SCU Mix legend

1. Pure Non-domestic; single occupier
2. Multi Non-domestic; same activity
3. Non-domestic; multiple activities
4. Non-domestic & domestic: Non-domestic dominant
5 & 6. Domestic & non-domestic: neither dominant
7. Domestic & non-domestic: Domestic dominant
8. Pure domestic: >= 10 households
9. Pure domestic: >1 and < 10 households
10. Pure domestic: single household
Not classified

# Modelling Building Stocks and Their Energy Use

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Agenda

- Construction of the Urban Energy Model
- Can we model 'buildings?'
- Allocating floor space, use type and energy meters
- Analysing floor space and use type
- Mapping building attributes
- Simulating performance, calibration and verification
- Conclusions

London Building Stock Model (LBSM)

+
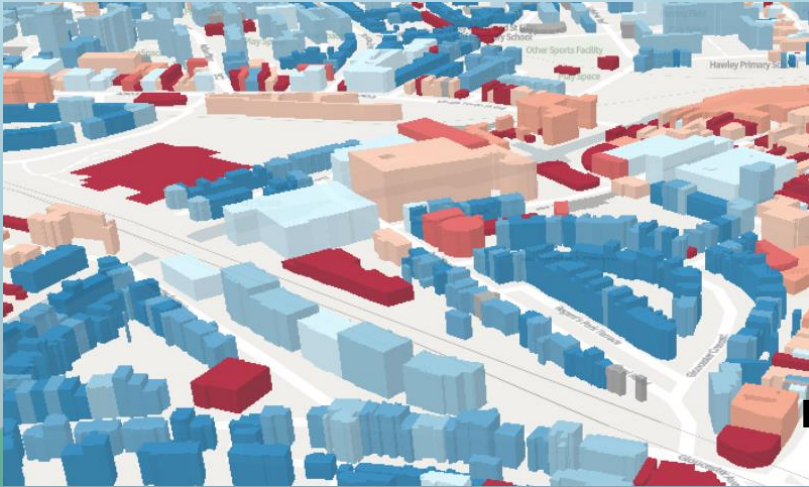
3DStock

Automatic generation of detailed built form from publicly available national datasets.

10+ years of development

SimStock

Automatic generation of detailed simulation models to predict energy and environmental performance.

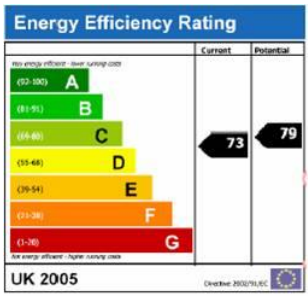Built on Energy Plus

3DStock architecture

3D model of building stock

SCU Mix class

1. Pure Non-domestic; single occupier
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Not classified

Source: Name of source

What is a building use type?

HOMES

OFFICES

SHOPS

???????

What happens when buildings meld?

Example:
A shop extends across the ground floor of two adjacent buildings.
Operated as one premises.
Probably supplied by one set of energy meters for electricity and gas (but these could also serve upper floors).

If the shop is split between buildings how can the energy use data be reconciled?

Solution: Self-Contained Unit (SCU)

SCU

SCU:
An envelope that wraps around a collection of buildings without dividing any of the associated premises and contains all the energy meters that relate to contained premises.
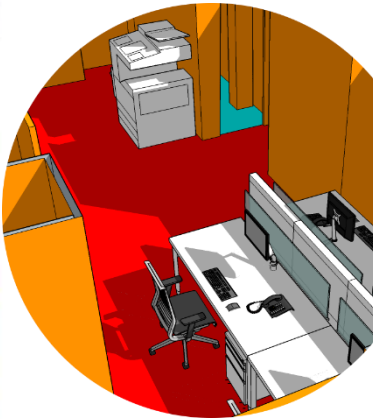
How do we know what is contained?

… for most premises types the Valuation Office Agency (VOA) **measure** and **classify** the rateable space

… which means we know the floorspace of each activity on each floor

	record_type	asst_ref	uarn	ba_code	baref	line	floor	description	area
	character varying(2)	bigint	bigint	character varying(4)	character varying(25)	smallint	character varying(50)	character varying(240)	numeric(8,2
109	02					6	Ground	**Kitchen**	3.4
110	02					7	Ground	**Office (incl Reception)**	52.7
111	02					8	Ground	**Internal Storage**	5.0
112	02					1	Ground	Retail Zone A	29.9

… and we can model average electricity consumption in each activity area, by end use

| description character varying(240)	area numeric(8,2)		
Kitchen	3.46	Lighting, DHW, catering etc.	1,556 kWh per annum
Office (incl Reception)	52.71	Lighting, computers, small power etc.	5,571 kWh per annum
Internal Storage	5.03	Lighting, computers, DHW etc.	209 kWh per annum
Retail Zone A	29.93		

Total: 7,336 kWh per annum

Domestic (residential) floor areas

… floor area not available from VOA, so LiDAR used to calculate:

	scu_id bigint	floor numeri	d_uprns_in_scuf bigint[]	toids_in_scuf character varying[]	f2f_heigh numeric(1	f2f_confide numeric(6	gea numeric	notes character varying(500)
1	52101124830014	2.0	{5097200}	{'osgb1000004051745'}	{296.70}	{10.1000}	60.00 (0.2.3)	Agreement between LiDAR and the stratified floor count.
2	52101124830014	1.0	{5097198,5097199}	{'osgb1000004051745'}	{296.70}	{10.1000}	84.00 (0.2.3)	Agreement between LiDAR and the stratified floor count.
3	52101124830014	0.0	{5097201}	{'osgb1000004051745'}	{296.70}	{10.1000}	92.00 (0.2.3)	Agreement between LiDAR and the stratified floor count.

Matching energy meters to premises
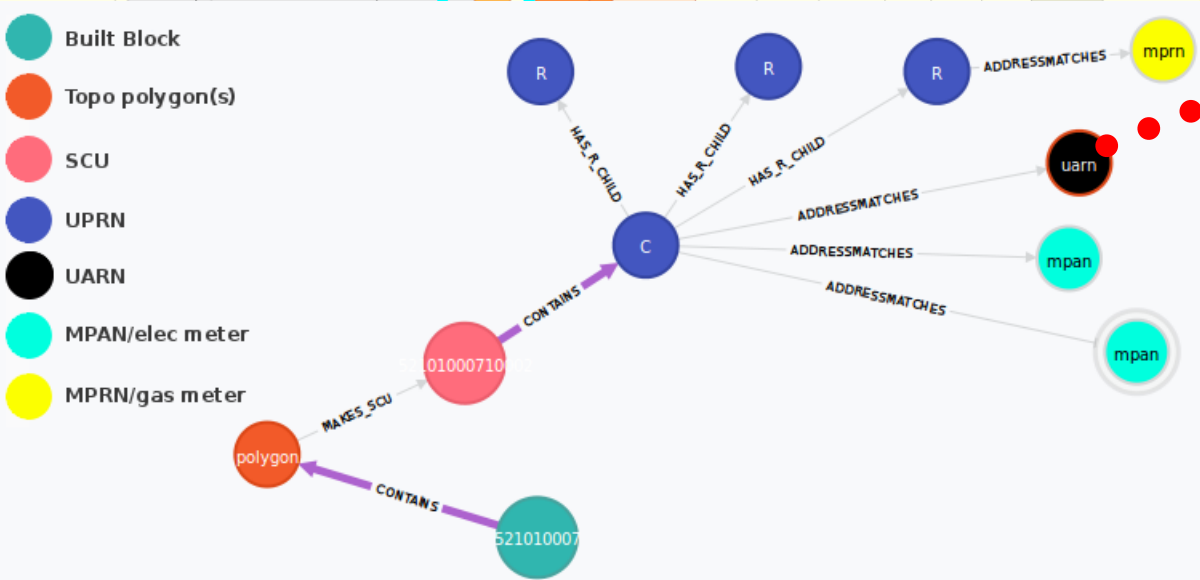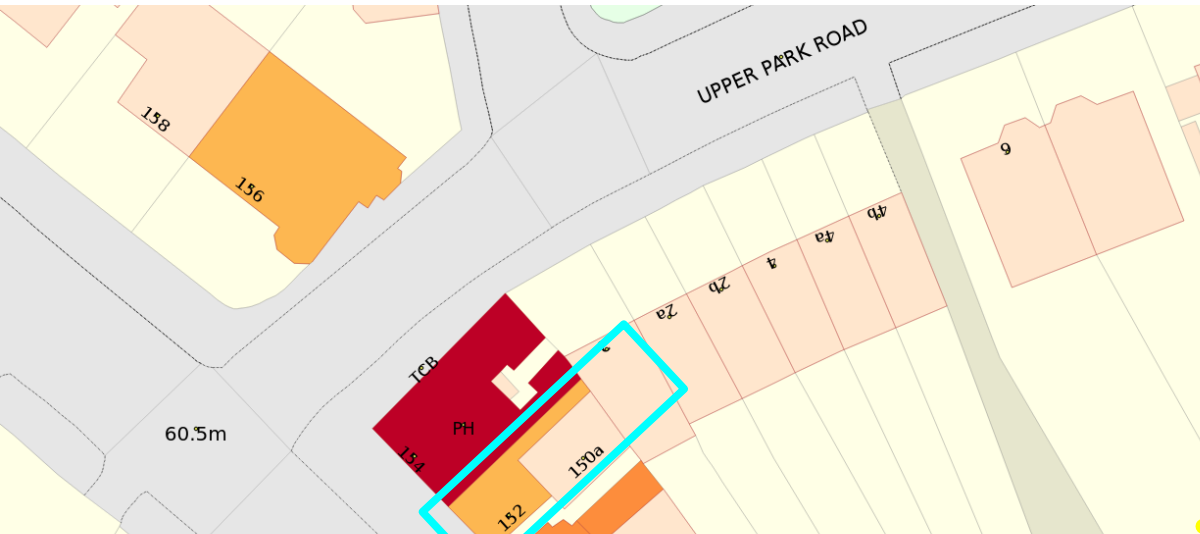
Relationships between meters, premises and buildings can be complicated with associations at various levels and often different between electricity and gas

