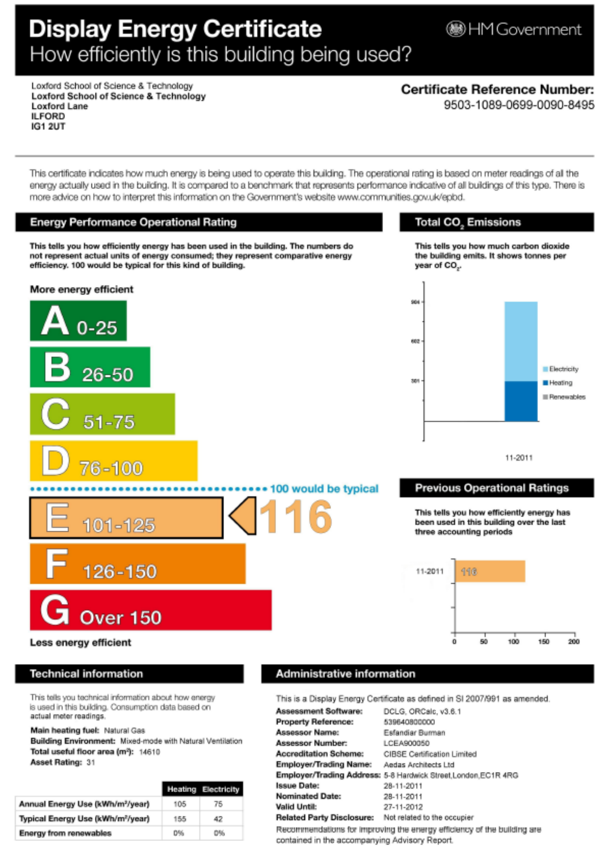
Main heating fuel: Grid Supplied Electricity
Building environment: Heating and Natural Ventilation
Total useful floor area (m^2): 15560.369
Building complexity (NOS level): 5
Building emission rate ($kgCO_2/m^2$): 13.08

Benchmarks

Buildings similar to this one could have ratings as follows:

46 If newly built

89 If typical of the existing stock



Display Energy Certificate

How efficiently is this building being used?

HM Government

Loxford School of Science & Technology
Loxford School of Science & Technology
Loxford Lane
ILFORD
IG1 2UT

Certificate Reference Number:
9503-1089-0699-0090-8495

This certificate indicates how much energy is being used to operate this building. The operational rating is based on meter readings of all the energy actually used in the building. It is compared to a benchmark that represents performance indicative of all buildings of this type. There is more advice on how to interpret this information on the Government's website www.communities.gov.uk/epbd.

Energy Performance Operational Rating

This tells you how efficiently energy has been used in the building. The numbers do not represent actual units of energy consumed; they represent comparative energy efficiency. 100 would be typical for this kind of building.

Total CO_2 Emissions

This tells you how much carbon dioxide the building emits. It shows tonnes per year of CO_2.

Previous Operational Ratings

This tells you how efficiently energy has been used in this building over the last three accounting periods

Technical information

This tells you technical information about how energy is used in this building. Consumption data based on actual meter readings.

Main heating fuel: Natural Gas
Building Environment: Mixed-mode with Natural Ventilation
Total useful floor area (m^2): 14610
Asset Rating: 31

	Heating	Electricity
Annual Energy Use ($kWh/m^2/year$)	105	75
Typical Energy Use ($kWh/m^2/year$)	155	42
Energy from renewables	0%	0%

Administrative information

This is a Display Energy Certificate as defined in SI 2007/991 as amended.

Assessment Software: DCLG, ORCalc, v3.6.1
Property Reference: 539640800000
Assessor Name: Esfandiar Burman
Assessor Number: LCEA900050
Accreditation Scheme: CIBSE Certification Limited
Employer/Trading Name: Aedas Architects Ltd
Employer/Trading Address: 5-8 Hardwick Street,London,EC1R 4RG
Issue Date: 28-11-2011
Nominated Date: 28-11-2011
Valid Until: 27-11-2012
Related Party Disclosure: Not related to the occupier

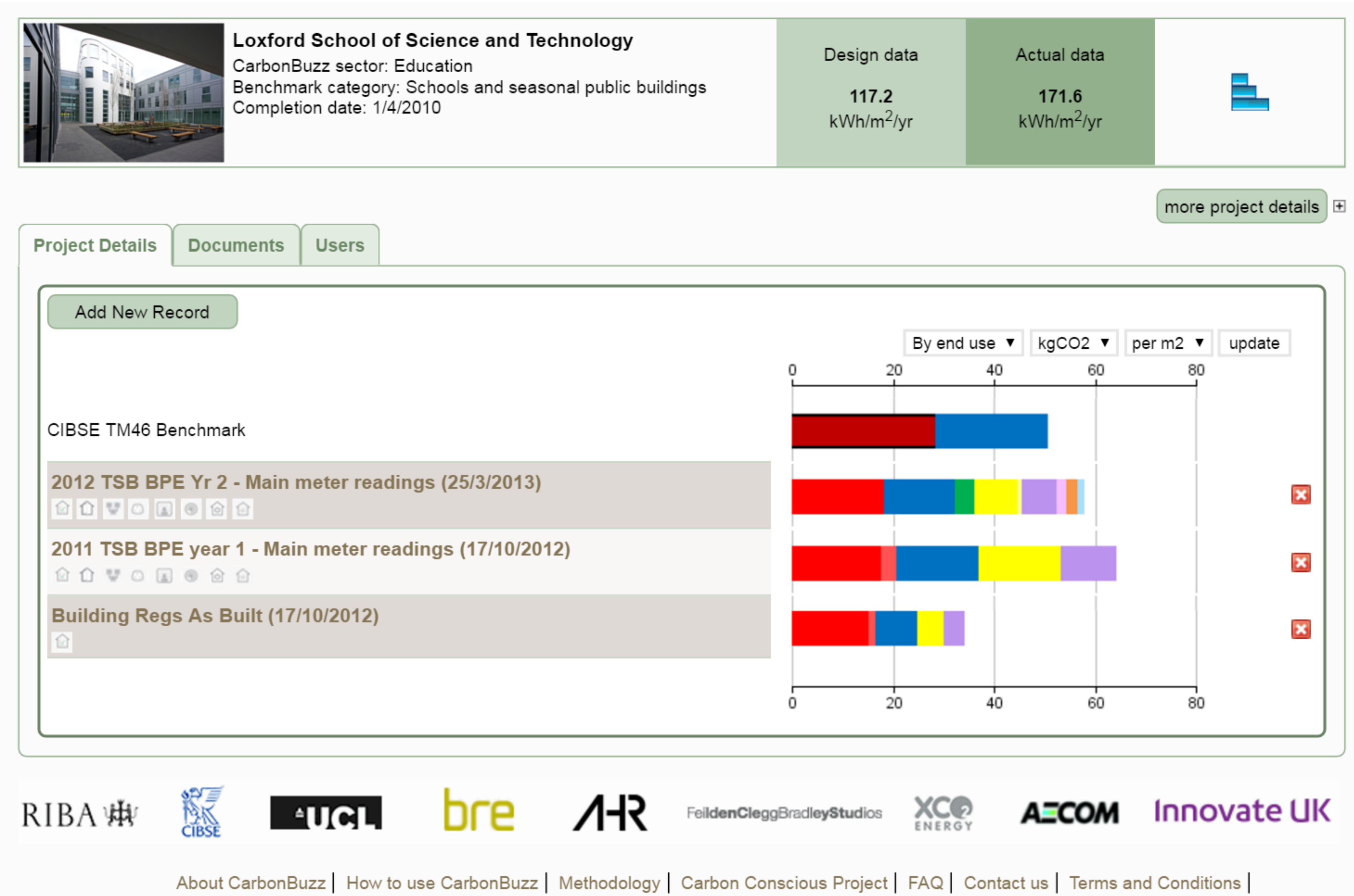
Recommendations for improving the energy efficiency of the building are contained in the accompanying Advisory Report.

BRUKL

EPC

DEC

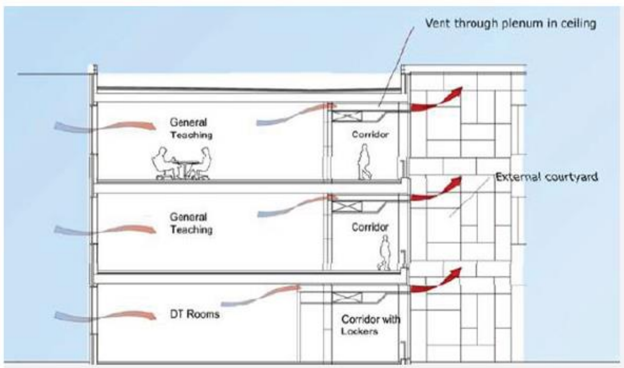
ENERGY END USE DATA AND CIBSE TM46 BENCHMARK

