CIBSE Benchmarking Project

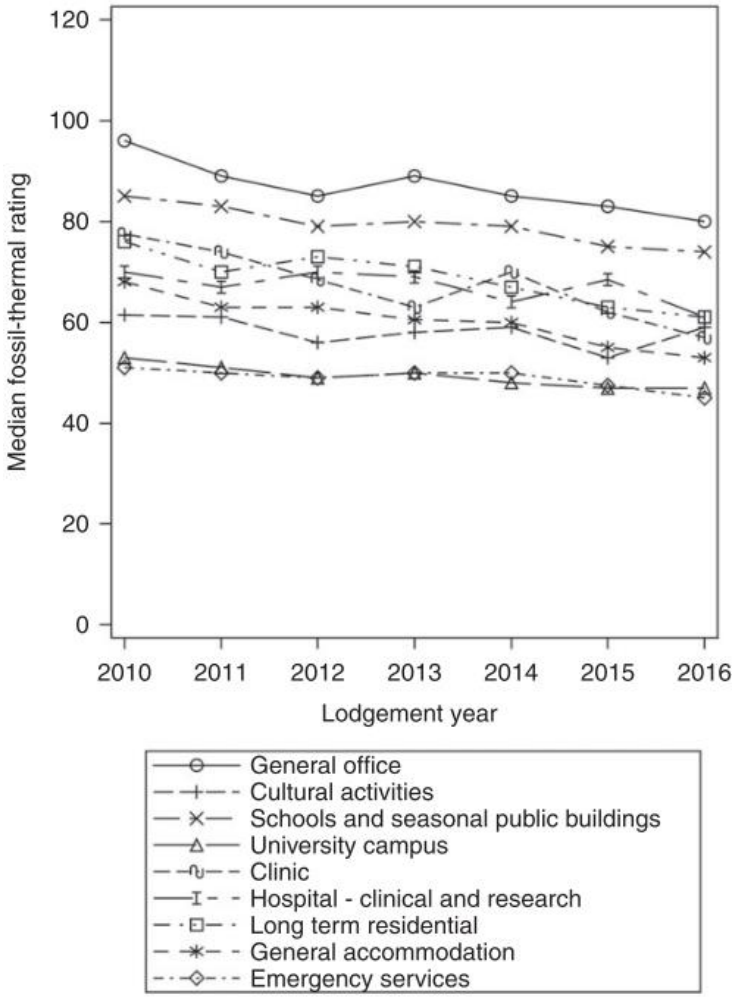
Dynamic and Interactive Online Benchmarking Tool

Dr Sung-Min Hong

UCL IEDE

Introduction

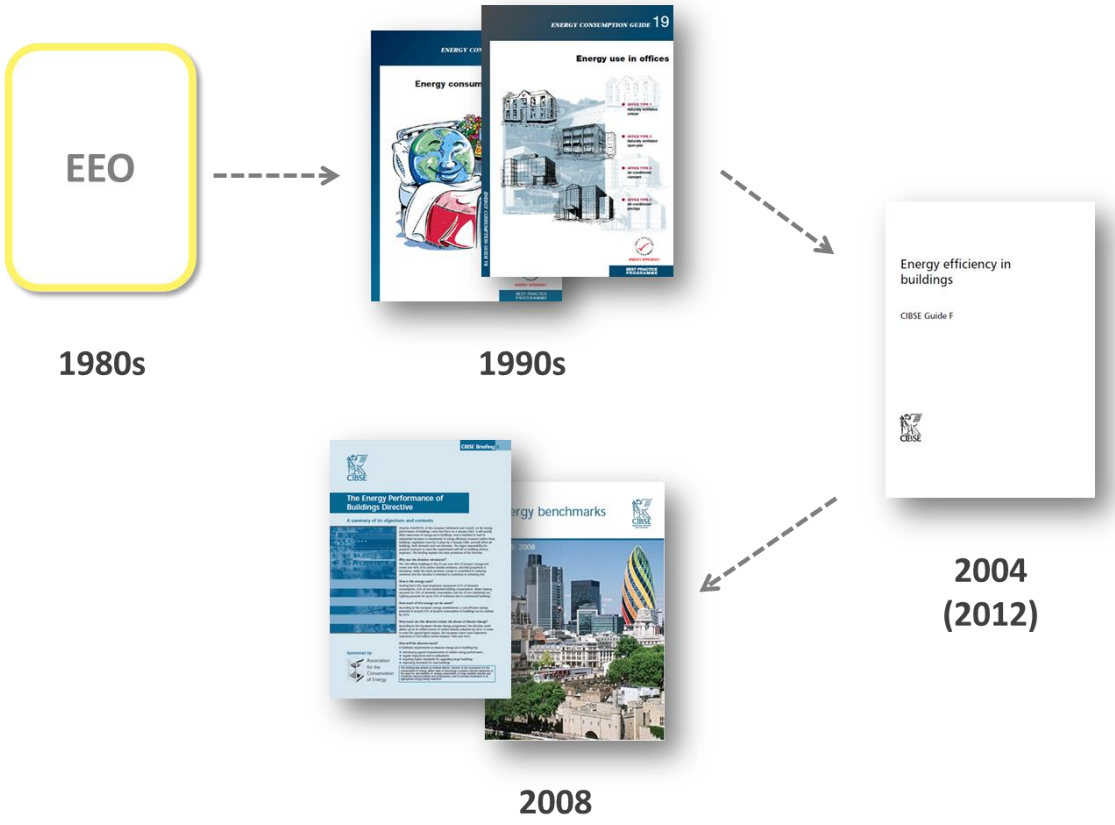
- Lecturer at UCL Institute for Environmental Design & Engineering (IEDE)
- Building scientist / MSc EDE / PhD in energy benchmarking
- Course director of MSc Environmental Design and Engineering
- Data-driven approach to understanding energy performance of buildings
- Key collaborations with DfE, MoJ and SFT



Benchmarking context / background

A need for providing better benchmarks

- Most existing energy benchmarks based PROBE study from 1990s



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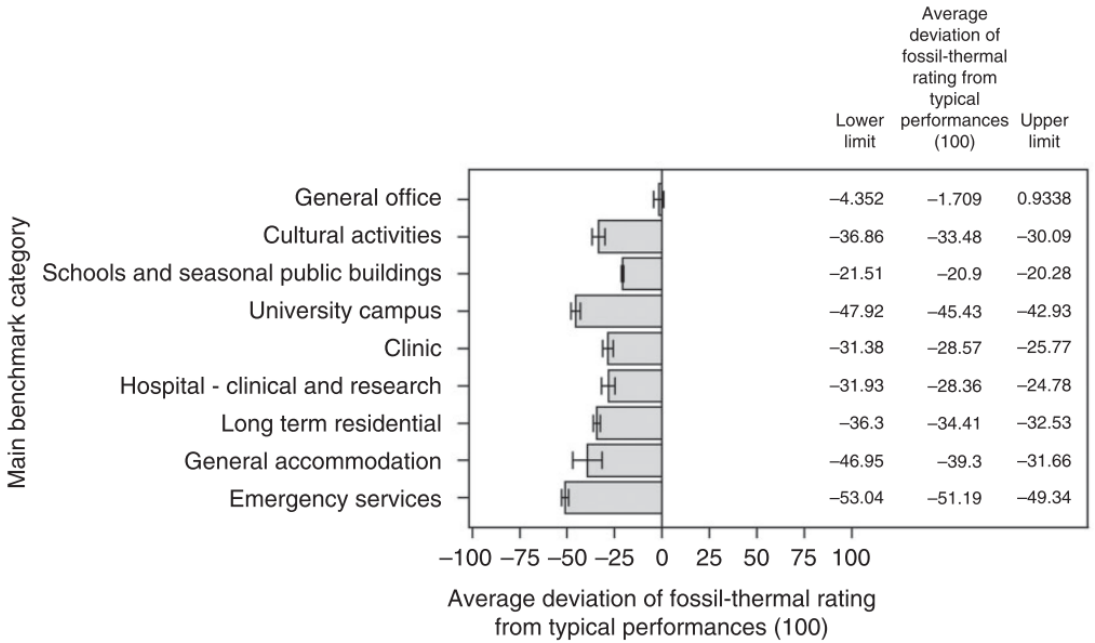
- Existing energy benchmarks often out-of-date



Benchmarking context / background

A need for providing better benchmarks

- Most existing energy benchmarks based PROBE study from 1990s
- Existing energy benchmarks often out-of-date
- Absolute figures without much contextualisation