Complexity often increases with size
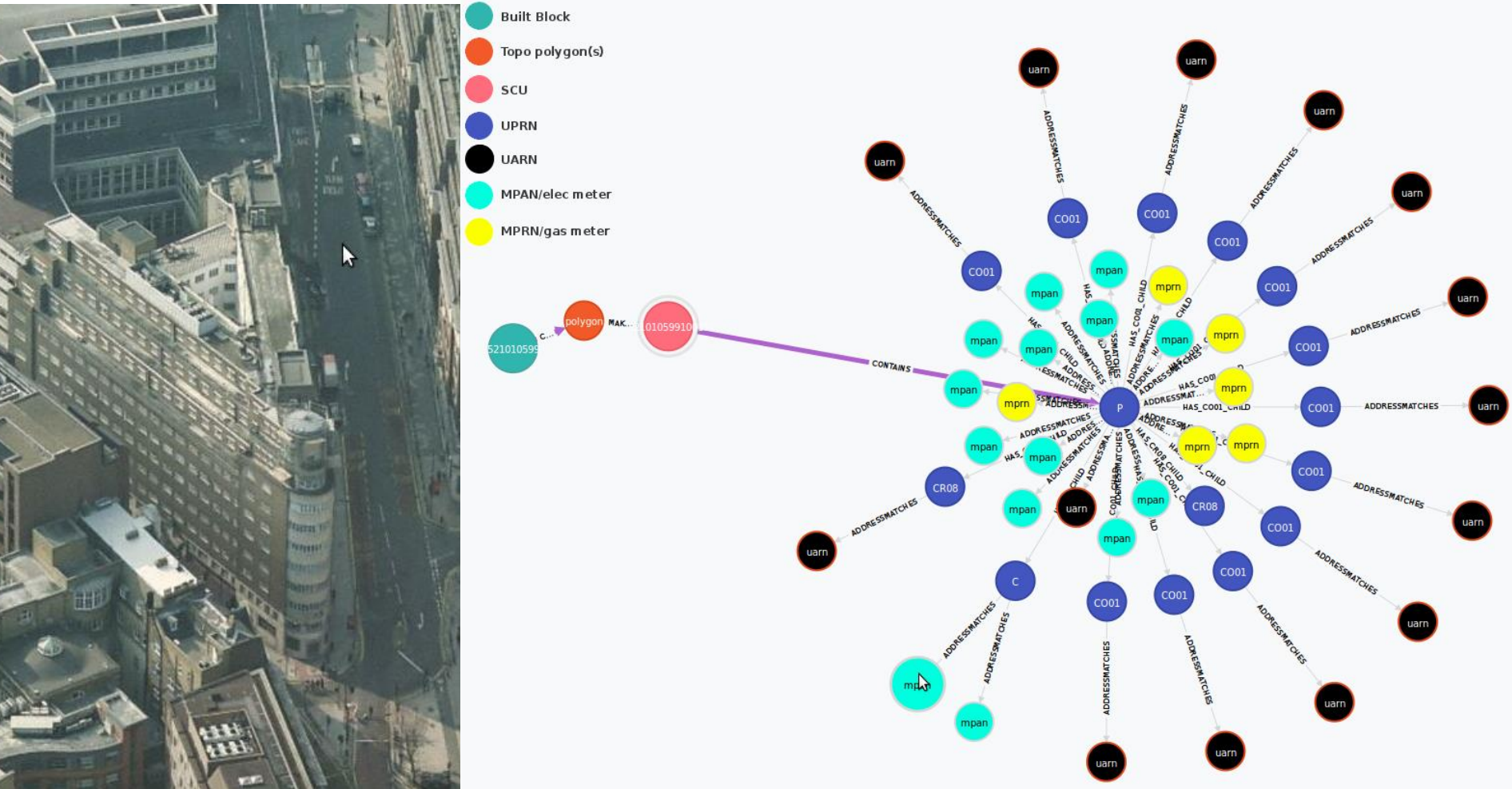
Not all buildings have addresses

Lower EUI

Higher EUI
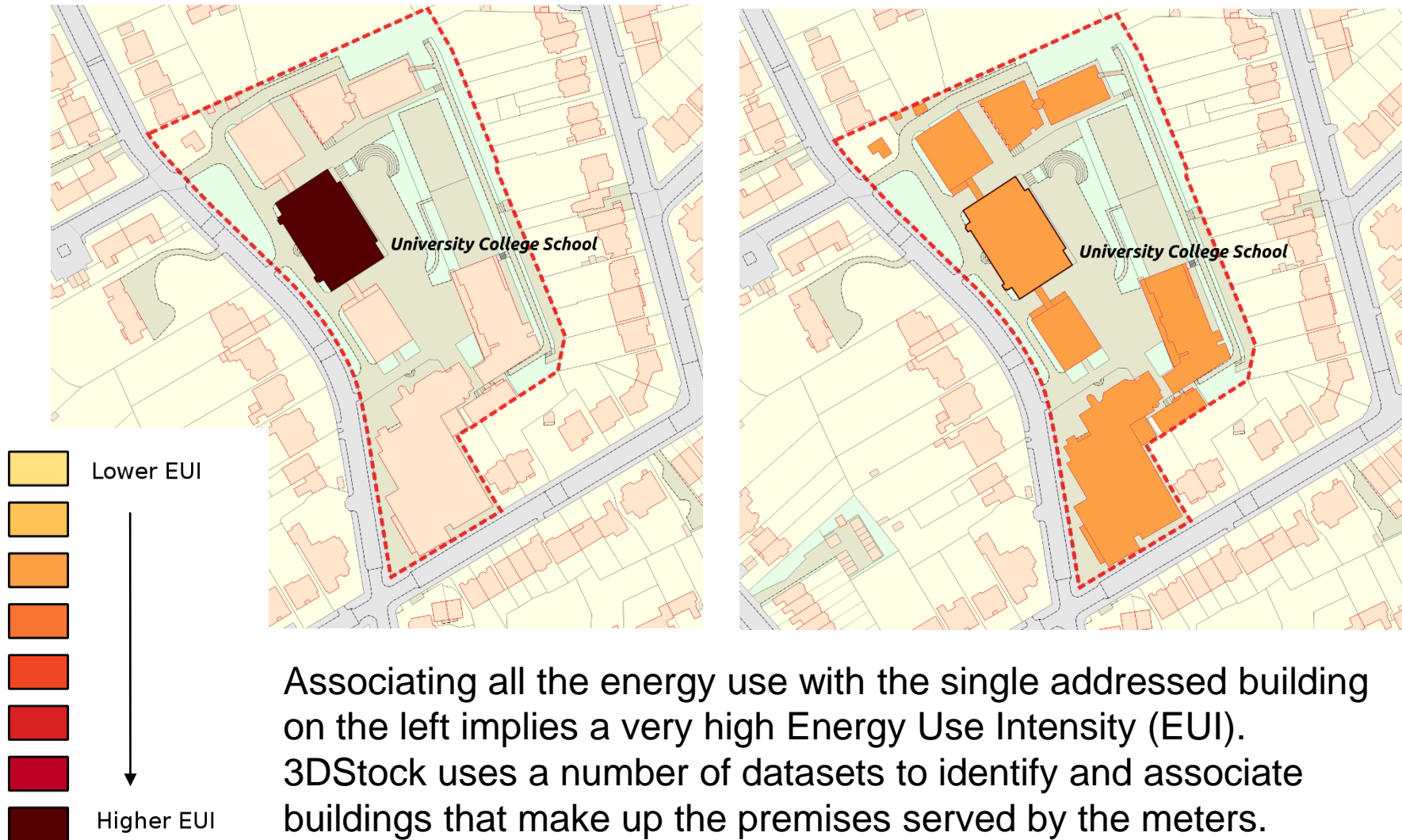
Associating all the energy use with the single addressed building on the left implies a very high Energy Use Intensity (EUI). 3DStock uses a number of datasets to identify and associate buildings that make up the premises served by the meters.