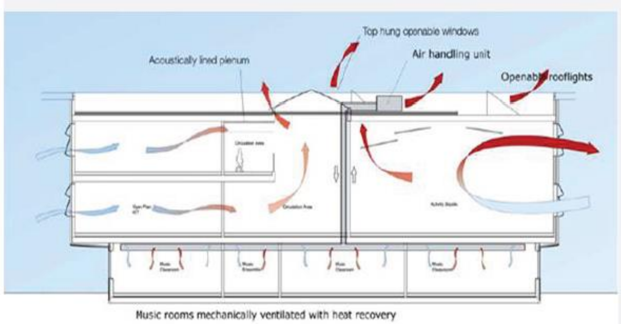


BPE FINDINGS | VENTILATION CONTROLS

No temperature profiles, CO_2 triggers only – no night purge

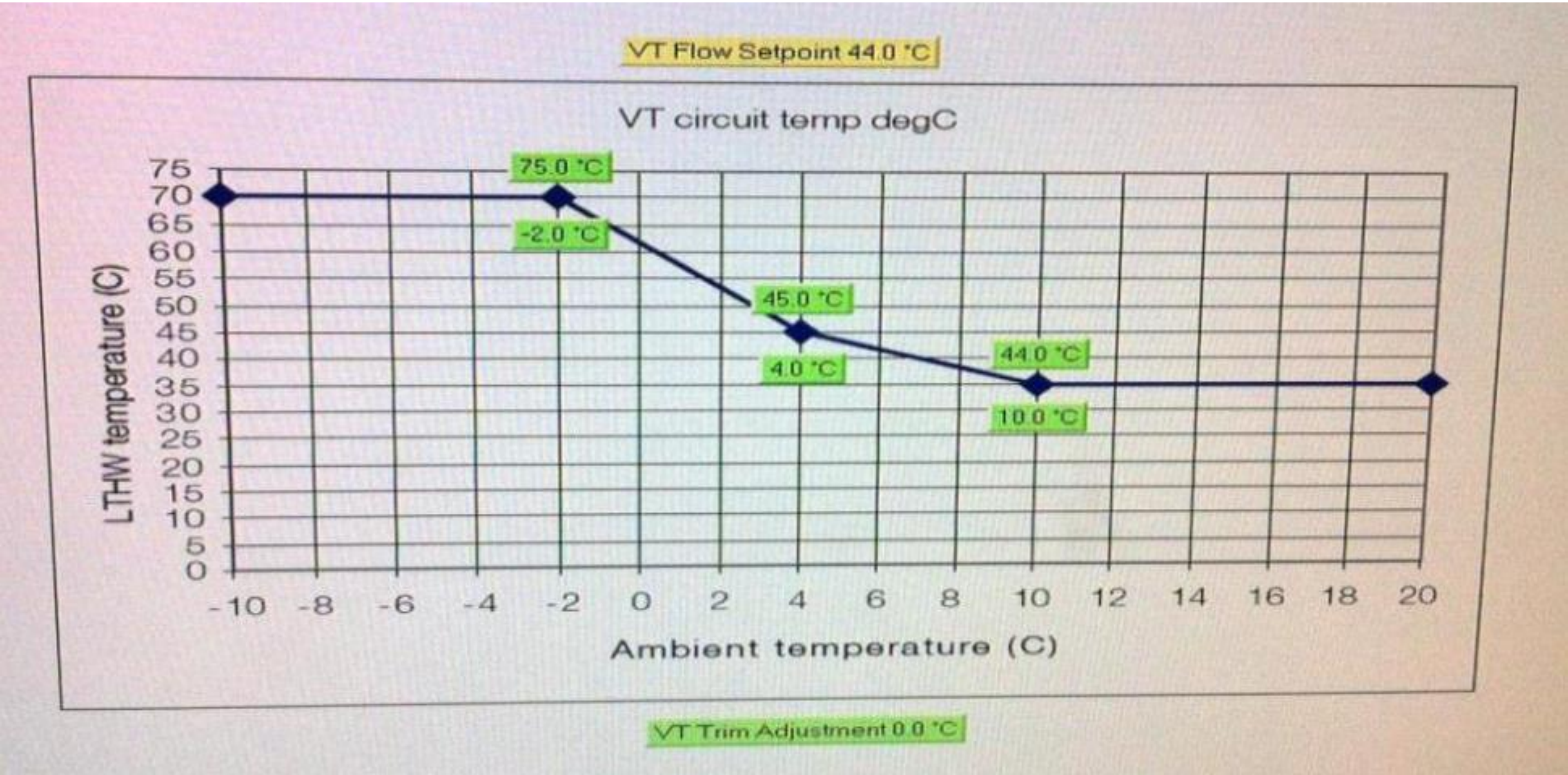
Seasonal commissioning omitted



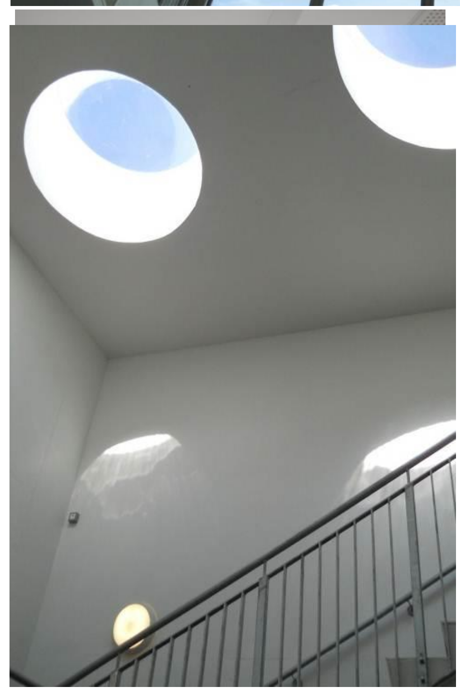


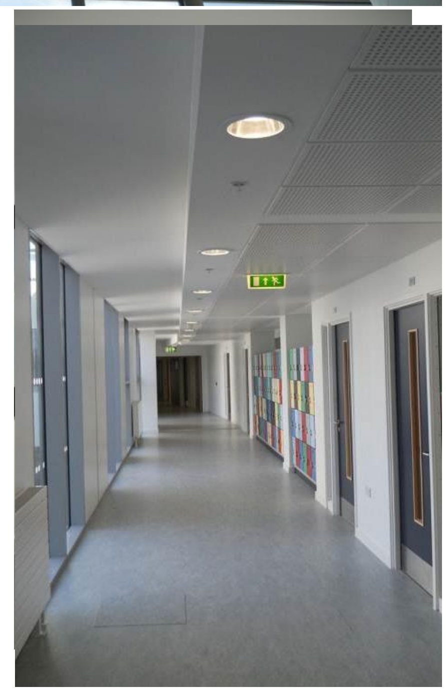
BPE FINDINGS | HEATING CONTROLS

Open doors mean ground floor too cold – flow temperature increased to 70 degC – above GSHP efficiency point



BPE FINDINGS | LIGHTING CONTROLS OMITTED ZONAL SETTINGS





Stockport Academy

- Simple layout
- Central atrium
- Steel frame
- Cavity walls
- Full mech vent, + ch beams
- GSHP, UFH
- PIR with daylight dimming
- Part L fabric only, EPC B
- BMS
- Traditional contract

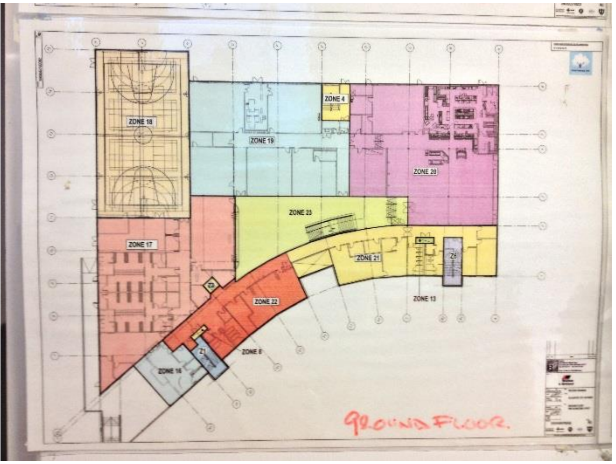
Petchey Academy

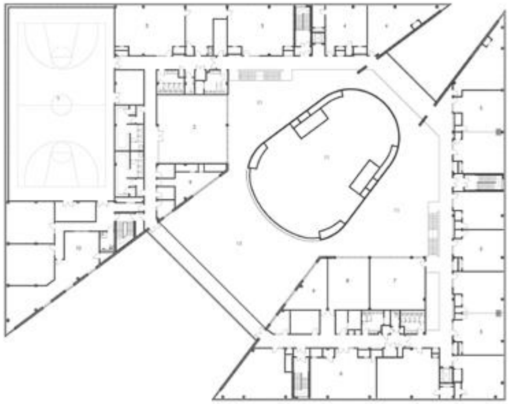
- Simple layout
- Central atrium
- Concrete frame
- Lightweight cladding
- Full mech vent
- Cooling with HR
- PIR and absence detection
- Pre-Part L ~EPC C
- BMS
- D&B contract

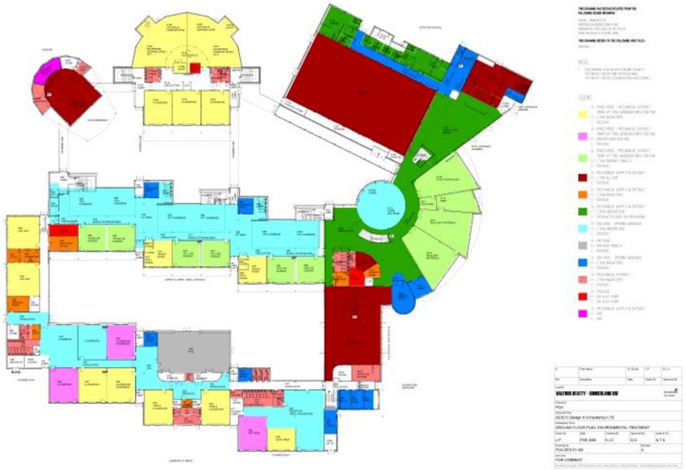
Pennywell 360 Academy

- ‘Village’ layout
- Large internal breakout areas
- Steel frame
- Lightweight cladding & blockwork
- Mixed mode + earth ducts, biomass
- PIR & daylight dimming
- Part L fabric, EPC B
- BMS
- D&B contract

AHR BPE FINDINGS







O&M OK but patchy on BMS

GSHP not lead system

AHU inverters not enabled

CO2 sensors missing

Faulty AHUs

No out-of hour, half-term or holiday operation set

Lighting controls

High server loads

Metering

O&M patchy

server room and data hub rooms on the same cooling circuit as the rest of the building