Table 20.1 Fossil and electric building benchmarks — *continued*

Building type	Energy consumption ber / (kW·h·m^{-2}) per ye	
	Good practice	
	Fossil fuels	Electricity
Entertainment: (continued)		
— social clubs	140	60
— bingo clubs	440	190
Education (further and higher)[3][c]:		
— catering, bar/restaurant	182	137
— catering, fast food	438	200
— lecture room, arts	100	67
— lecture room, science	110	113
— library, air conditioned	173	292
— library, naturally ventilated	115	46
— residential, halls of residence	240	85
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— science laboratory	110	155
Education (schools)[4]:		
— primary	113	22
— secondary	108	25
— secondary (with swimming pool)	142	29
Hospitals[5]:		
— teaching and specialist	339	86
— acute and maternity	422	74
— cottage	443	55

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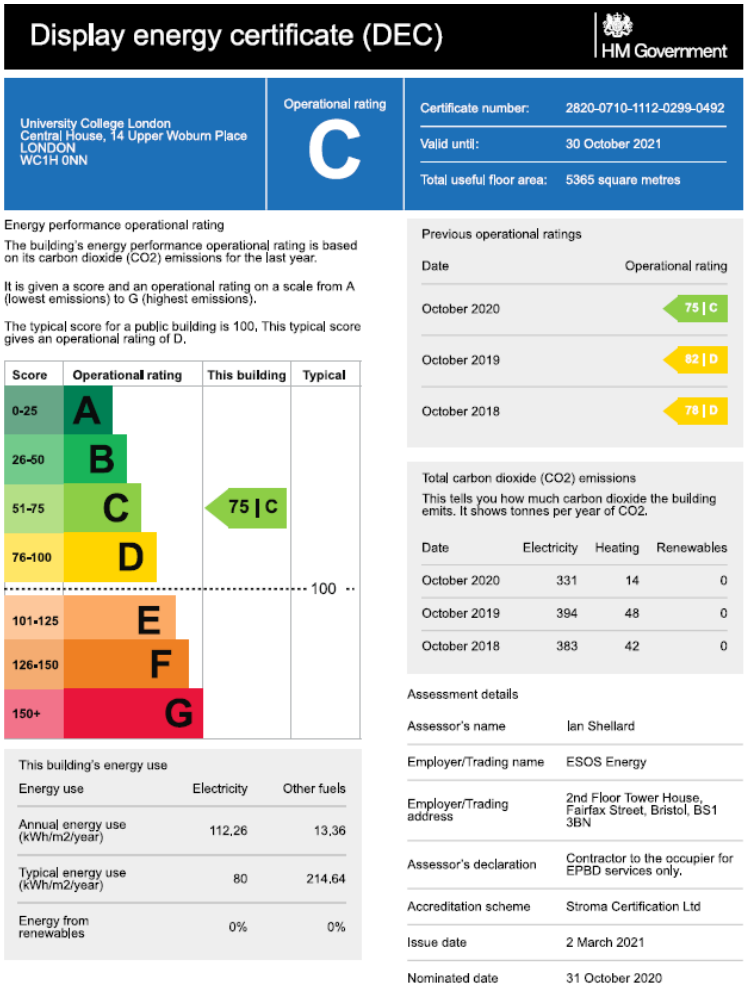

Display energy certificate (DEC)

HM Government

University College London
Central House, 14 Upper Woburn Place
LONDON
WC1H 0NN

Operational rating: C

Certificate number: 2820-0710-1112-0299-0492
Valid until: 30 October 2021
Total useful floor area: 5365 square metres

Energy performance operational rating

The building's energy performance operational rating is based on its carbon dioxide (CO2) emissions for the last year.

It is given a score and an operational rating on a scale from A (lowest emissions) to G (highest emissions).

The typical score for a public building is 100. This typical score gives an operational rating of D.

Score	Operational rating	This building	Typical
0-25	A		
26-50	B		
51-75	C	75 | C	
76-100	D		100
101-125	E		
126-150	F		
150+	G		

This building's energy use

Energy use	Electricity	Other fuels
Annual energy use (kWh/m2/year)	112,26	13,36
Typical energy use (kWh/m2/year)	80	214,64
Energy from renewables	0%	0%

Previous operational ratings

Date	Operational rating
October 2020	75 | C
October 2019	82 | D
October 2018	78 | D

Total carbon dioxide (CO2) emissions

This tells you how much carbon dioxide the building emits. It shows tonnes per year of CO2.

Date	Electricity	Heating	Renewables
October 2020	331	14	0
October 2019	394	48	0
October 2018	383	42	0

Assessment details

Assessor's name	Ian Shellard
Employer/Trading name	ESOS Energy
Employer/Trading address	2nd Floor Tower House, Fairfax Street, Bristol, BS1 3BN
Assessor's declaration	Contractor to the occupier for EPBD services only.
Accreditation scheme	Stroma Certification Ltd
Issue date	2 March 2021
Nominated date	31 October 2020

Benchmarking context / background

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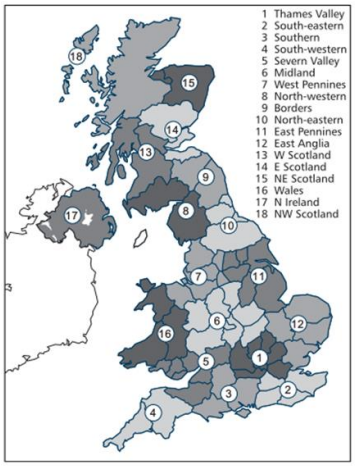
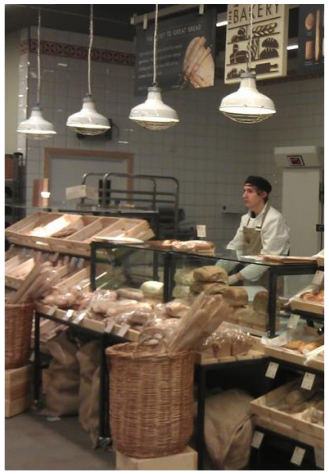


Weather adjustment

Extended occupancy

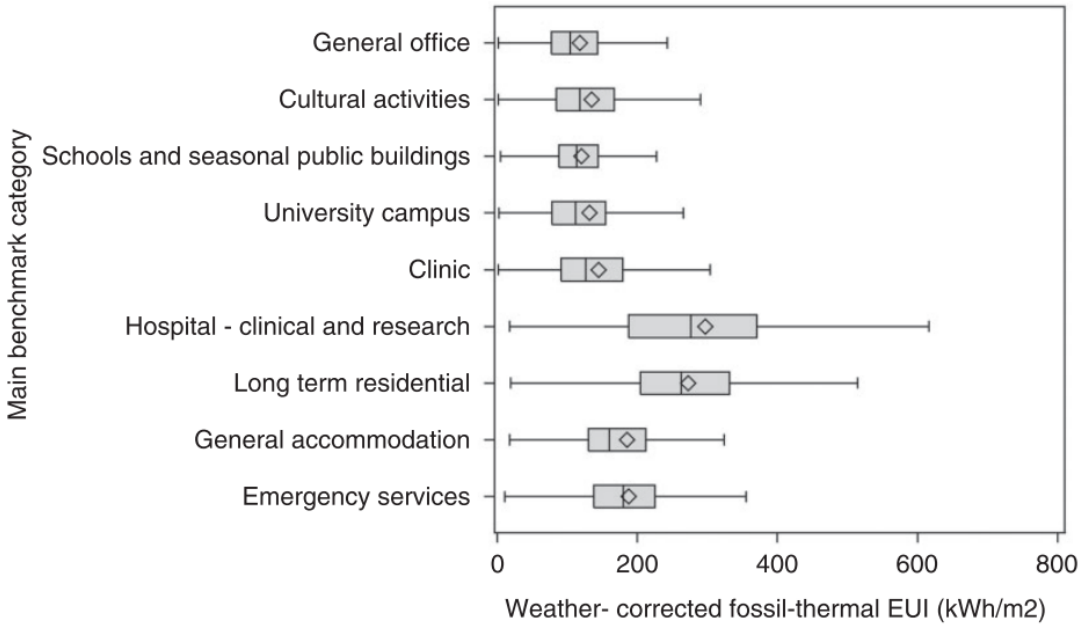


Separable energy uses

Benchmarking context / background

A need for providing better benchmarks

- Most existing energy benchmarks based PROBE study from 1990s
- Existing energy benchmarks often out-of-date
- Absolute figures without much contextualisation
- Limitations in data on commercial buildings