Central London **ground** floor level

Key

- Arts & Leisure
- Community
- Education
- Emergency
- Excluded
- Factory
- Health
- Hospitality
- Miscellaneous
- Office
- Shop
- Sport
- Transport
- Uncoded
- Warehouse
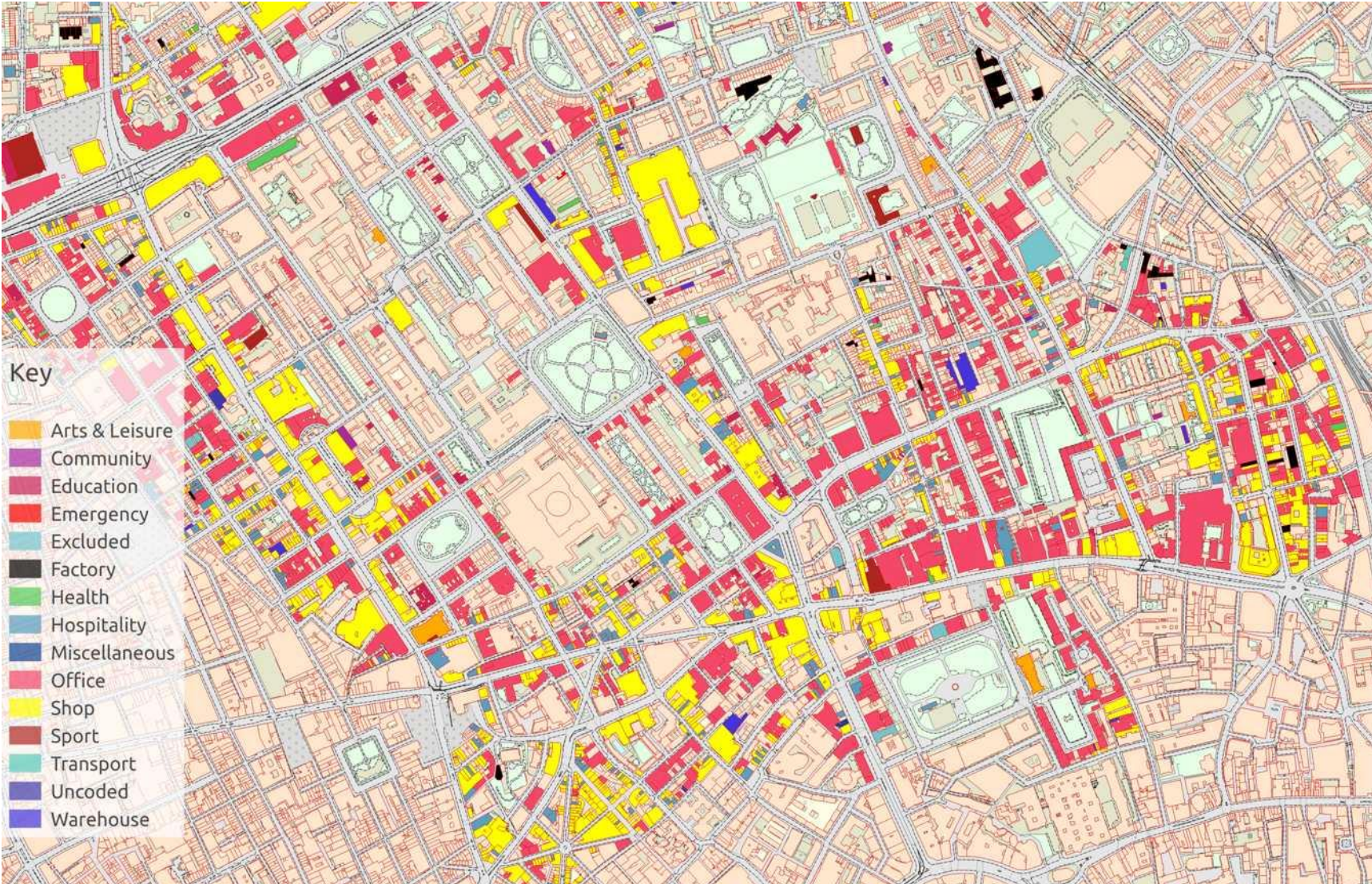
Central London **first** floor level