Out-of hour heating & cooling

AHU inverters not enabled

Lighting controls

Metering

O&M patchy

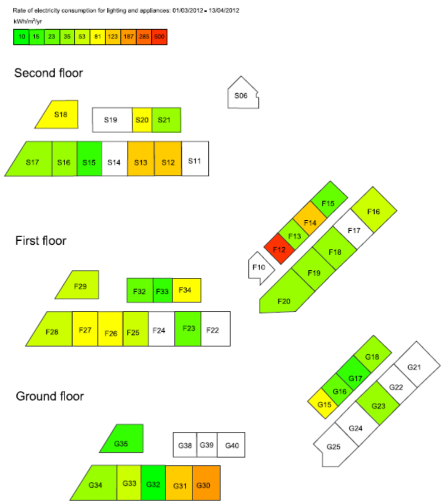
High lighting loads

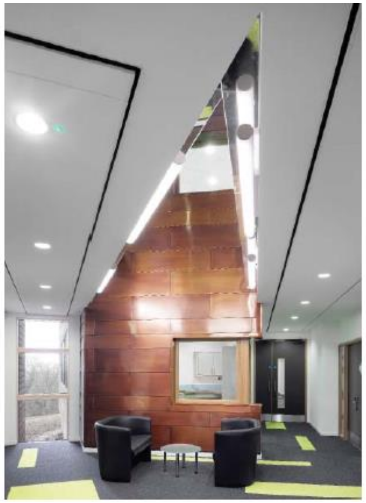
Metering

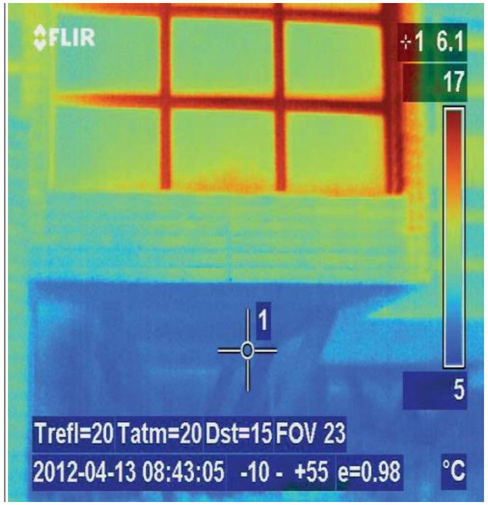
BMS – installation, profiling, logs

Zoning not enabled

AHR BPE OF POOL AND TREMOUGH INNOVATION CENTRES | NZEB



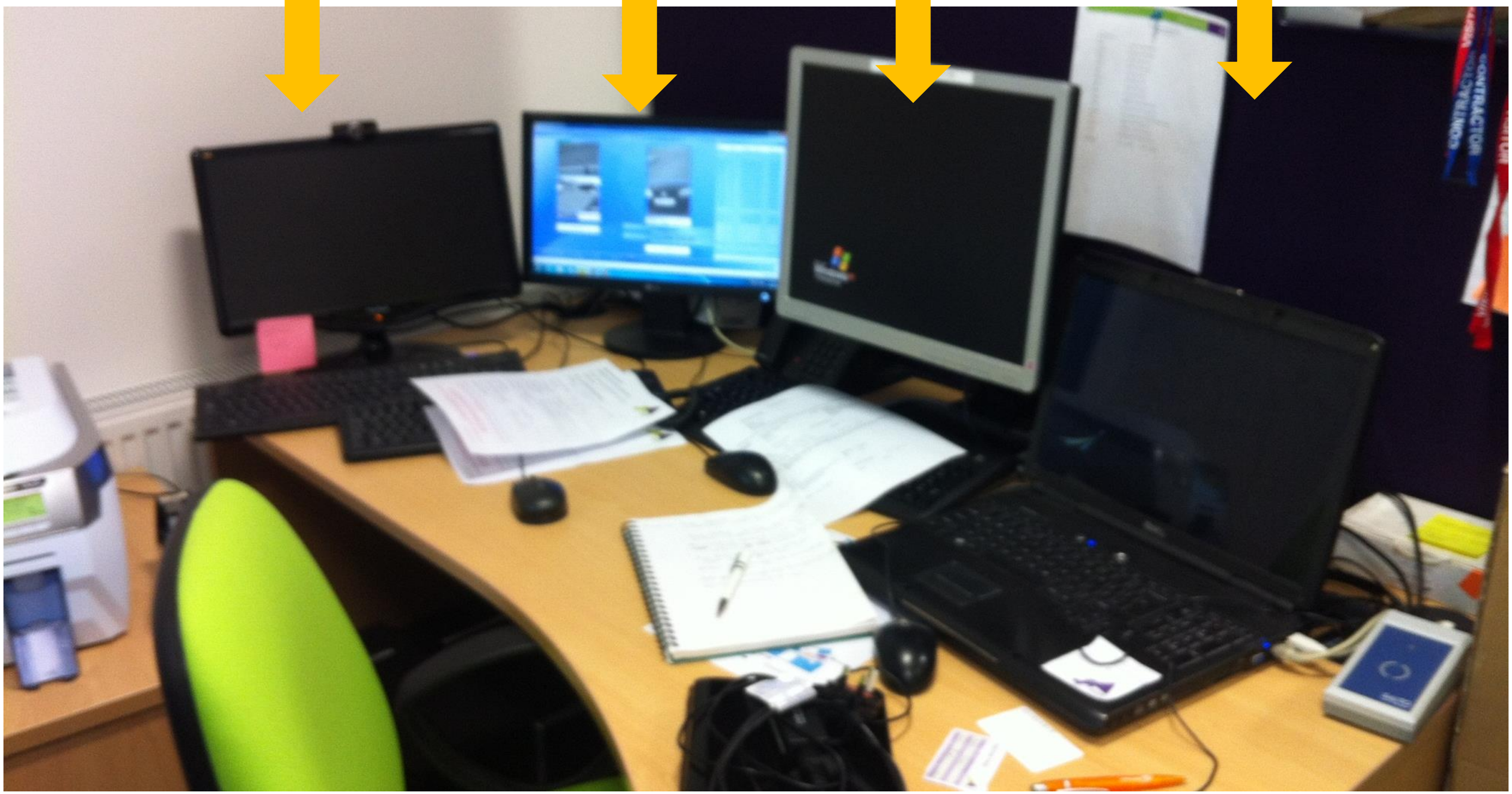




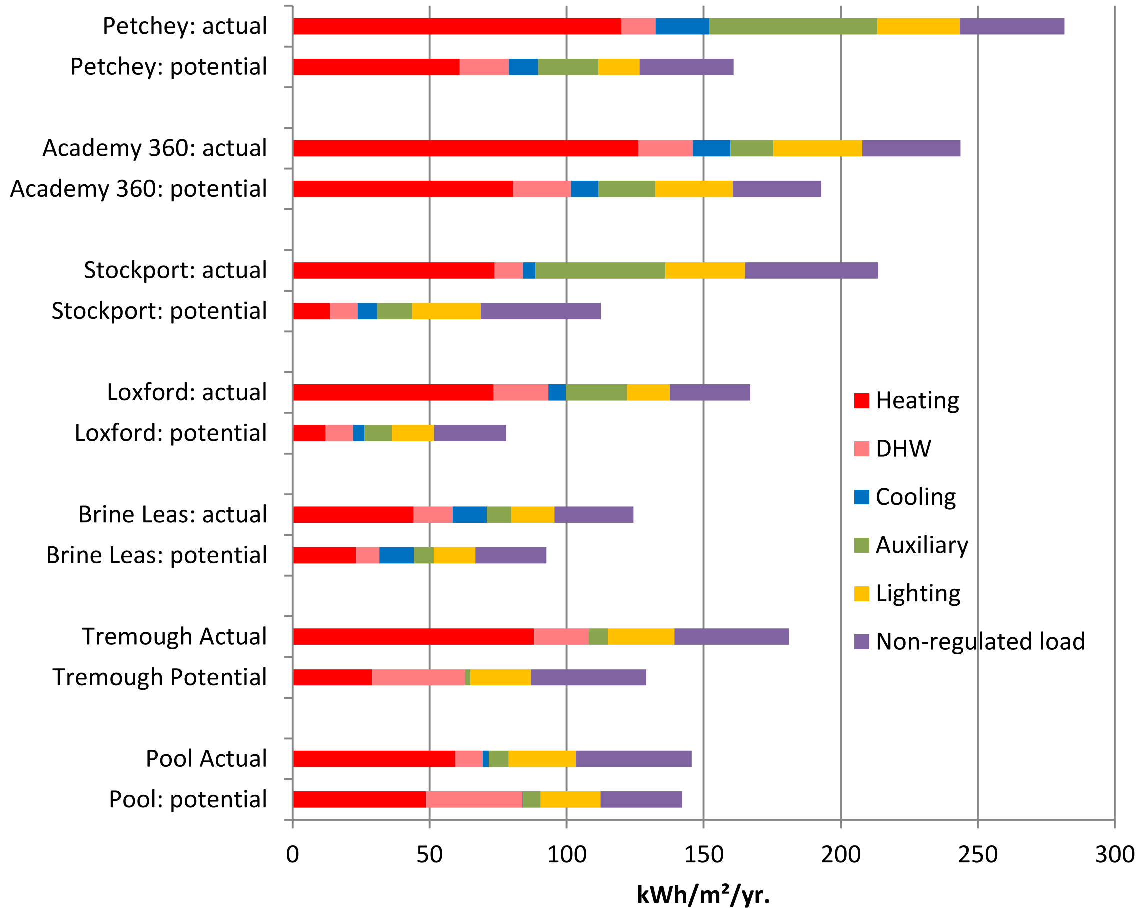
BPE FINDINGS | RECONCILIATION OF METERED AND SUBMETERED ENERGY DATA

BPE FINDINGS | BMS CONTROL SYSTEMS COMPLEX, LACK OF LOGGING FUNCTION

Security cameras **Number plate recognition** **BMS** **Alarms**



PERFORMANCE GAP | COMPLEX SERVICES



Large full mech vent
~£100K potential saving

Large mixed mode
~ £27K potential saving

Large full mech vent
~£71K potential saving

Large mostly nat vent
~£62K potential saving

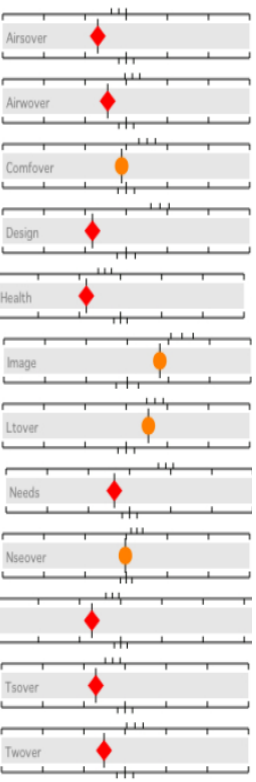
Small full mech vent
~£4K

Large full nat vent zero carbon target