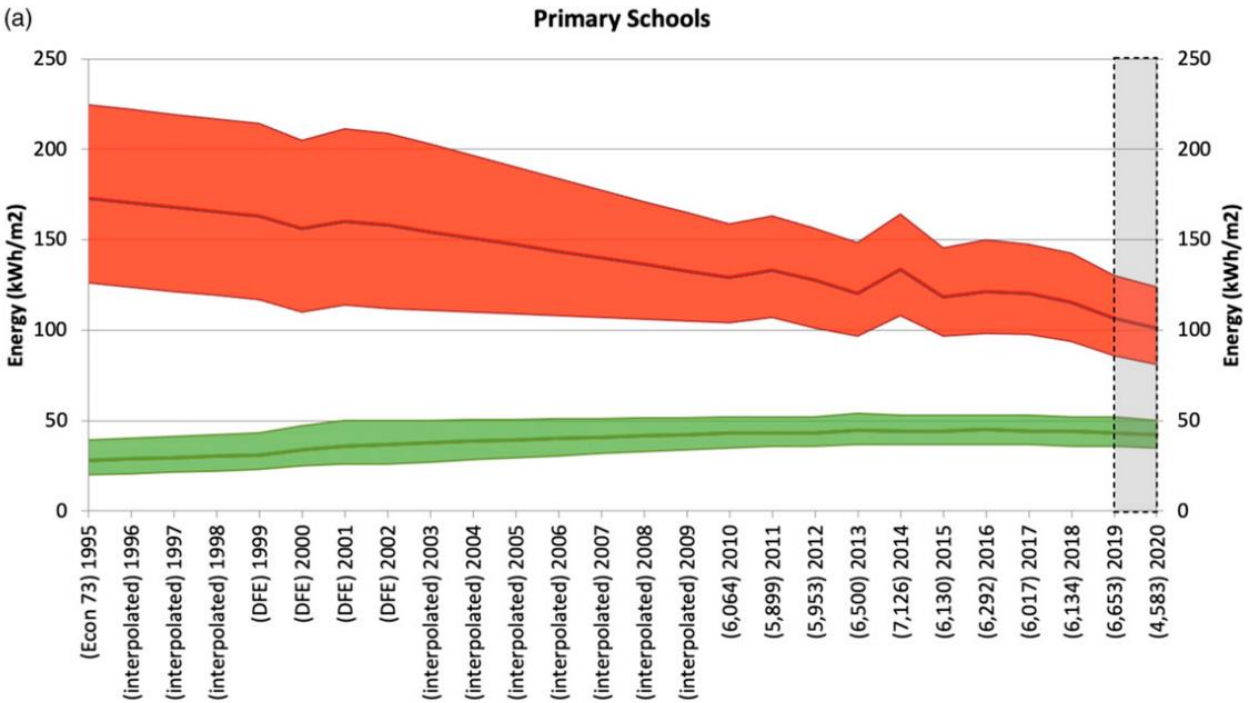


Benchmarking context / background

Opportunities and challenges

Review and Establish Existing and New Energy Benchmarks

- Continued changes in energy use
- Existing and new energy benchmarks



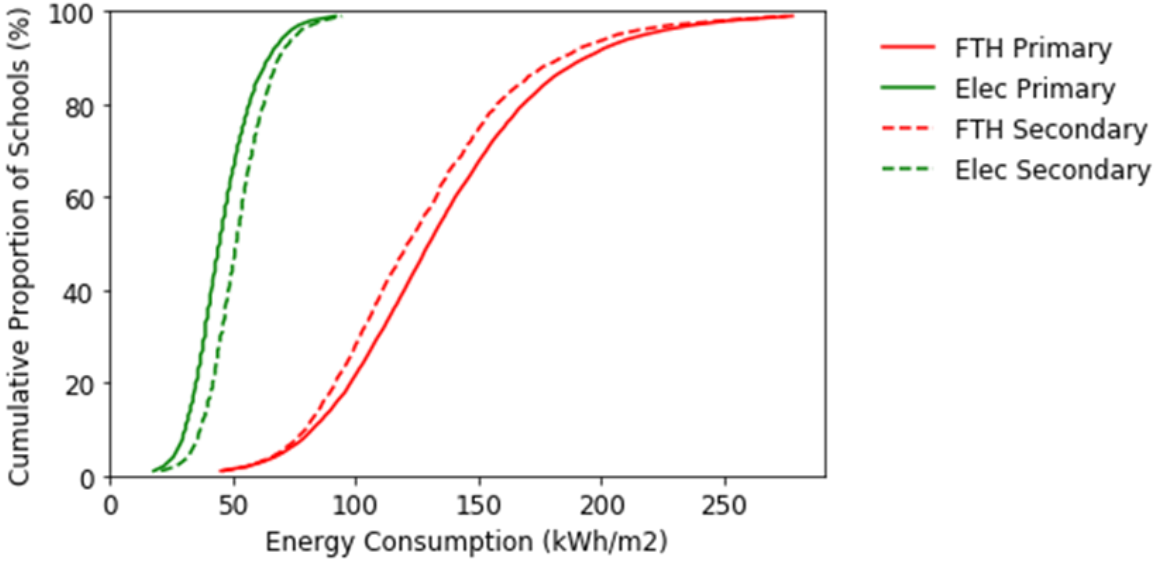
Hong et al. 2021

Benchmarking context / background

Opportunities and challenges

Review and Establish Energy Benchmarks

- Continued changes in energy use
- Existing and new energy benchmarks
- Classifications of activities
- **Dynamic approach to benchmarking**



Benchmarking context / background

Opportunities and challenges

Improve the Relevance of Benchmarking

- Rich data available (e.g. Display Energy Certificate)
- Potential for contextualised benchmarks (e.g. Air-conditioned buildings)

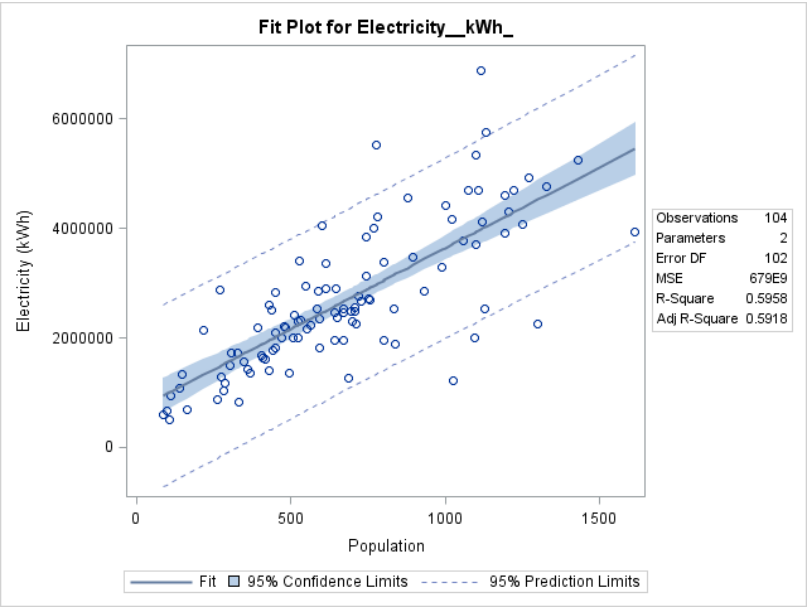
Activity type + Weather + Occupancy **+ ?**