Key

- Arts & Leisure
- Community
- Education
- Emergency
- Excluded
- Factory
- Health
- Hospitality
- Miscellaneous
- Office
- Shop
- Sport
- Transport
- Uncoded
- Warehouse
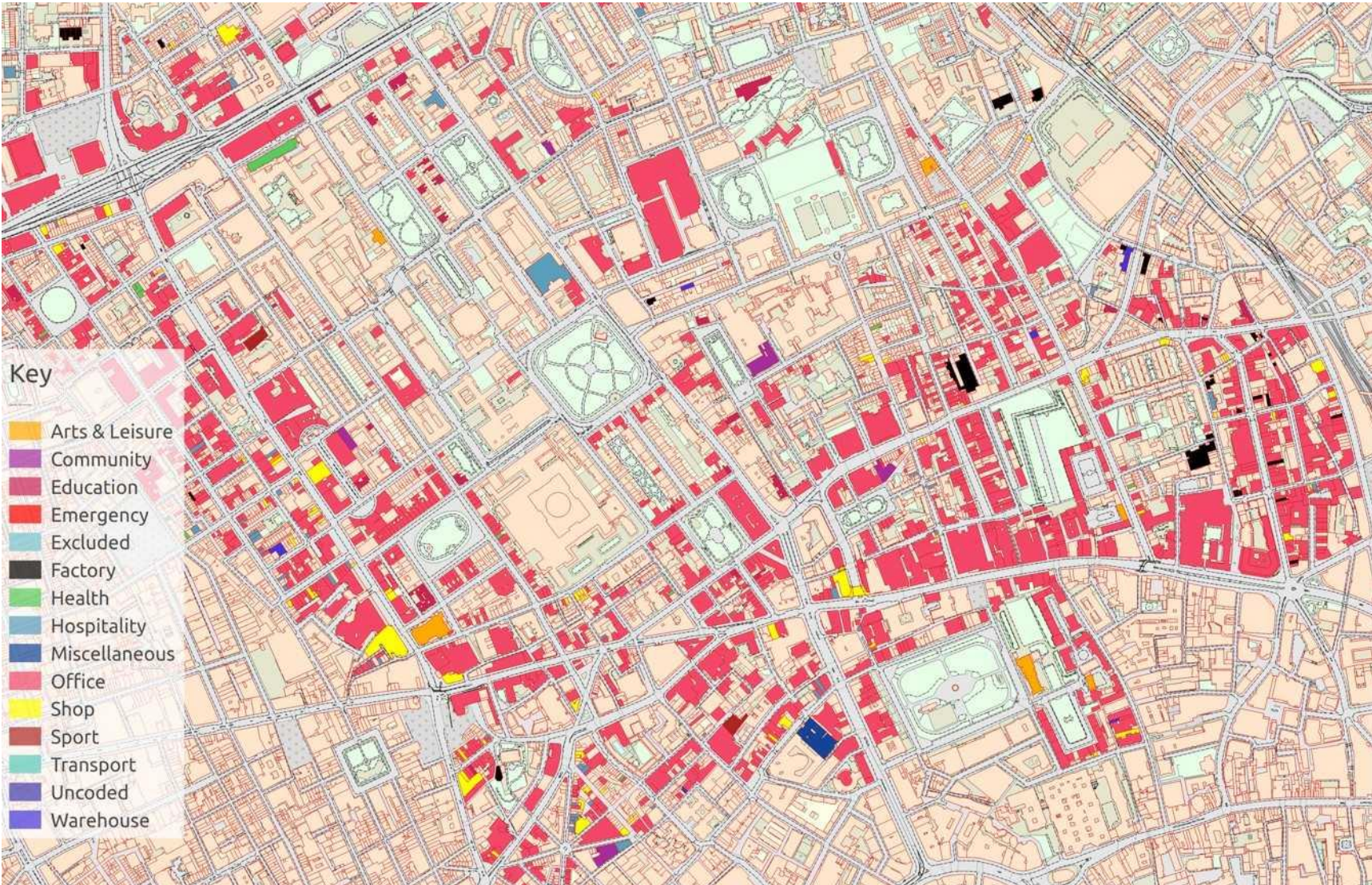
3D data allows detailed analysis of floor space