Large full nat vent zero carbon target

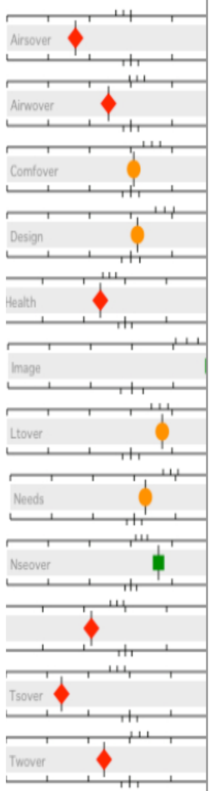
15-44% potential savings | on average £30-40K/yr/building

FEEDBACK ON COMFORT | RESULTS OF BUILDING USE SURVEYS



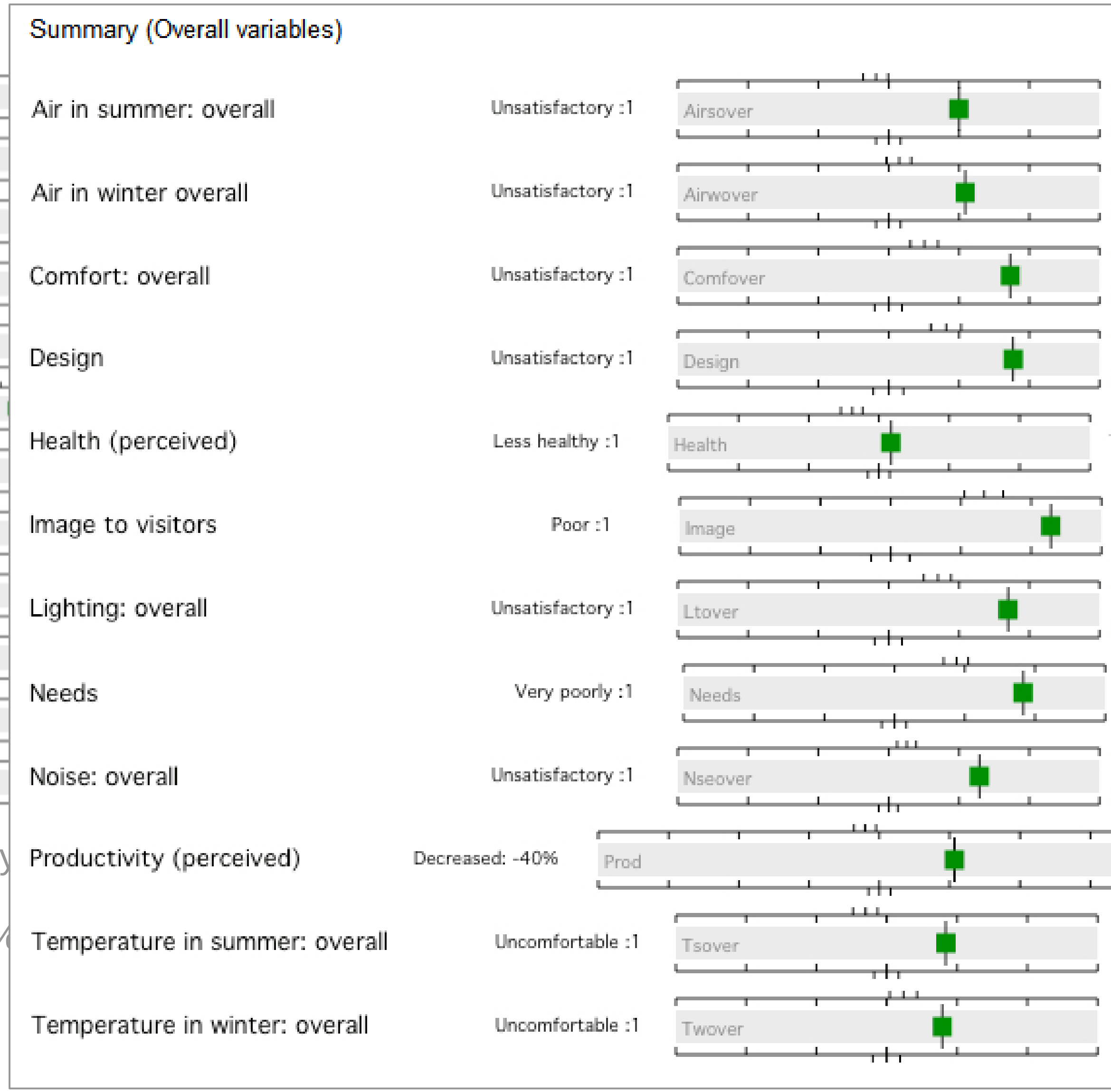
Academy 360

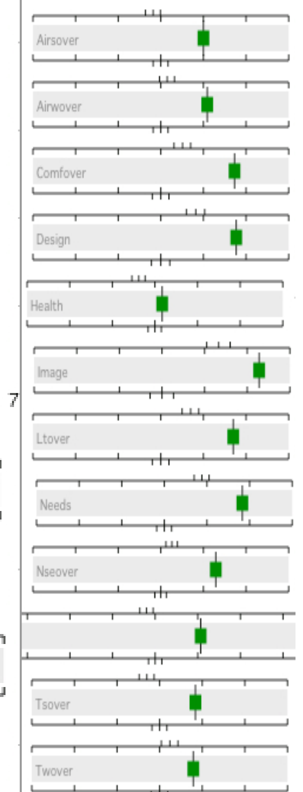
17%



Petchey

44%





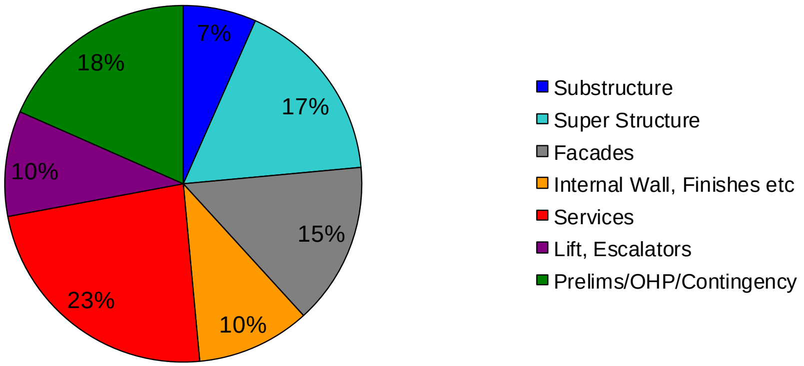
Tremough IC

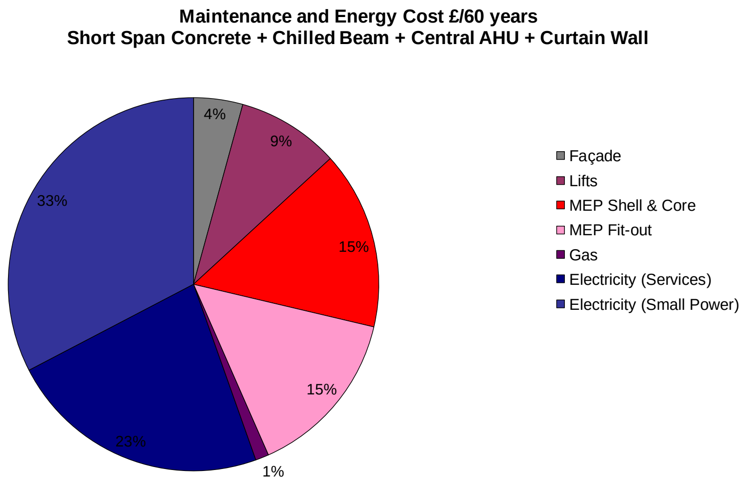
~5%

CAPITAL AND WHOLE LIFE COST OF MECHANICAL SYSTEMS

MEP services tend to account for…

20-30% of Capital Cost





Over 85% of Whole life cost

Source: Aecom

Capital cost of unused/underutilised equipment: Metering, BMS, sensors and controls, AHU inverters, actuators, LZCs, etc. can amount to 2-5% of capital cost

Misplaced value engineering: fabric performance and air-tightness, all openings, floor to floor heights, thermal mass, entrance lobbies, seasonal commissioning, daylighting, controls, training, manuals & log book – compliance or architecture?