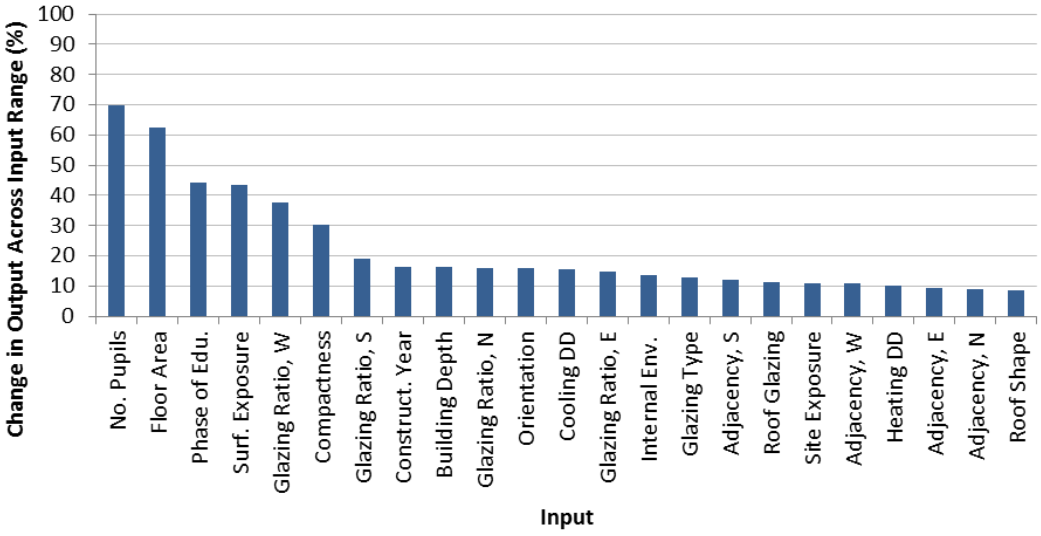
Benchmarking context / background

Opportunities and challenges

Improve the Relevance of Benchmarking

- Rich data available (e.g. Display Energy Certificate)
- Potential for contextualised benchmarks (e.g. Air-conditioned buildings)
- **Explore and adopt advanced methods to utilise large datasets**



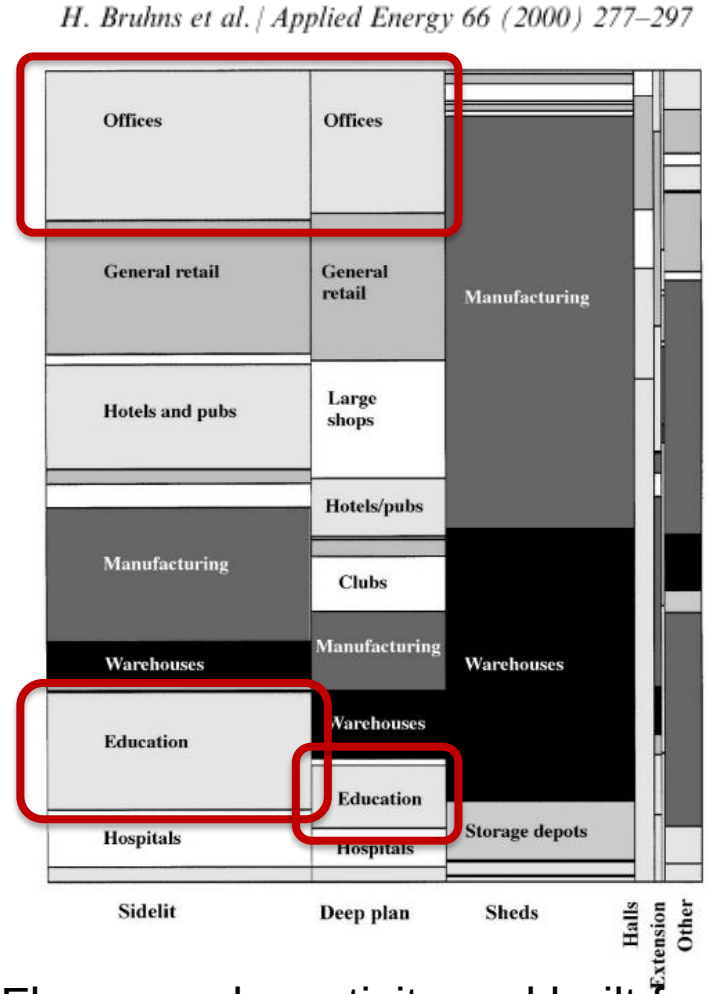


Benchmarking context / background

Opportunities and challenges

Challenges

- Efforts concentrated on a small number of activity types
- Access to the private sector
- **Explore innovative methods for gathering data**

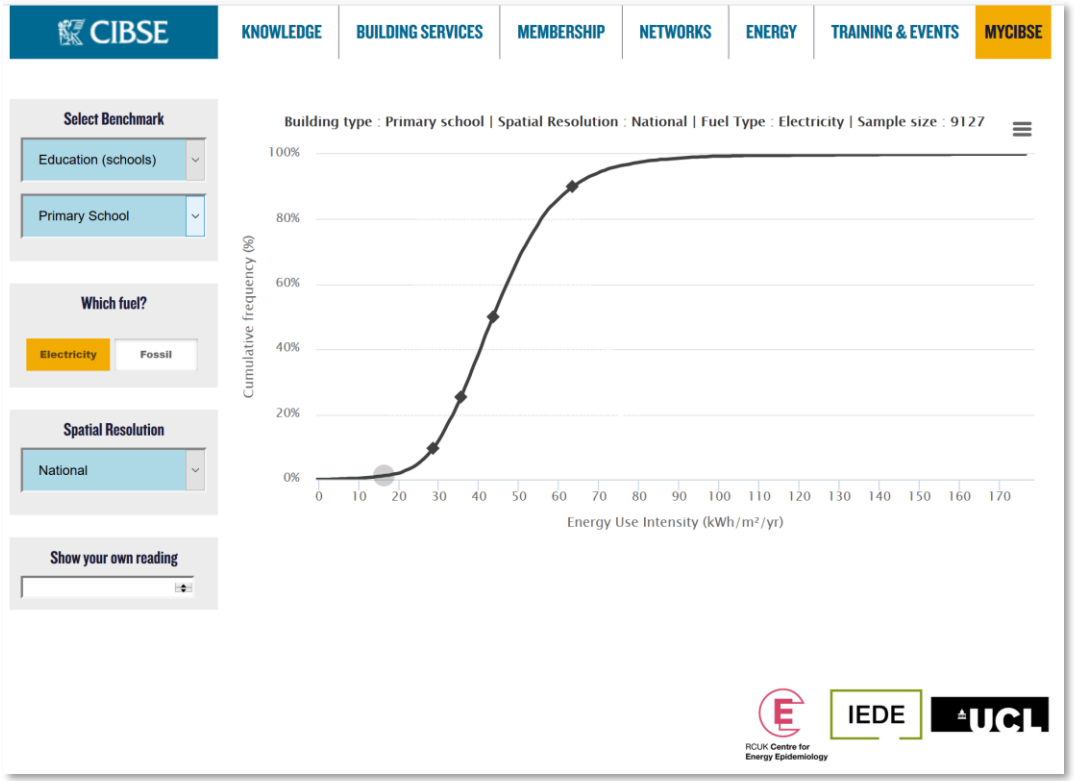


Floor area by activity and built form

Moving benchmarking forward

The CIBSE Benchmarking Tool

- Digitisation of benchmarks
- Easy access to a broader range of stakeholders
- Platform for exploring advanced and innovative techniques
- Relevant and reliable energy benchmarks
- A venue for providing insights based on data from across public and private sectors

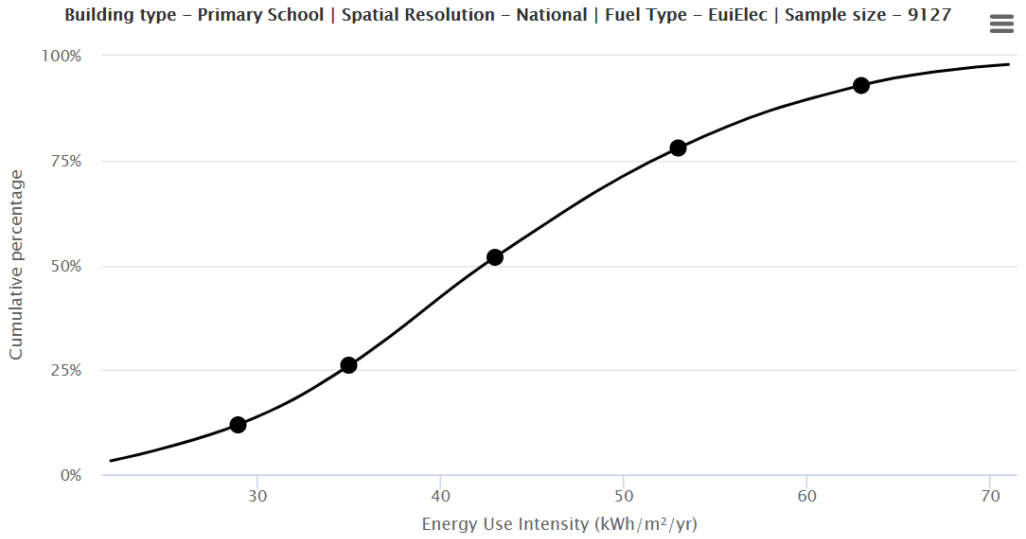


https://www.cibse.org/knowledge/energy-benchmarking-tool-beta-version

Moving benchmarking forward

Using data to improve building operation

- Access to the latest patterns of energy use
- Use distribution curve for wider application of empirical data
- Setting targets made easier
- Get contextualised energy benchmarks without expert knowledge