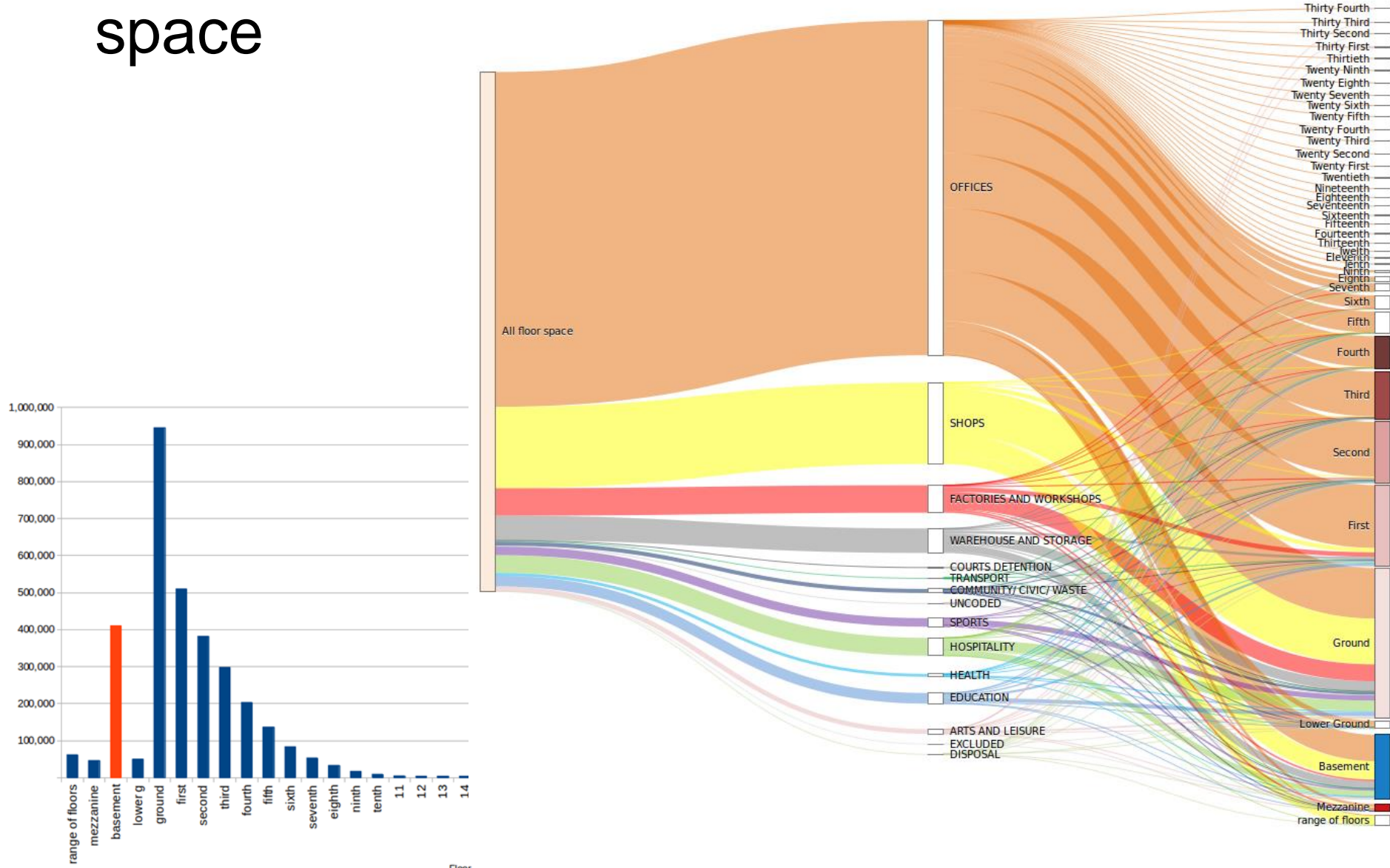
LBSM current status
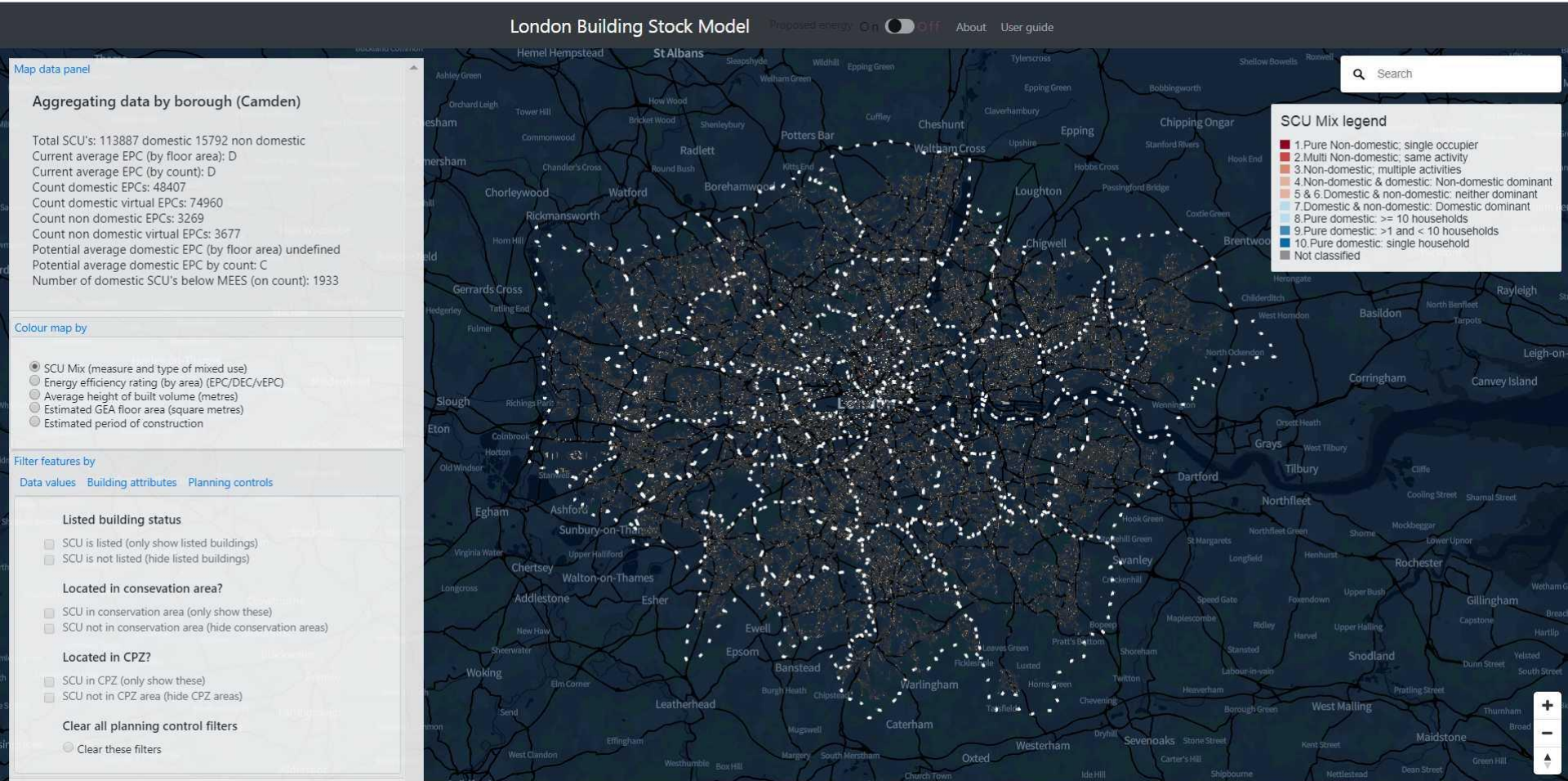
Borough of Camden showing SCU mix
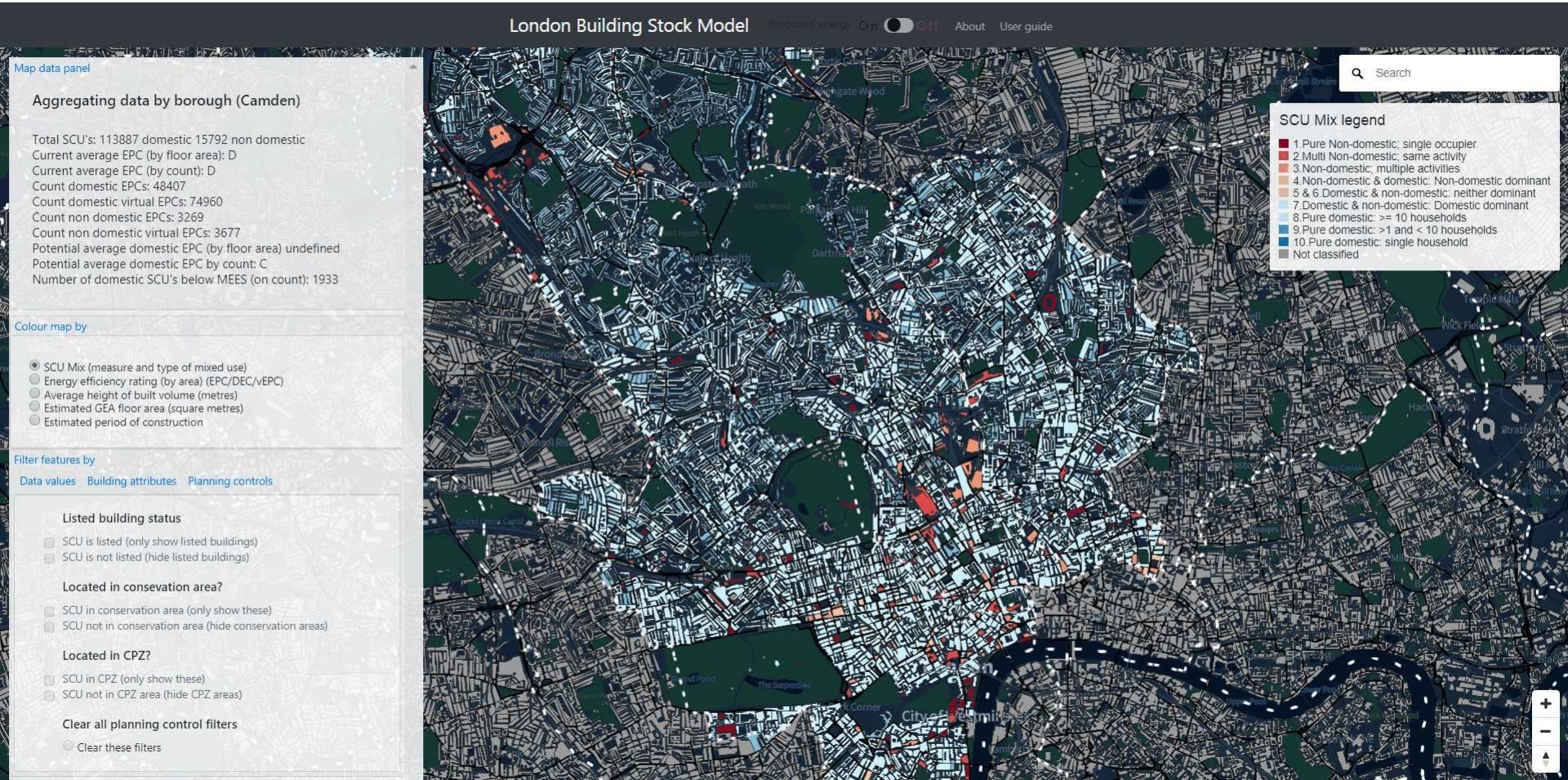
Domestic/non-domestic building mix
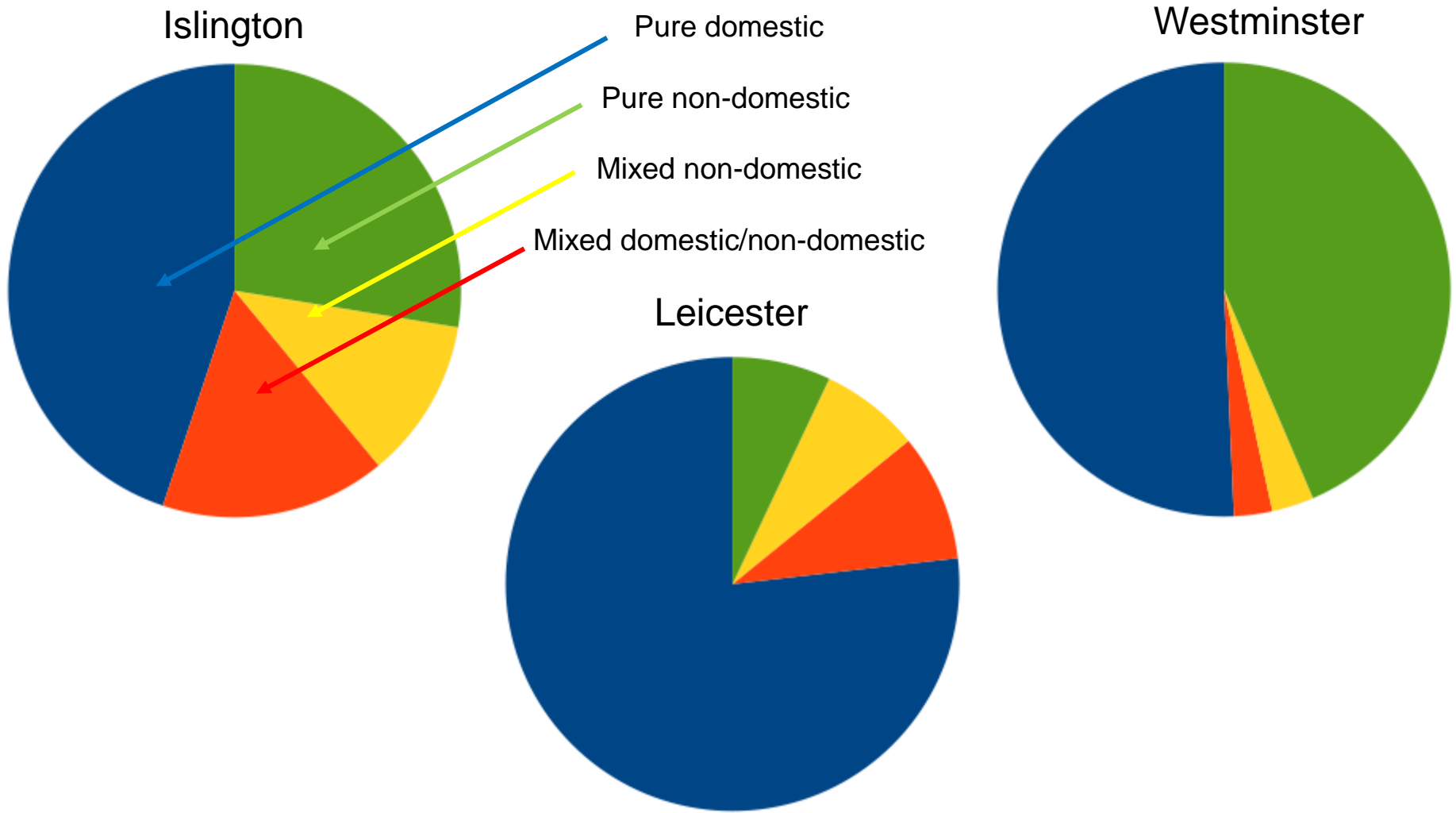
Use type mix at Lower Super Output Area (LSOA)