Increased management, maintenance and energy costs: between 15-44% of total annual energy costs could be saved amounting to potentially tens of thousands of pounds per year

Mitigation costs: ~ 50% of annual energy costs – Soft Landings with energy disclosure approximately 0.1% of construction budget

Profit loss of consultants and contractors

Productivity loss for occupiers and FM

It adds up…

THE COST OF BUILDING PERFORMANCE EVALUATIONS

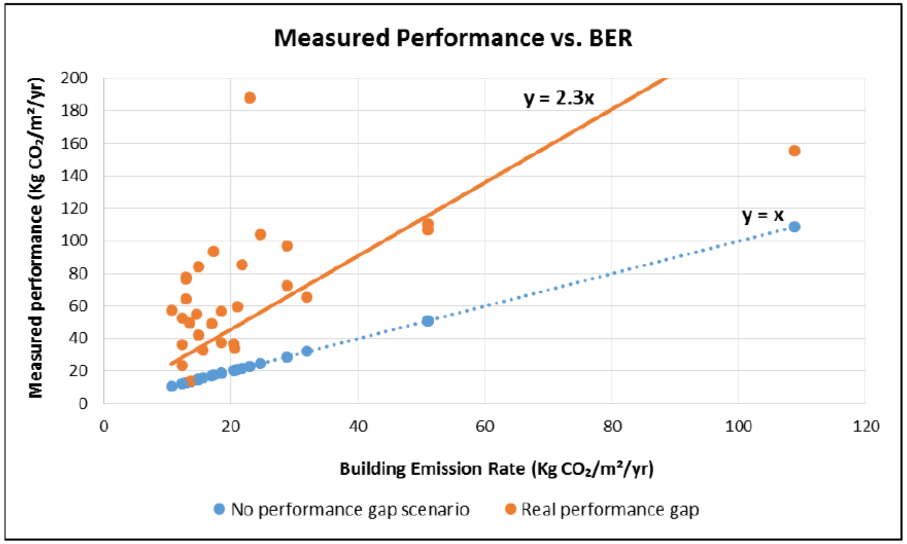
50% of our time went on gathering energy data

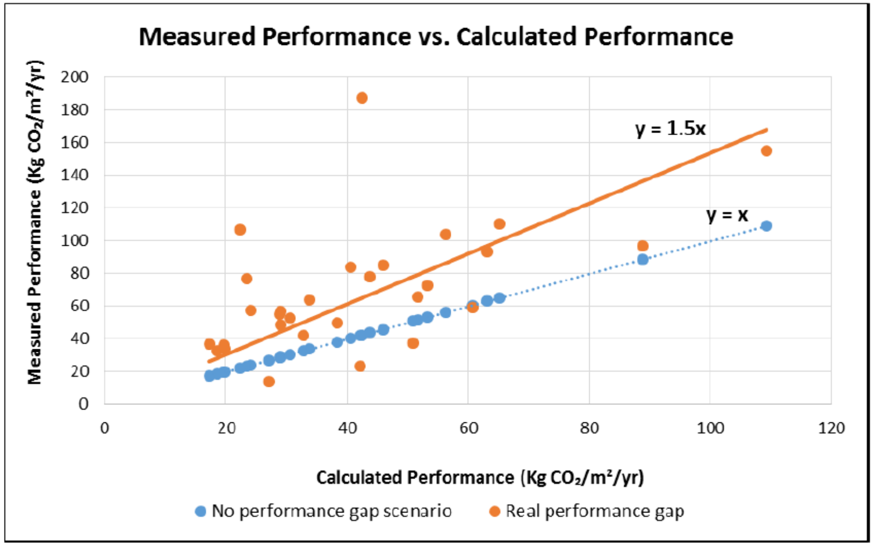
20% on chasing client, consultant and contractor teams for design vs as-built data

25% on analysis of the data gathered and additional energy modelling

5% on gathering occupant feedback

INNOVATE UK BPE OVERALL PERFORMANCE GAP



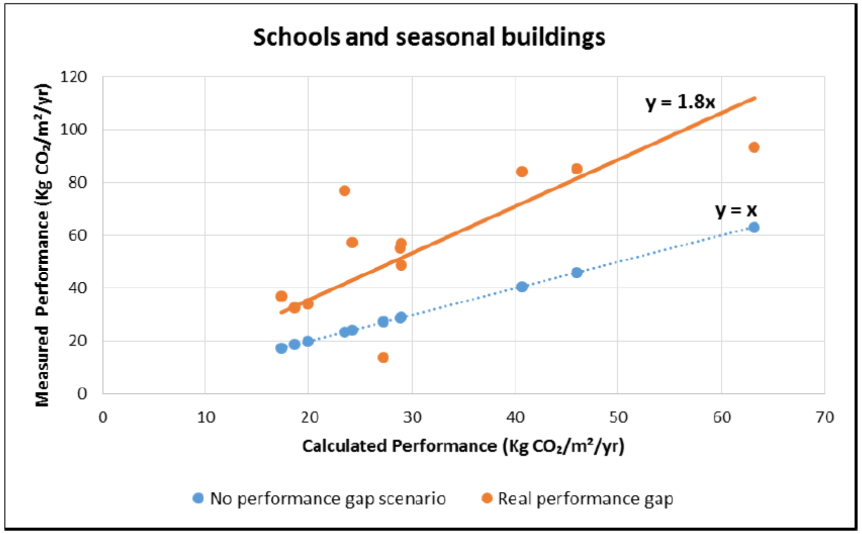


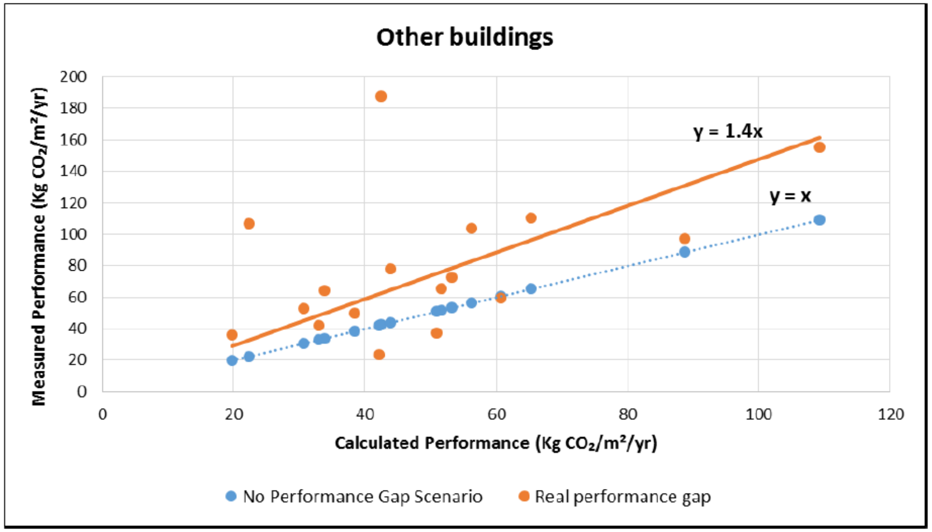
- 30 BPE buildings with EPC data and measured performance
- Building Emission Rate (BER) does not take into account equipment load
- Fuel CO_2 conversion factors are also different
- Measured performance is 2-3 times the BER

- Allowance for equipment load (NCM allowance)
- Identical fuel CO_2 conversion factors
- Measured performance is around 50% higher than the calculated performance
- Valid if building operation broadly follows the NCM standardised operation of the respective building category

Source: Burman, E. 2016. *Building Performance Gap: A Way Forward*, Building Performance Evaluation – Understanding the Performance Gap, University College London, 16 February 2016.

PERFORMANCE GAP AND SEASONAL USE



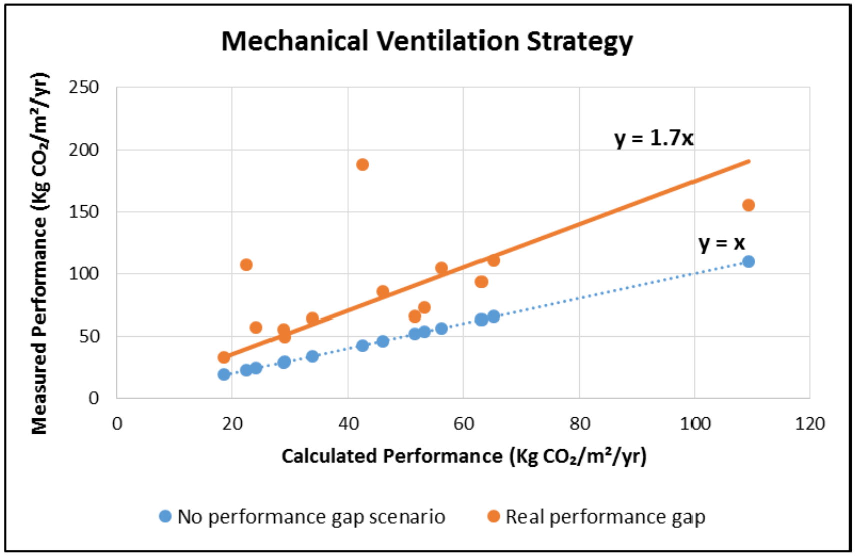


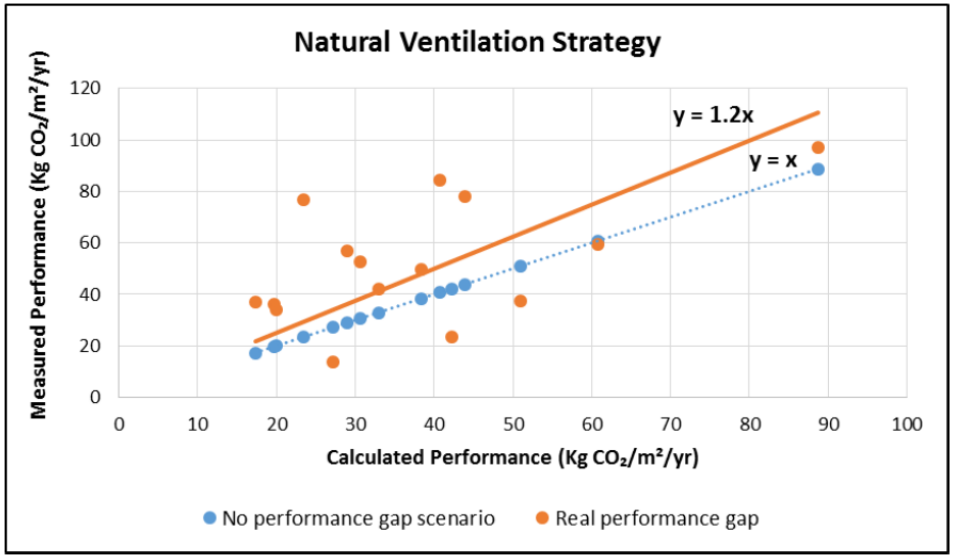
Schools and seasonal buildings pose a particular problem for this type of analysis:

- The standardised profiles used in the National Calculation Methodology assume building is not in use during half-term breaks and school holidays.
- In practice buildings services across the whole building are operational even if only part of the building is used during these periods!
- This combination leads to higher performance gap compared to other building categories.