Building Type	Good practice electricity	Typical practice electricity	Source
Primary School	35	43	DEC

Moving benchmarking forward

Using data to improve building operation

An on-going and multi-phased project

Phase 1

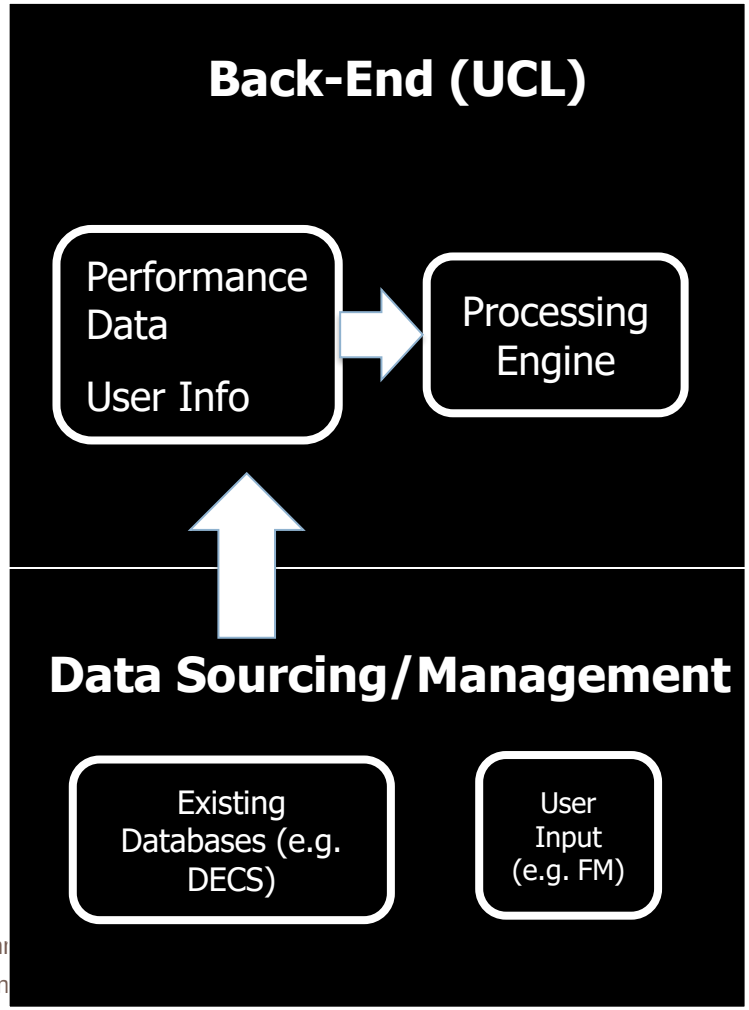
- 1.1 Establishing the framework
- 1.2 Processing engine & database
- Developing the tool