Energy Performance Certificates (EPCs) at LSOA
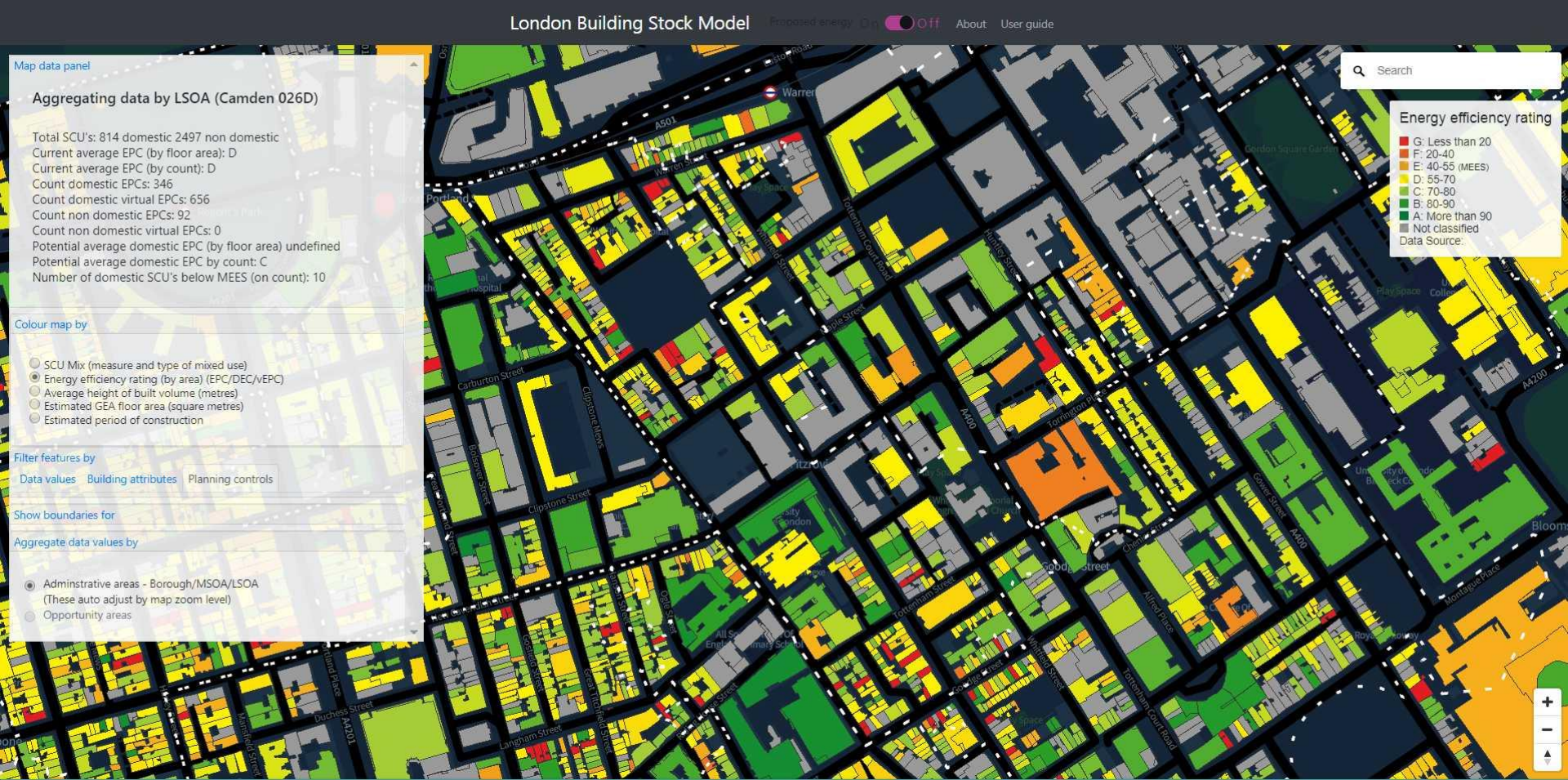
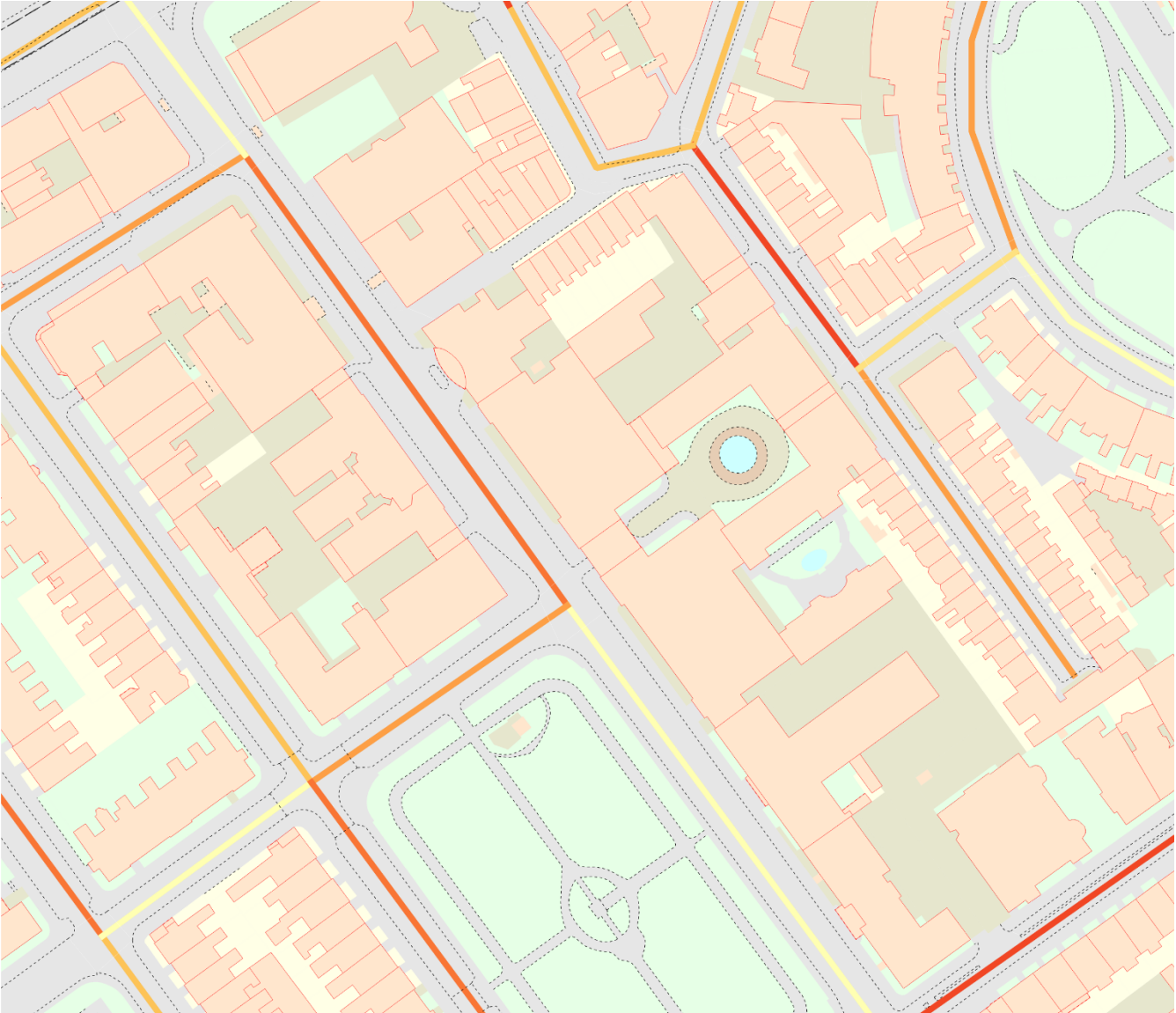# Period of construction at LSOA
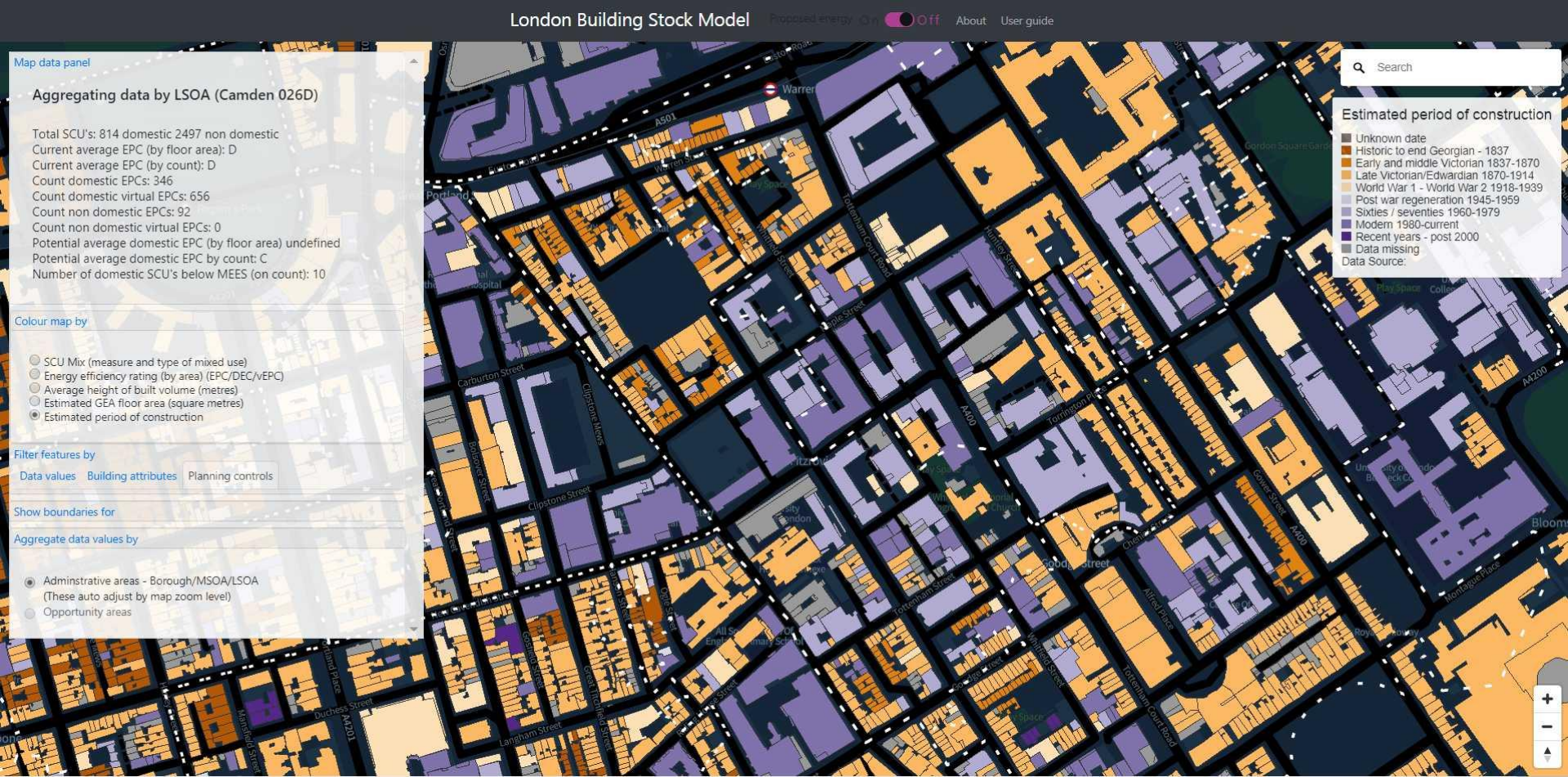
Detail available for each SCU