Source: Burman, E. 2016. *Building Performance Gap: A Way Forward*, Building Performance Evaluation – Understanding the Performance Gap, University College London, 16 February 2016.

PERFORMANCE GAP AND VENTILATION TYPE

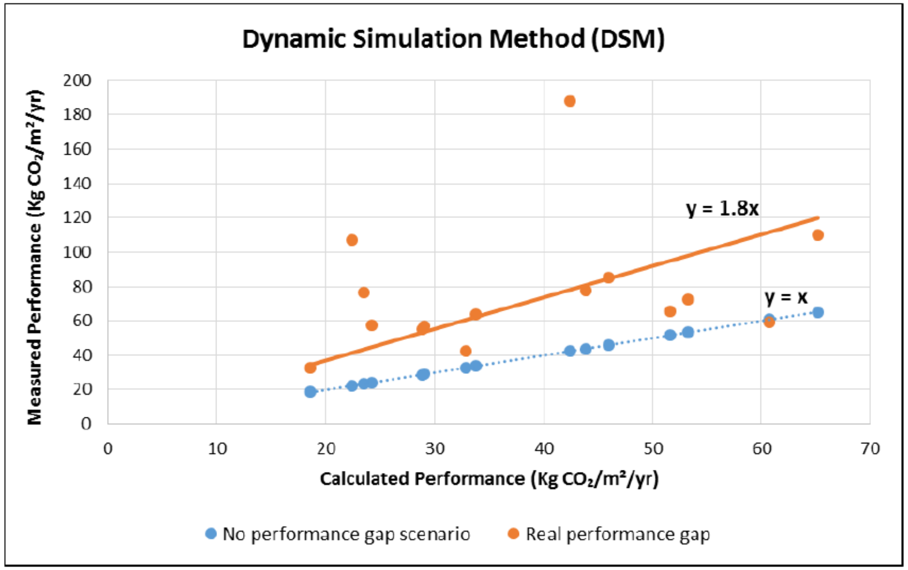


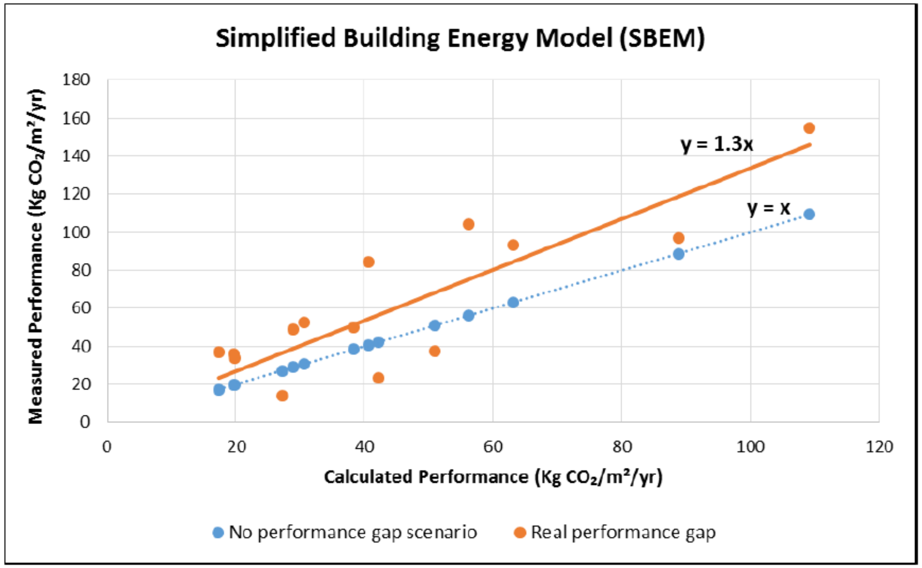


- BPE buildings with mechanical ventilation show higher energy performance gap than naturally ventilated buildings.
- Operational risks of MV systems not fully understood and mitigated at design stages and in-operation!

Source: Burman, E. 2016. *Building Performance Gap: A Way Forward*, Building Performance Evaluation – Understanding the Performance Gap, University College London, 16 February 2016.

PERFORMANCE GAP AND COMPLEXITY

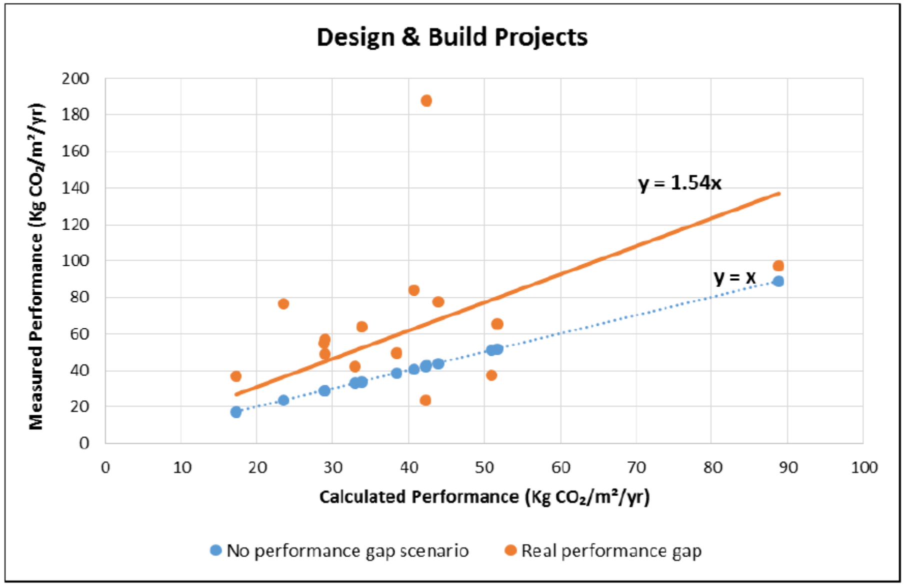


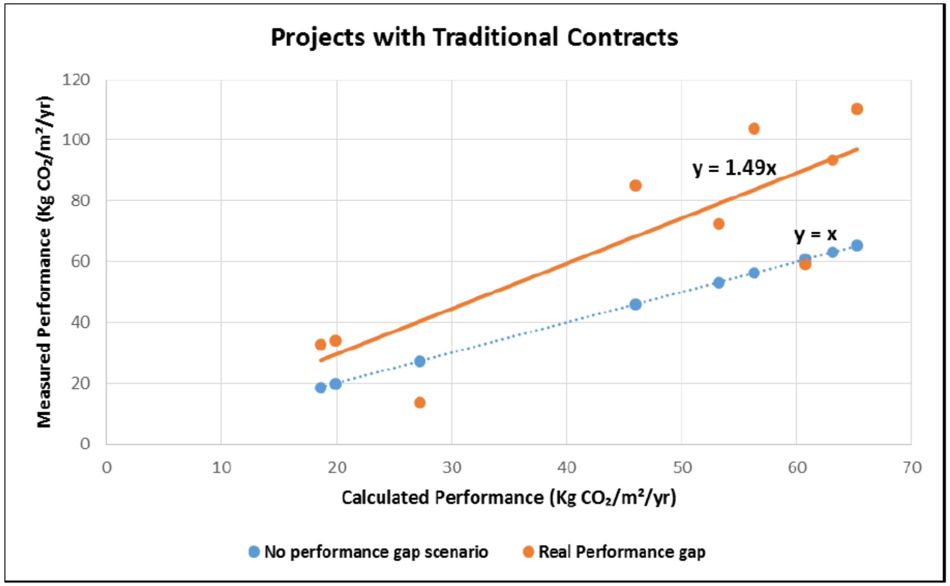


- Buildings that were subject to DSM analysis show higher performance gap than buildings that used SBEM!
- Does not necessary tell us which calculation method is better.
- **Buildings** that used **DSM** are generally **larger and more complex**.

Source: Burman, E. 2016. *Building Performance Gap: A Way Forward*, Building Performance Evaluation – Understanding the Performance Gap, University College London, 16 February 2016.

PERFORMANCE GAP AND PROCUREMENT ROUTE



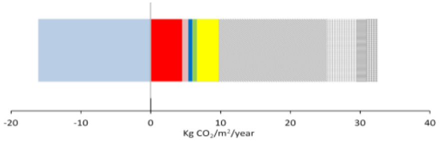


- The energy performance gap in D&B procured buildings is 'slightly' higher than traditionally procured buildings.
- However, this analysis is skewed by an outlier!

Source: Burman, E. 2016. *Building Performance Gap: A Way Forward*, Building Performance Evaluation – Understanding the Performance Gap, University College London, 16 February 2016.