Phase 2

- 2.1 User engagement
- 2.2 Data crowd-sourcing / Gamification

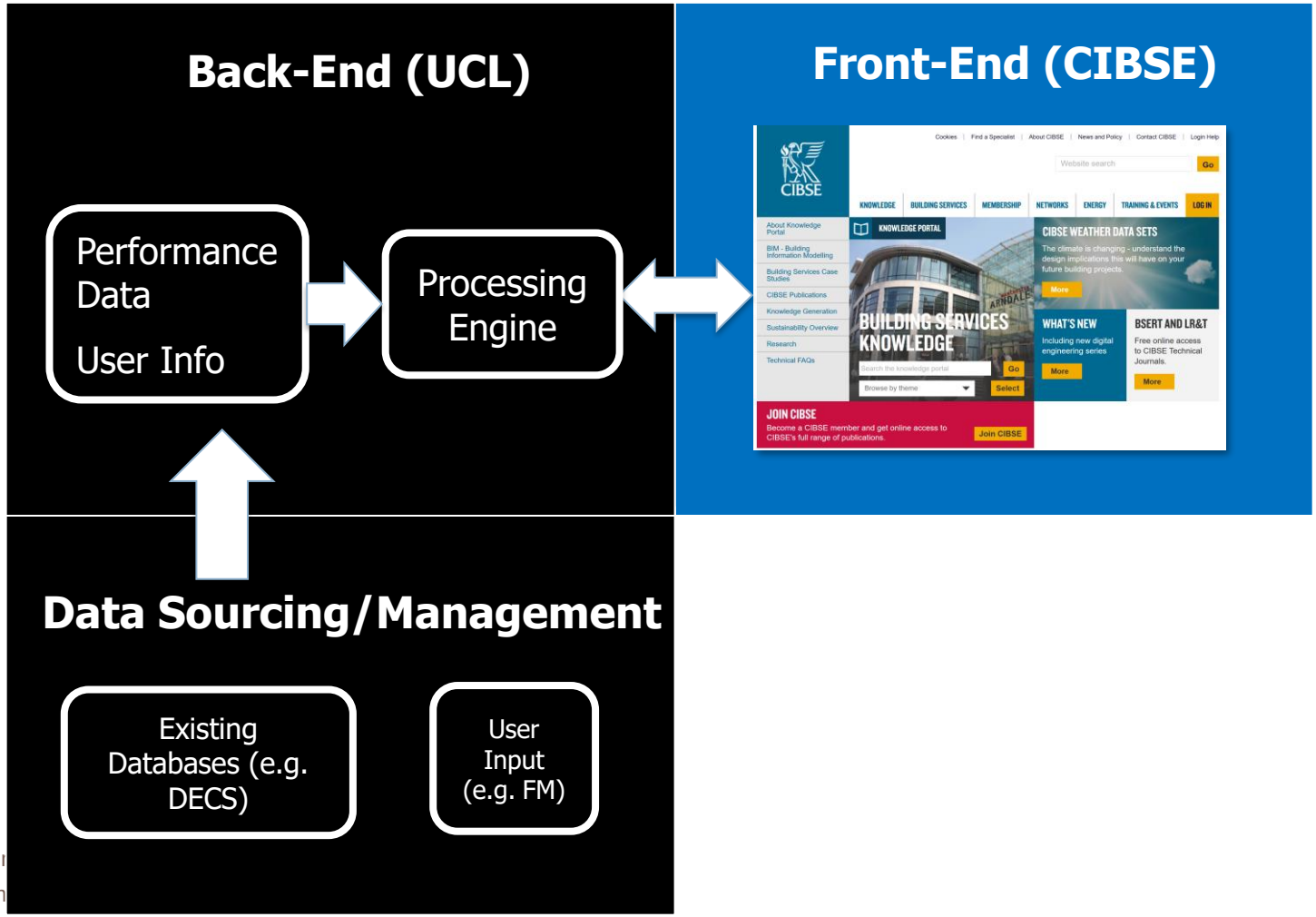
Moving benchmarking forward

Establishing the framework – Phase 1



Moving benchmarking forward

Establishing the framework



Moving benchmarking forward

Improving relevance of comparisons

Built form

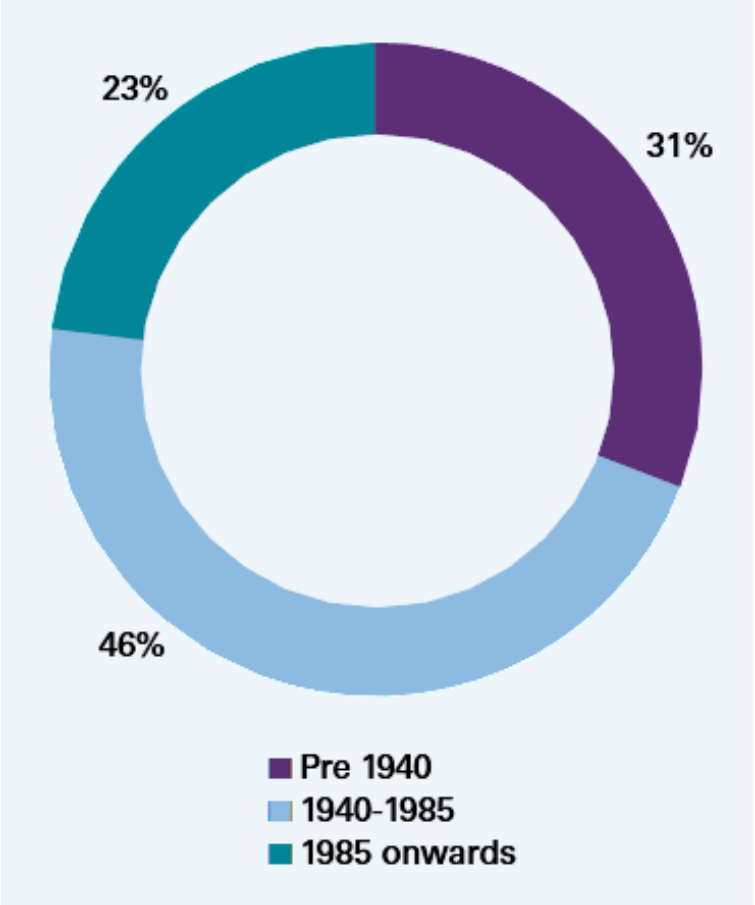
- Compact, exposed, tall, deep etc.

Age

- Newly built buildings only account for small proportion of the stock

Building services

- Boiler efficiency, lighting density etc.

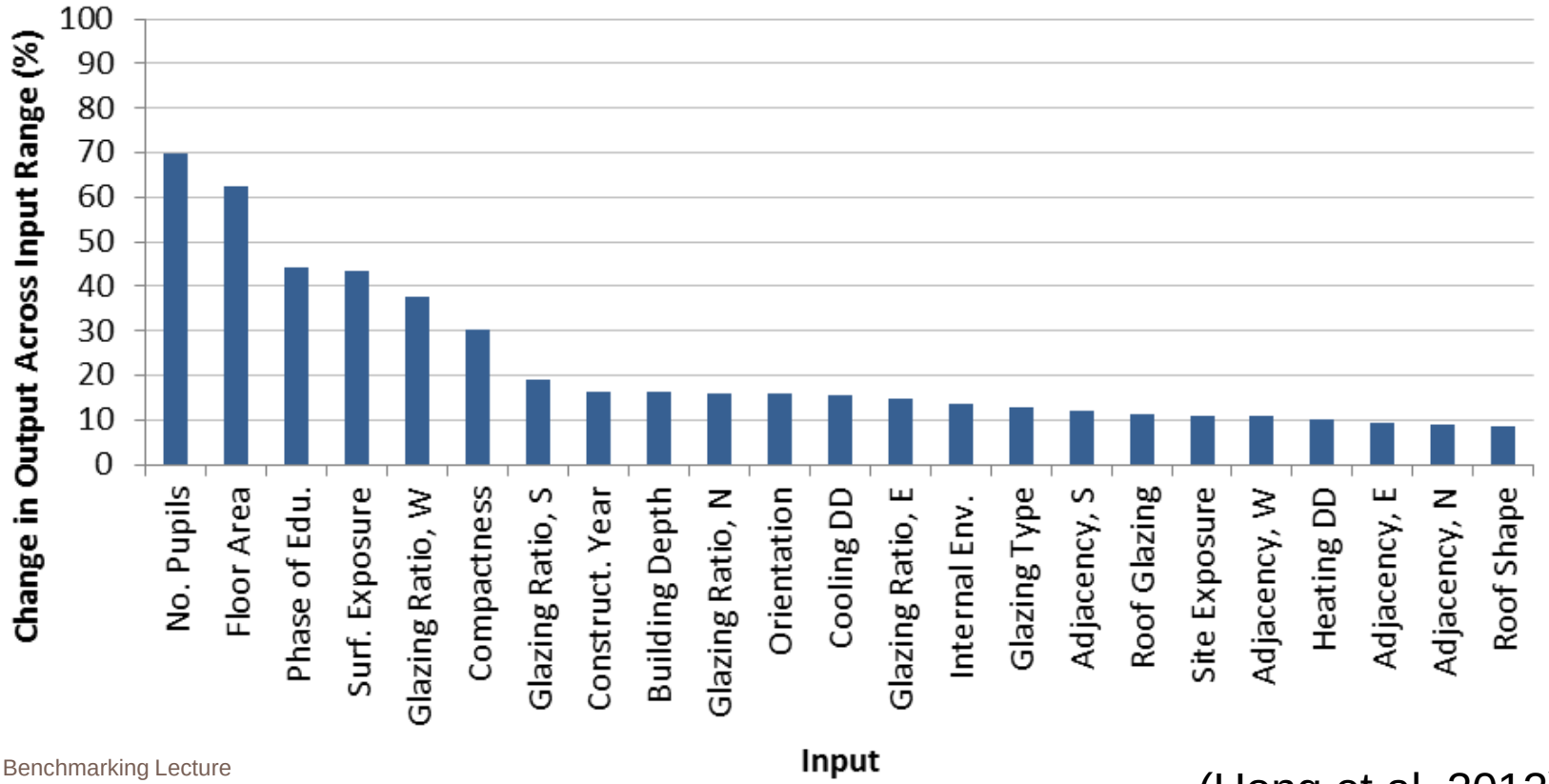


(Carbon Trust 2009)

Moving benchmarking forward

Improving relevance of comparisons

Machine Learning + Dynamic Simulation Modelling



(Hong et al. 2012)

Moving benchmarking forward

Improving relevance of comparisons

Better classification

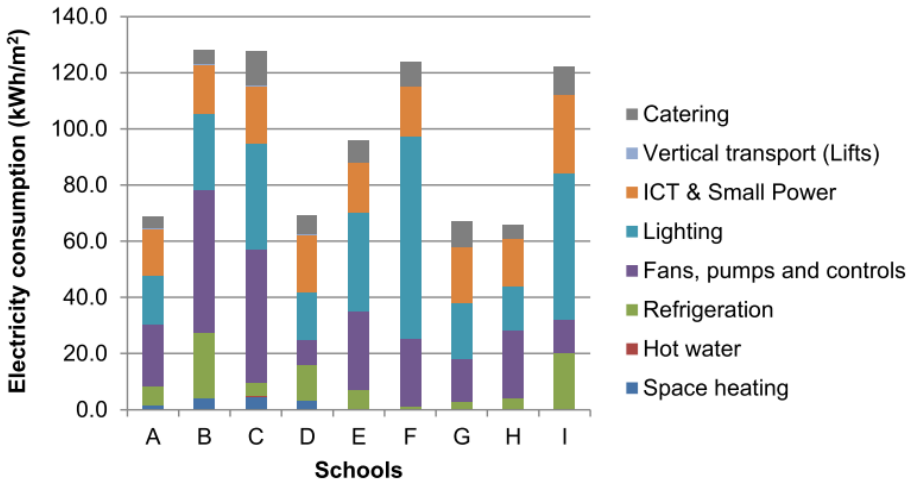
+

Improved contextualisation

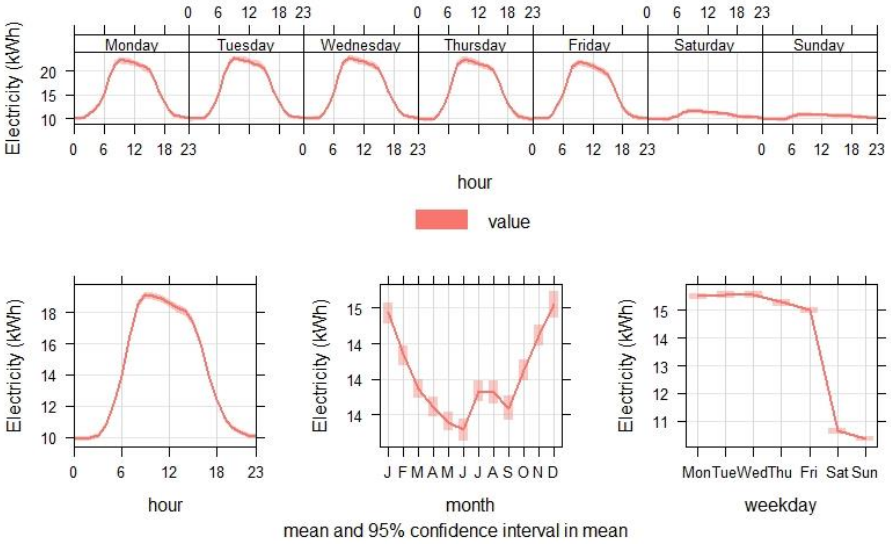
Moving benchmarking forward

Improving relevance of comparisons

End-use benchmarks



Sub-hourly benchmarks



Moving benchmarking forward

Improving reliability of comparisons

- Publish benchmarks based on research by UCL
- Raw data aggregated and analysed and kept securely
- Examples:
  - Department for Education
  - Ministry of Justice
  - Scottish Futures Trust / NHS / SEON