Application: district energy potential routes

Camden

MWh / m of segment length (pa)

- 0 - 1
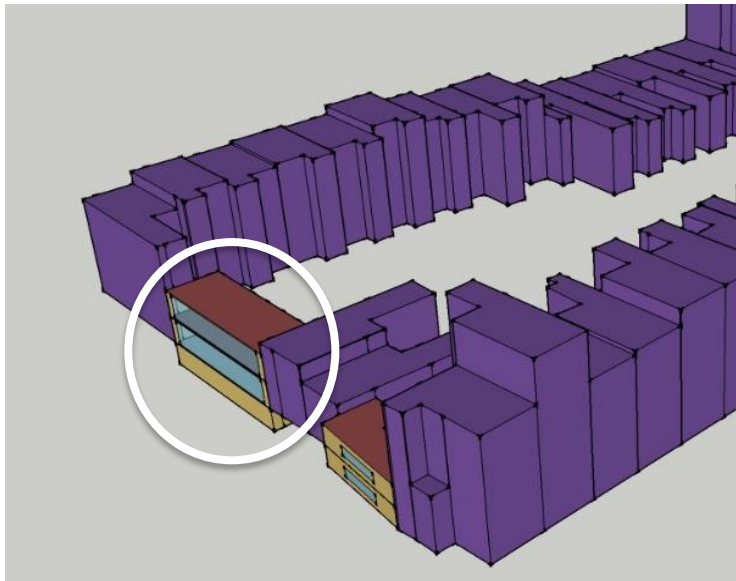- 1 - 2
- 2 - 4
- 4 - 6
- 6 - 9
- 9 - 20
- 20 - 100
- 100+

SimStock

SimStock: Automatic generation of Energy Plus Input Description Files (IDFs)

Built form divided into Built Blocks which contain a number of adjacent SCUs demarcated from each other by roads and other physical separations.
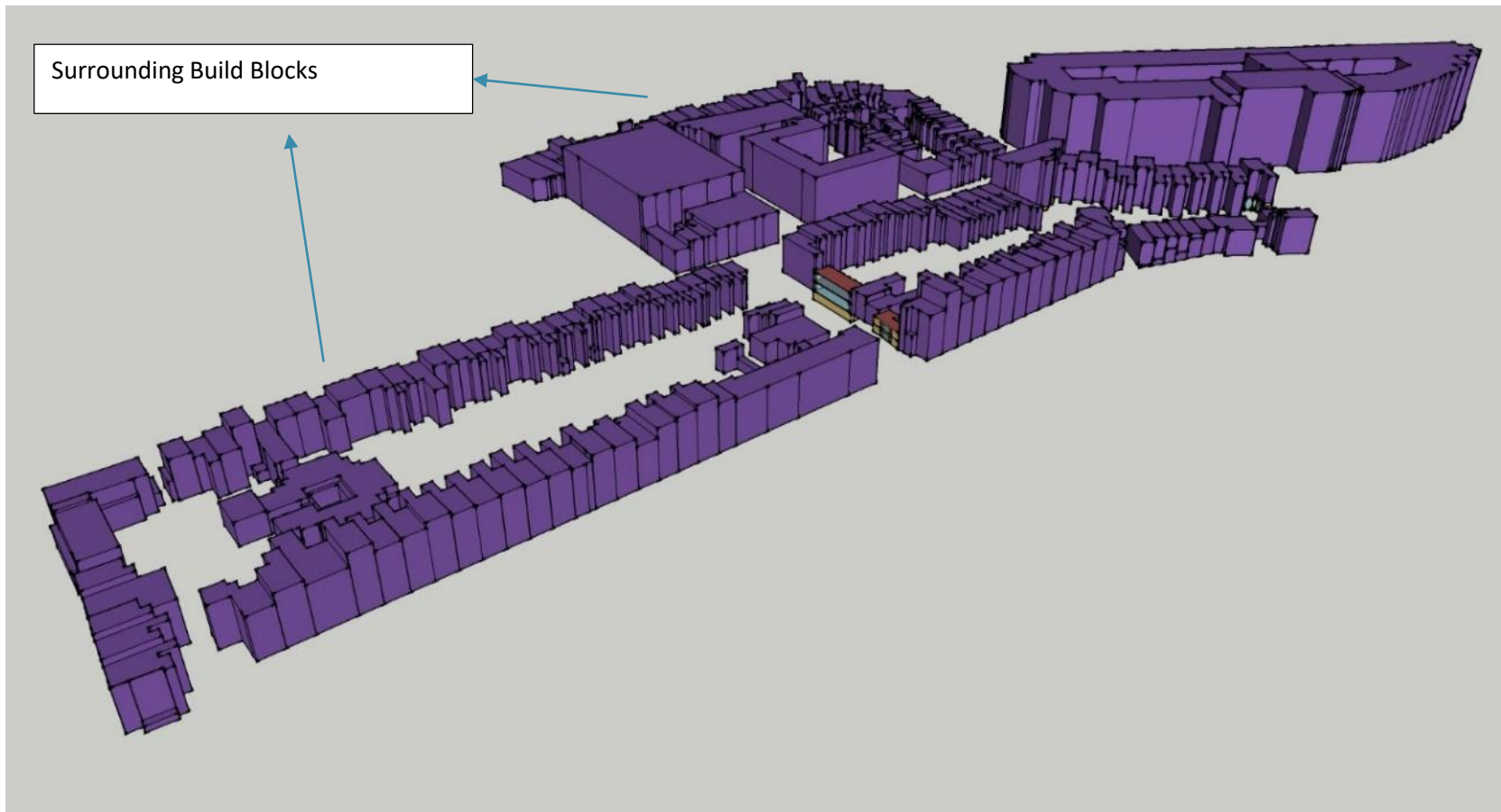

Each Built Block is comprised of a set of SCUs divided into zones each having a unique 'use type', eg: office, retail, residential, etc.