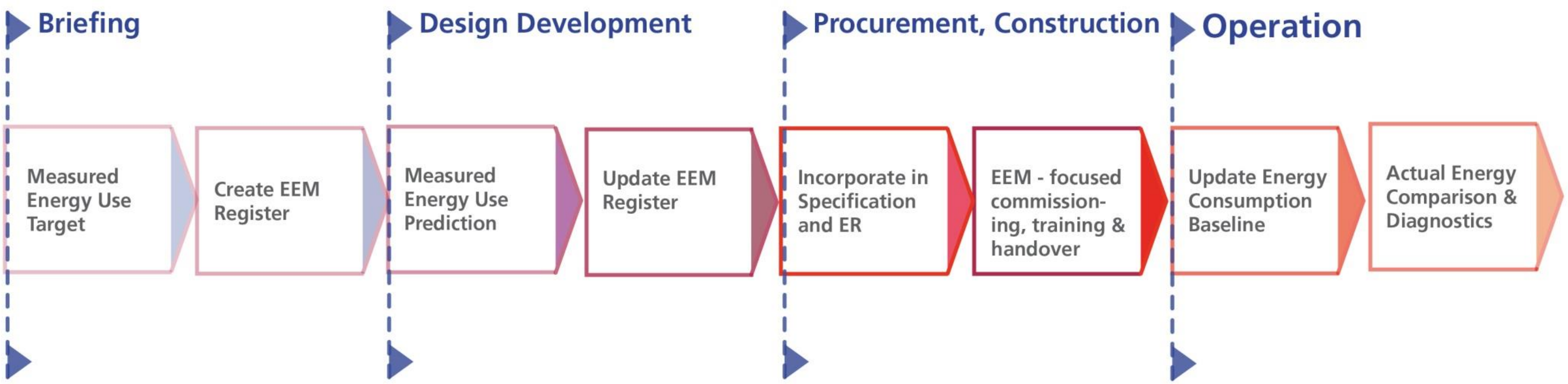
1. **How is the performance gap identified as a risk to projects?**
2. **What steps are being taken to improve certainty of performance outcomes?**
3. **Can capital, maintenance and mitigation costs be identified?**
4. **What else is needed to help create a business case for addressing the causes? (for example relationship between learning and indoor environmental quality, sector-wide benchmarking/targets etc.)**

TARGETING OPERATIONAL ENERGY USE | KEYNSHAM CIVIC CENTRE & ONE STOP SHOP



A

TARGETING OPERATIONAL PERFORMANCE

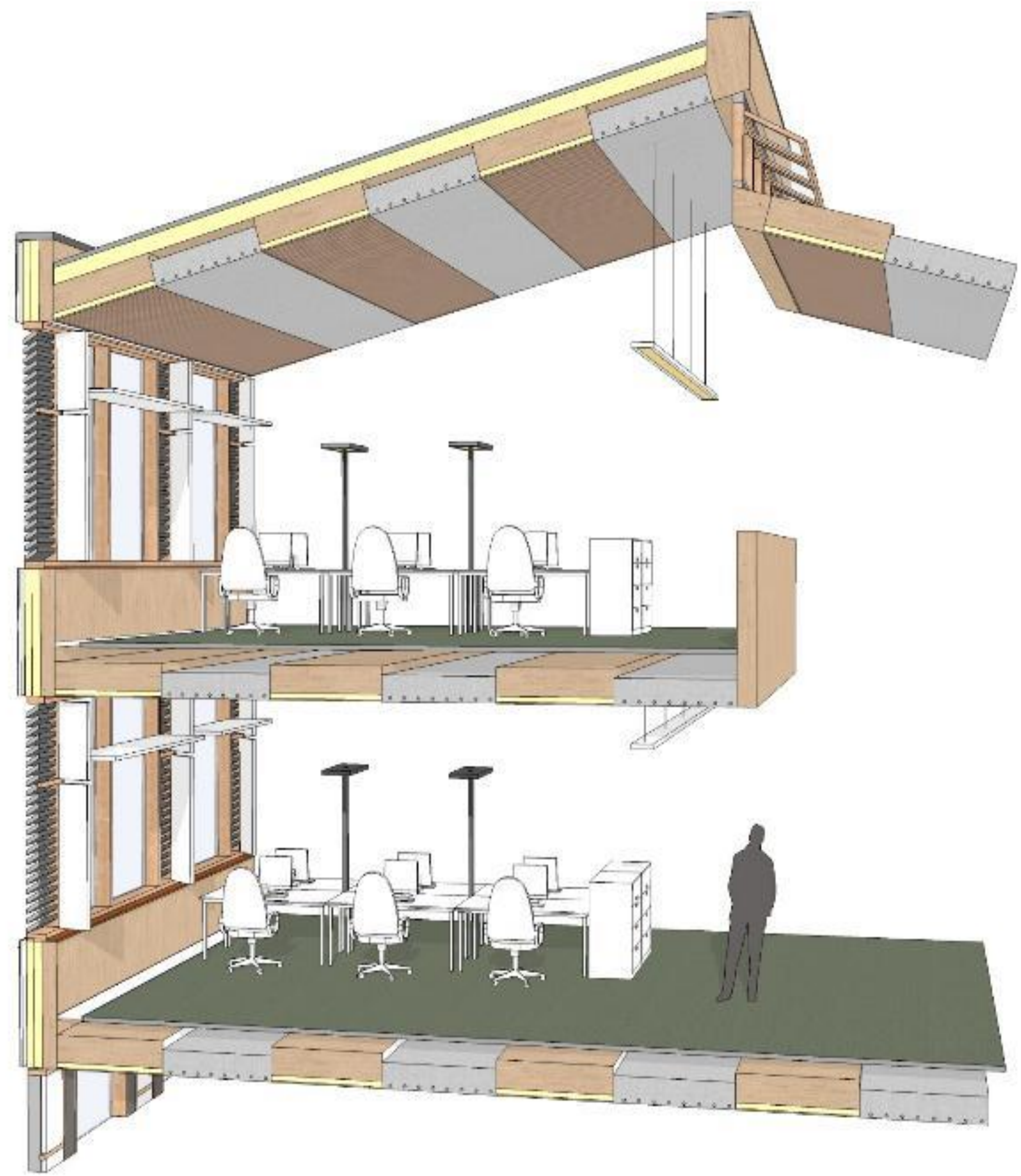


CarbonBuzz. an RIBA CIBSE platform

New types of contracts are needed to enable data sharing from start to end

ARCHITECTURAL WINS

- Timber windows with 150mm acoustic louvres
- Floor to floor heights – 3.05m
- Vent voids
- Lighting: light shelves, task lighting and voids to North
- Thermal Mass incorporating cooling pipe work



PROJECT BRIEF

- Reducing council offices from 10 to 4
- Working environment with a ‘one council’ culture
- Halve the council’s buildings energy use
- Efficient working: 688 people to 455 workstations – 3/2 desk sharing
- Targeting DEC A rating from the outset rather than BREEAM
- The first project to use BSRIA Soft Landings to achieve DEC A by 2nd year of operation

SPATIAL CONFIGURATION

TYPICAL OFFICE LAYOUT

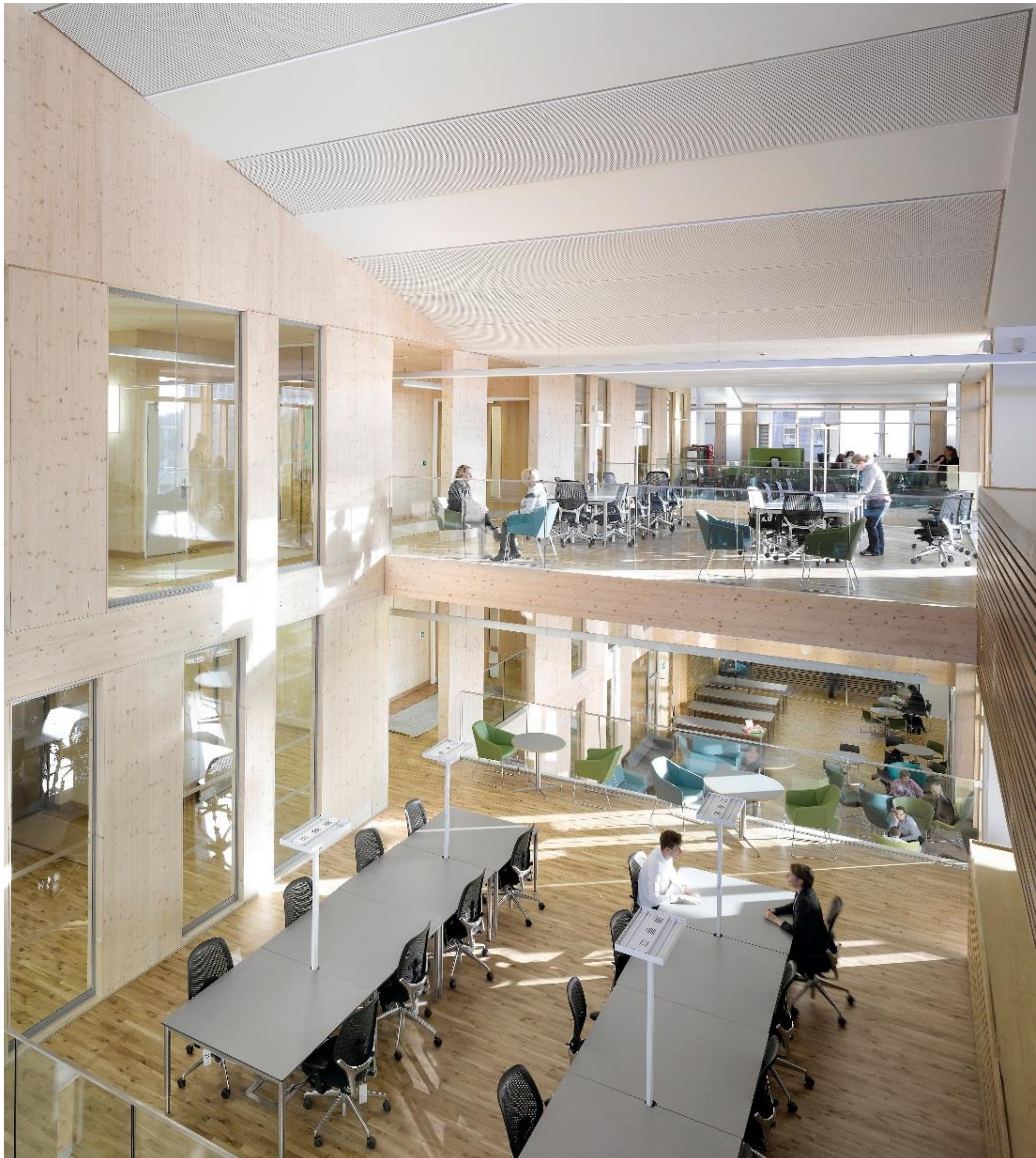
- Open plan offices
- Maximise NS orientation
- Voids on North perimeter
- Voids adjacent to circulation
- Meeting rooms and kitchenettes on W perimeter
- Tea points, meeting rooms & copy areas at east & west ends