Research Paper

BUILDING SERVICES ENGINEERING RESEARCH & TECHNOLOGY

Characterising the English school stock using a unified national on-site survey and energy database

Sung Min Hong, Daniel Godoy-Sh
Yair Schwartz, Ivan Korolija, Ann
and Dejan Mumovic

Abstract

The recent commitment towards a net-zero targ
UK's building stock. Accounting for over 10% of th
education sector will play an important role. This s
and secondary schools, using national on-site surv
Property Data Survey Programme (PDSP) data on
Energy Certificate (DEC) and school census data
a unified schools dataset. Statistical analyses wer
performance, and the relationship to several build
the possibility of assessing operational energy use
with detailed and accurate disaggregate informatio
study, provide opportunities to develop more rob
an opportunity to identify pathways for reducing
organisations seeking to achieve significant reduc
Practical Application: Outputs from this stud
sations to establish a basis for typical buildings
operational energy efficiency of school buildings,
improving energy efficiency of the school stock.

Keywords

School stock, building characteristics, energy use,

Received 17 March 2021; Revised 3 June 2021; Accepted 14

Introduction

In recent years, globally, there has been a mark
shift in policies towards decarbonisation.[1] In t
United Kingdom, the government recently comm
ted to achieving net-zero carbon status by 205

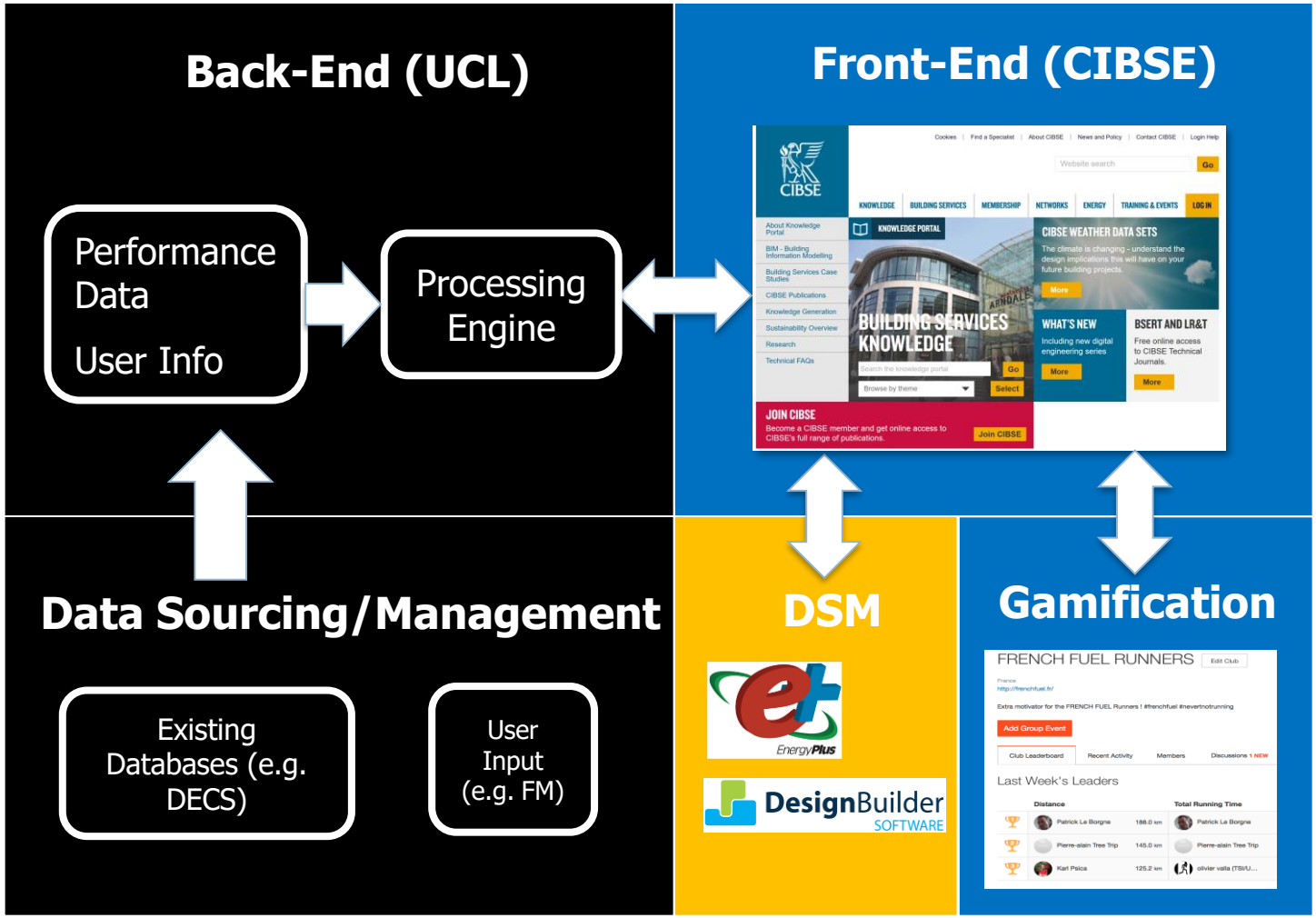
(a) Primary Schools

(b) Secondary Schools

Energy (kWh/m2)

Moving benchmarking forward

Establishing the framework – Phase 2



Moving benchmarking forward

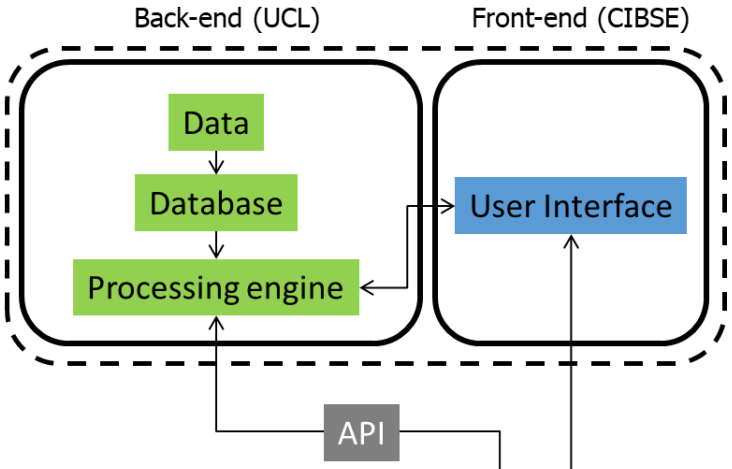
Interacting with users

- User-based data for reaching commercial buildings
- Increase sample sizes and coverage
- Up-to-date information

Phase 1 – Digitalisation of Benchmarking

Aim
- To digitise benchmarking by establishing a new framework

Objectives
- Develop a database and a processing engine
- Develop a user interface
- Test the concept and functions of the tool



Phase 2 – User Interaction

a. Designers/Engineers/FM

Aim
- To explore and implement intelligent data gathering processes for providing reliable and relevant energy benchmarks in the long-term

Objectives
- Develop a database to store user data
- Extend capability of processing engine to incorporate and deal with new data
- Develop front-end capability

b. Design Practices

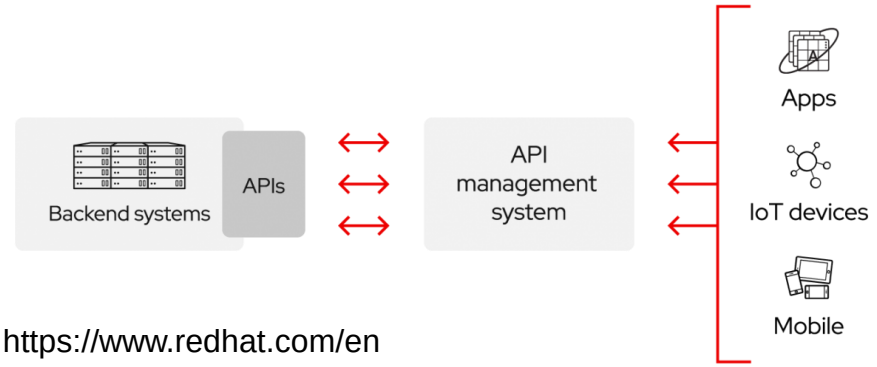
Aim
- To enable industry experts access the tool/database for design purposes