SimStock: Shading

Impact of shading from surrounding Built Blocks accounted for.
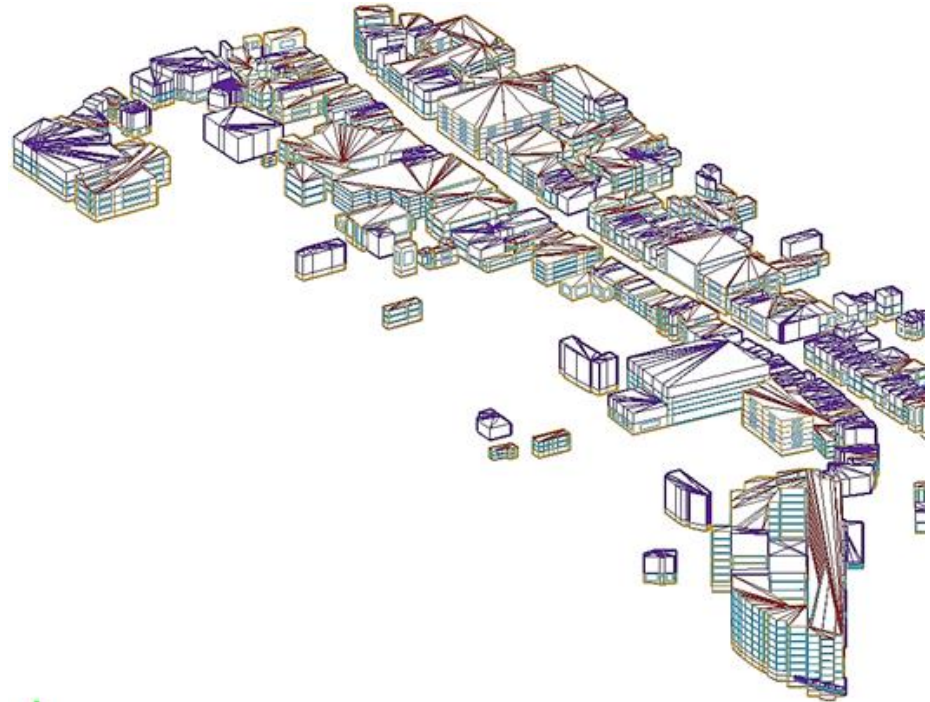

Surrounding Build Blocks

SimStock: Data sources

3DStock/LBSM:

- Floor area per floor

- Wall area / type

- Floor heights

- Shading

Other data

- Occupancy and operation profiles for each use type

- Window area related to age and materials
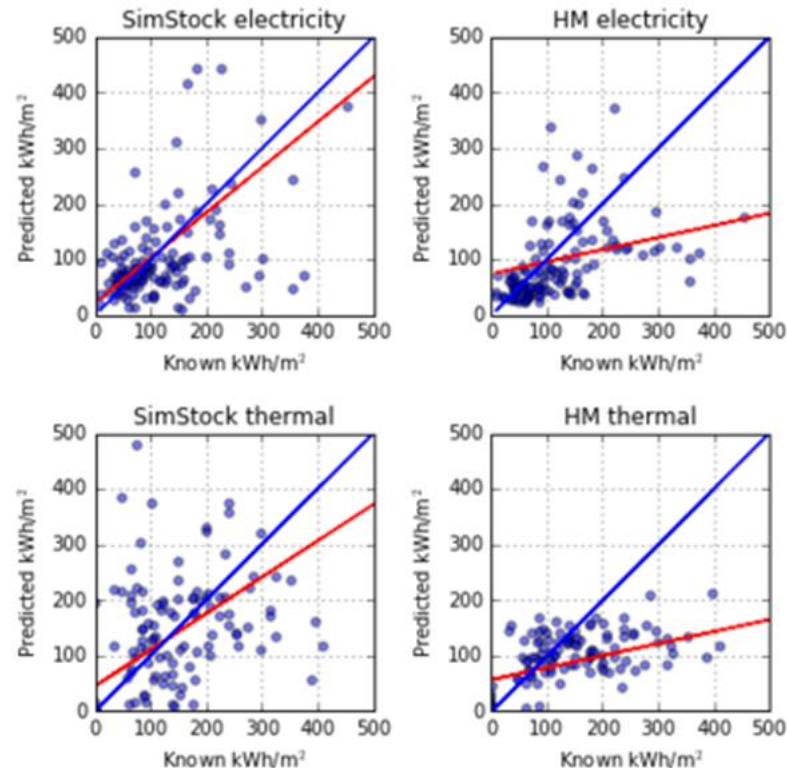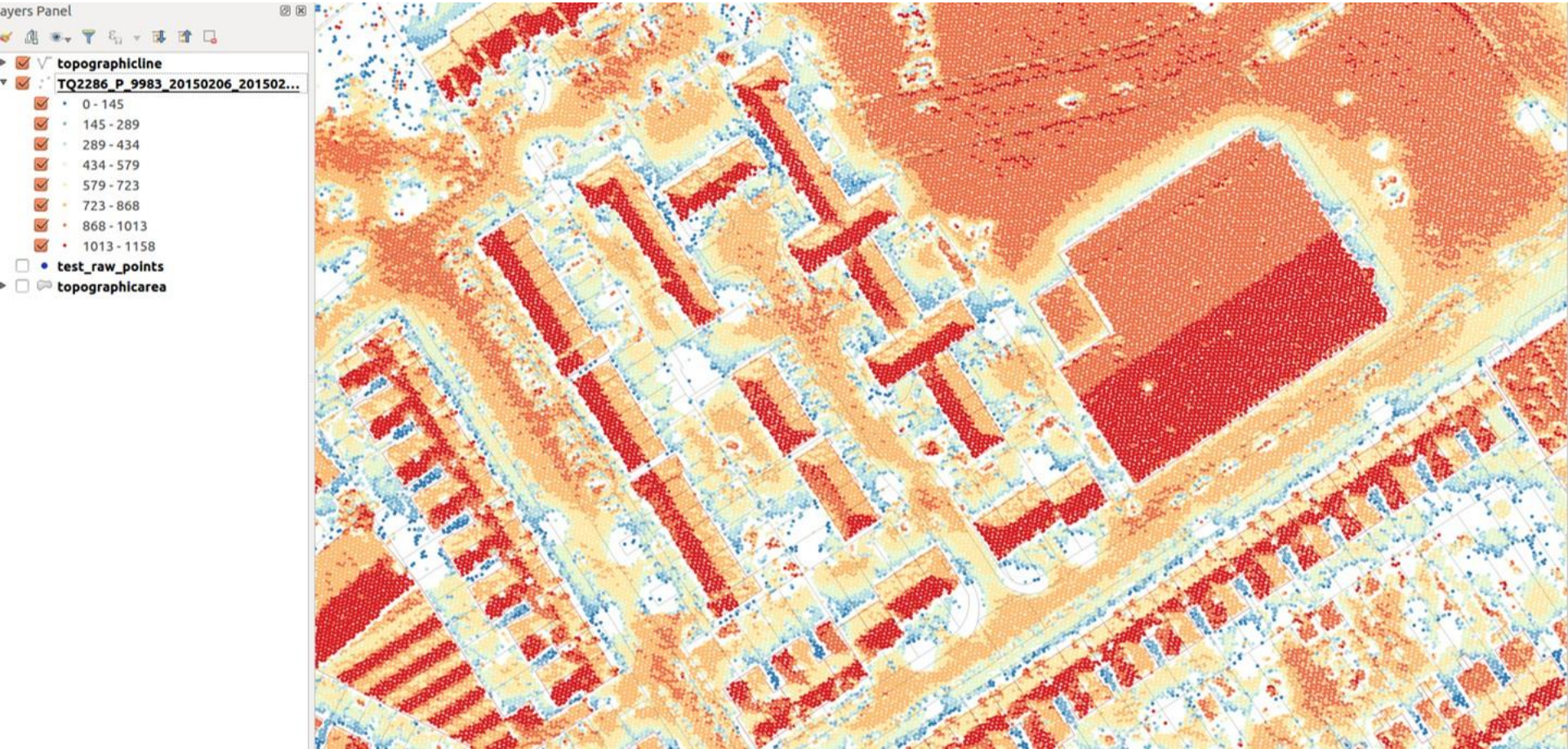
- Other details from NCM / SAP assumptions

SimStock: Outptus

Model calibration

- Simulations trained against partial population using stochastic parametric analysis and genetic algolrithms

- Refined model tested on remaining population

- Comparisons made with semi-empirical models

Solar mapping – initial development

Conclusions

- Urban building and energy models can be built from existing, publicly available data.

- Use type analysis shows that urban areas are considerably mixed within single buildings and this has implications for modelling in detail.

- Association of energy performance certificates and display energy certificates allows first order area based energy analysis.

- Initial indication that automatically generated simulation models are feasible for large areas and provide credible results.

Acknowledgements

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- Ivan Korolija
- Dominic Humphrey

Funders:

Engineering and Physical Science Research Council

Greater London Council

References:

- Centre for Energy Epidimiology: cee.ac.uk/3dstock, cee.ac.uk/simstock
- Centre for Reduction in Energy Demand Solutions (CREDS): www.creds.ac.uk/buildings-energy

Questions?

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