OPENINGS

- Acoustic buffer
- Light shelves
- Night ventilation
- High level automated glazed vents

ARCHITECTURAL DETERMINANTS

- Ventilation voids
- Visual integration of office and meeting areas
- Cross laminated timber structure
- Thermal mass in ceiling
- Good daylight penetration throughout



96%

Reduction in energy ££

81%

GAS USE REDUCTION kWh

67%

ELECTRICITY USE REDUCTION kWh

1150m²

OF PHOTOVOLTAIC PANELS PROVIDE 200,000kWH PER YEAR OF ELECTRICITY

20%

OF THE BUILDINGS TOTAL HEATING ENERGY REQUIREMENT IS PROVIDED BY WATER COOLING SERVERS

3:2

DESK-SHARING RATIO WHICH RESULTED IN THE TARGET OF 455 WORK-STATIONS FOR 688 STAFF

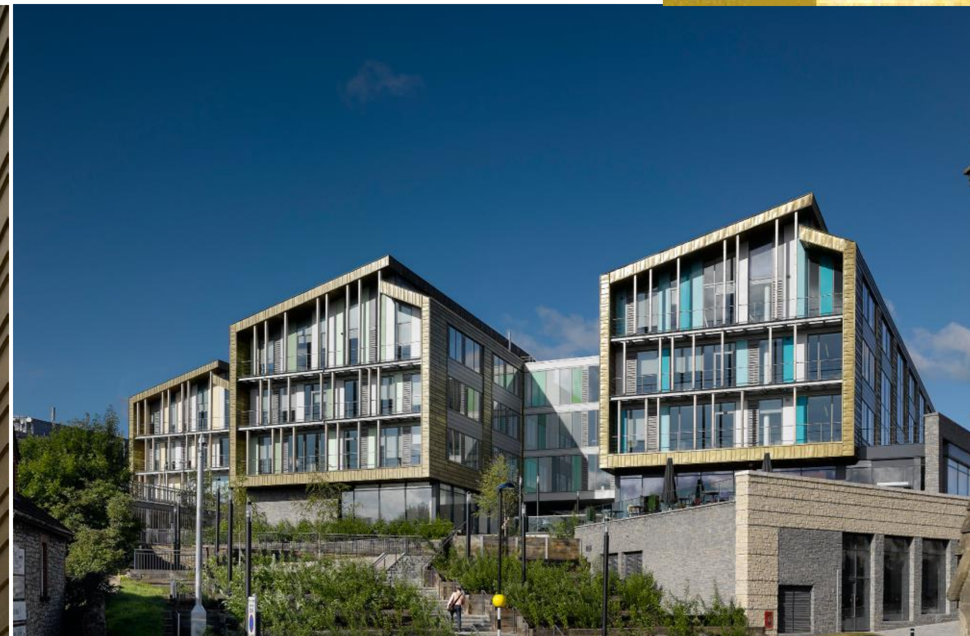
TOTAL ANNUAL CO_2 EMISSIONS/m^2 (TREATED FLOOR AREA)

36.3kgCO_2/m^2

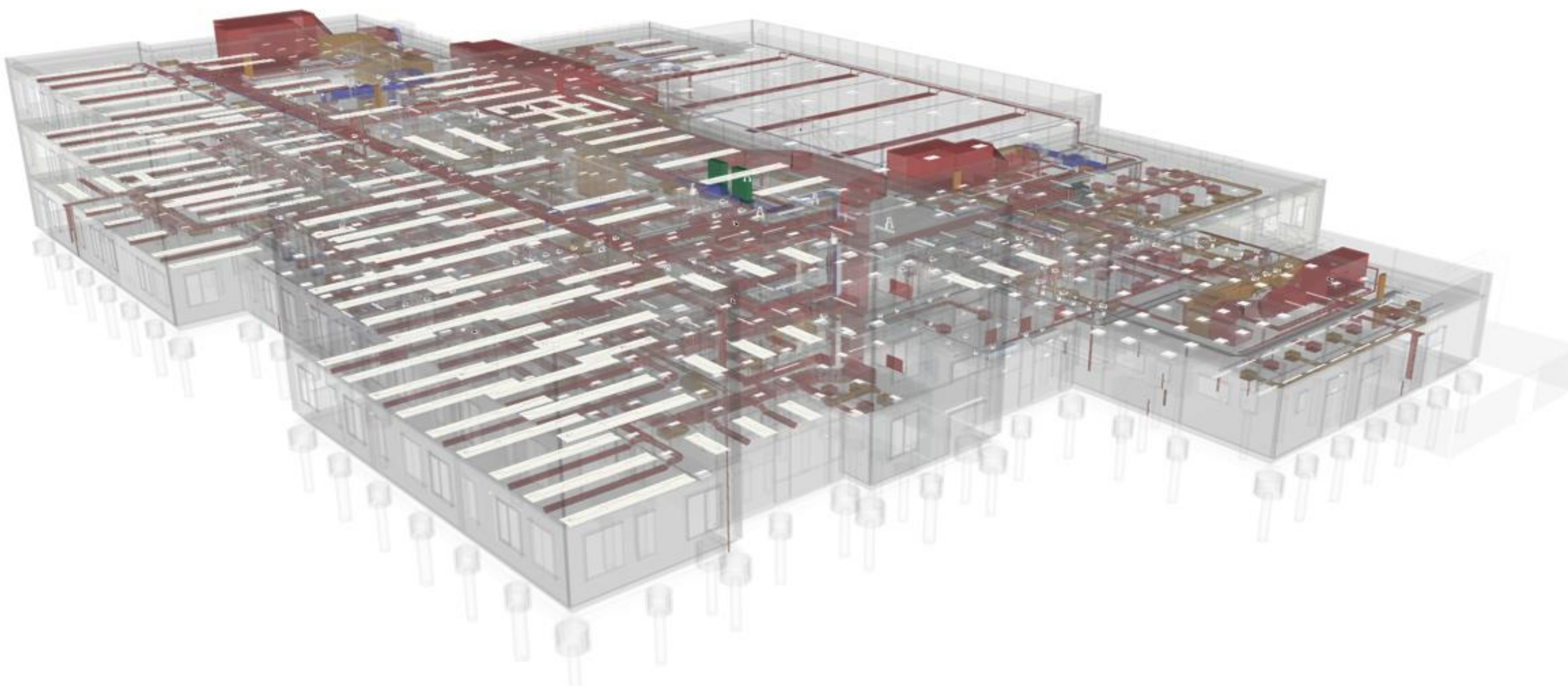
75%

NET TO GROSS INTERNAL AREA (OFFICES ONLY)

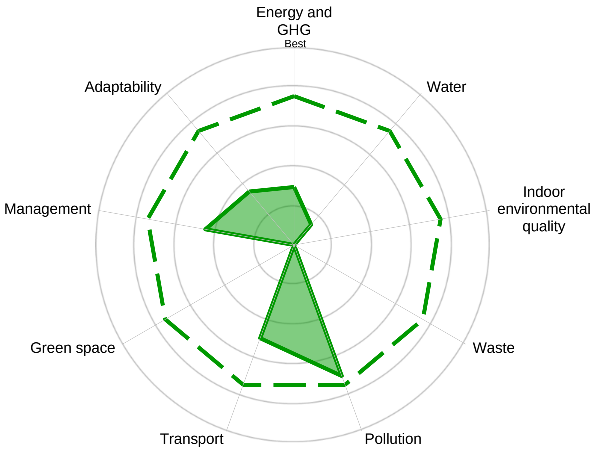
PERFORMANCE CONTRACTING | ARCHITECTURE IS A KEY BENEFICIARY

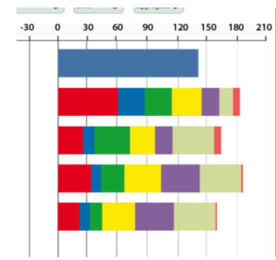


USE OF BIM TO FACILITATE FEEDBACK



CLOSING THE PERFORMANCE GAP | MEASUREMENT, VERIFICATION, DISCLOSURE





Investment KPIs

Virtual Information Models

Validation

1. **What are the barriers and incentives for energy performance contracting in the HE sector?**
2. **How can the roles and responsibilities of the project team be defined with building performance in mind?**

1. **Future R&D opportunities**
2. **Collaborative actions between HE institutions, EAUC, AUDE & industry to build momentum (i.e. shared templates, reporting, anonymised benchmarking, etc.)**

MENU

ENERGY PEOPLE BUILDINGS

THANK YOU