Objectives
- Develop an API
- Liaise with DesignBuilder to test the concept

Moving benchmarking forward

Interacting with users

- Create a link between the empirical data and digital engineering process
- Set / inform design targets
- Calibrate models based on actual energy use data



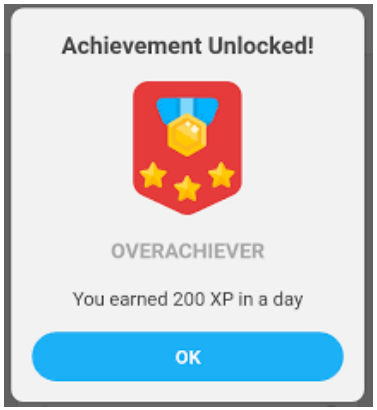
https://www.redhat.com/en

Moving benchmarking forward

Interacting with users

Gamification for Data Sharing Research

- Improve understanding on opportunities and barriers
- Explore gamification concept
- Enhance data sharing across commercial sector through a reward scheme
- Recognise individuals



CIBSE BUILDING PERFORMANCE AWARDS 2022

CIBSE Benchmarking Tool

Latest updates – replacing/updating CIBSE *Guide F*

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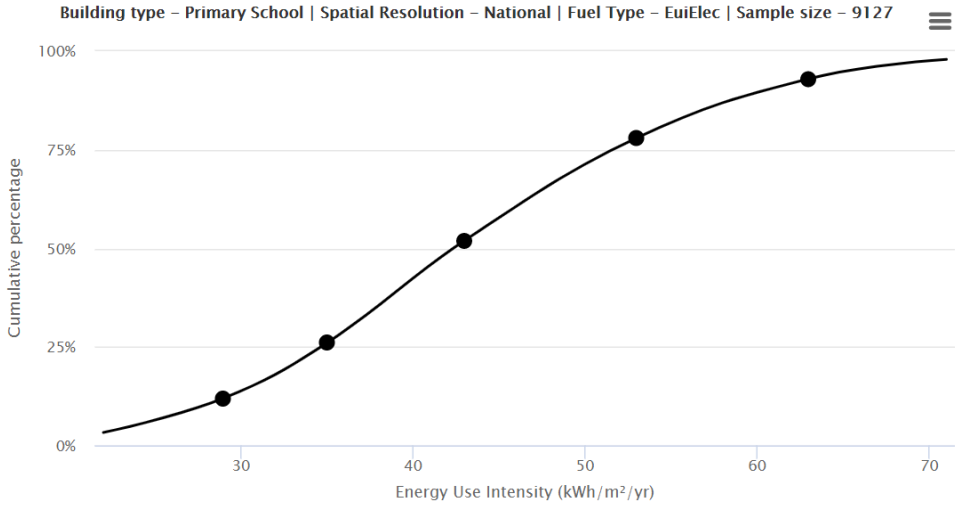
Hotels[6]:		
— holiday	260	80
— luxury	300	90
— small	240	80
Industrial buildings[7][e][f]:		
— post-1995; ≤5000 m^2	96	—
— post-1995; >5000 m^2	92	—
— pre-1995; ≤5000 m^2	107	—
— pre-1995; >5000 m^2	103	—



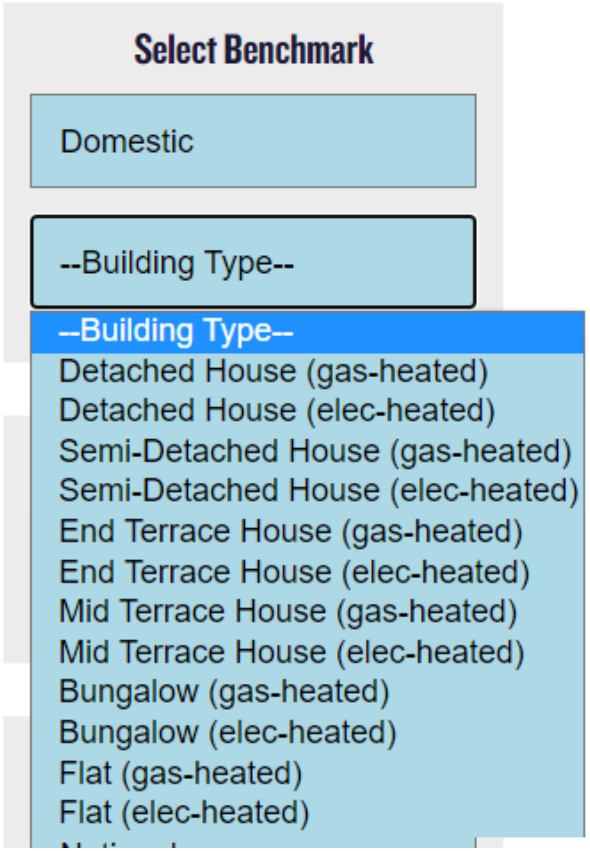
CIBSE Benchmarking Tool

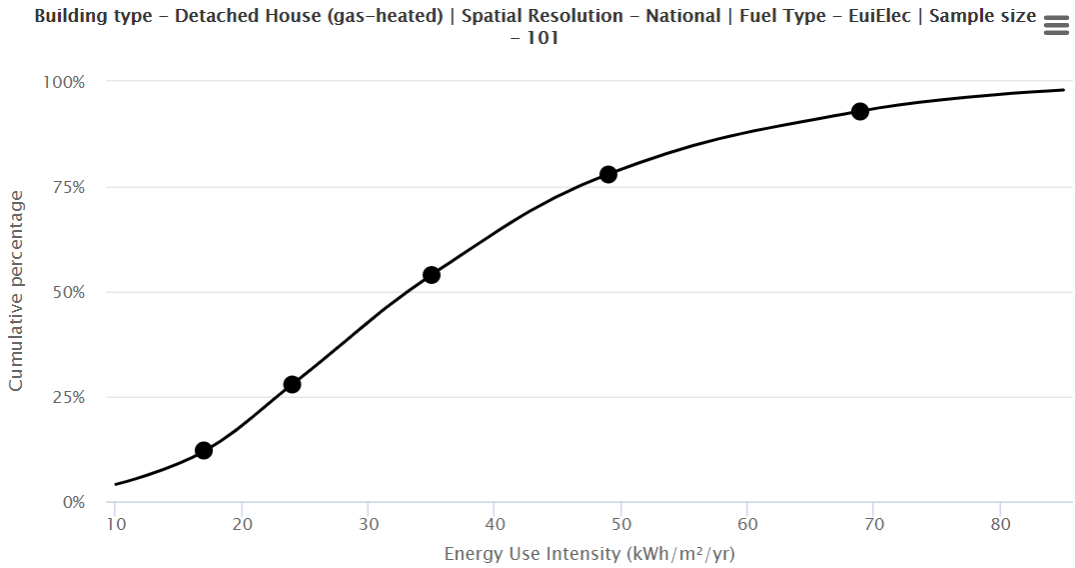
Latest updates – replacing/updating CIBSE *Guide F*

- **Education (higher)**
- **Education (schools)**
- **Entertainment** / Theatres
- **Hospitals** / General Acute Hospital, Teaching/Specialist Hospital
- **Local Authority Buildings** / Community centre, Residential care homes
- **Offices** / Central government offices, Local government office
- **Primary Health Care Buildings** / Health Centres and Clinics …
- **Public Buildings** / Prisons, Library, Museum …
- **Sports and Recreation** / Swimming pool

CIBSE Benchmarking Tool

Latest updates – domestic benchmarks





Building Type	Good practice electricity	Typical practice electricity	Source
Detached House (gas-heated)	24	35	BEIS

CIBSE Benchmarking Tool

Get in touch with us

Please get in touch with me if:

- you have access to large datasets on energy performance of buildings or know someone who might be interested in sharing their data **anonymously**
- you are a part of an organisation (e.g. NHS, local authority) which might be interested in a bit of research in exchange for data
- You are interested in participating in a research project on gamification

Thank you

s.hong@ucl.ac.uk