# 3DStock and SimStock

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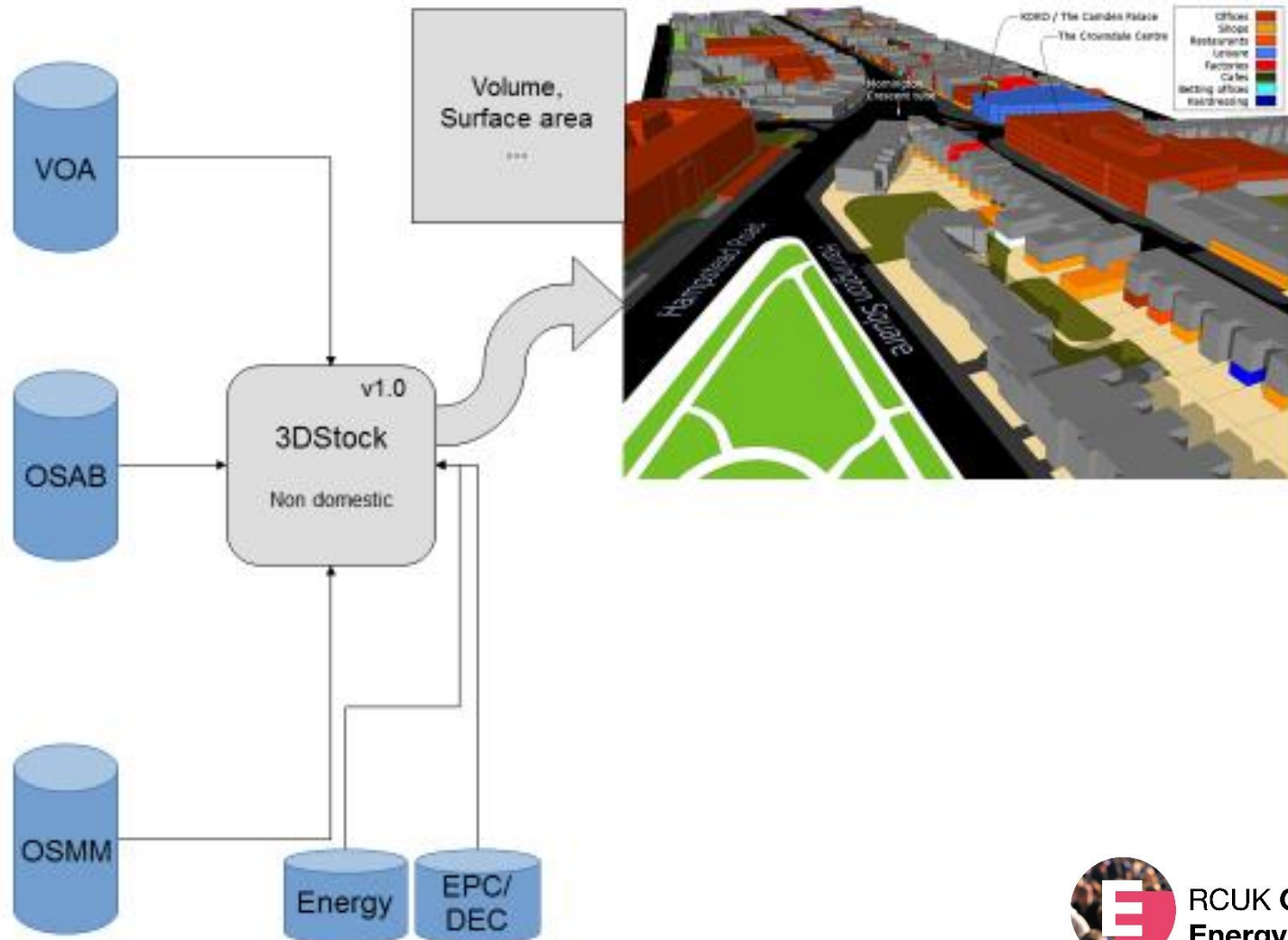RCUK **Centre for Energy Epidemiology**

# UK building stock modelling

- Domestic building stock extensively modelled using iconic buildings in National Housing Model

- Non-domestic building extremely heterogeneous and often mixed with domestic

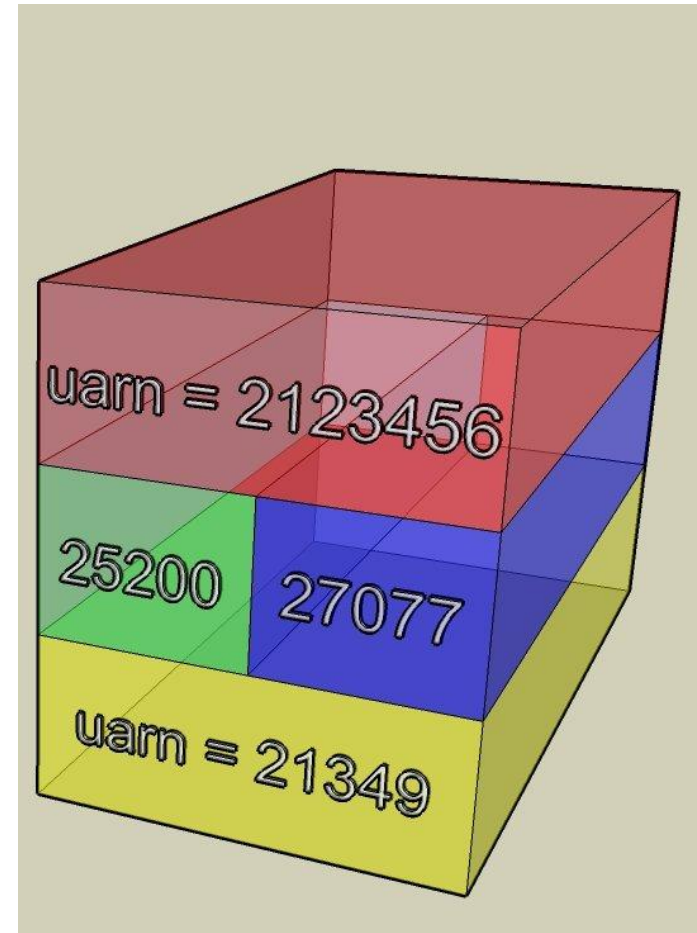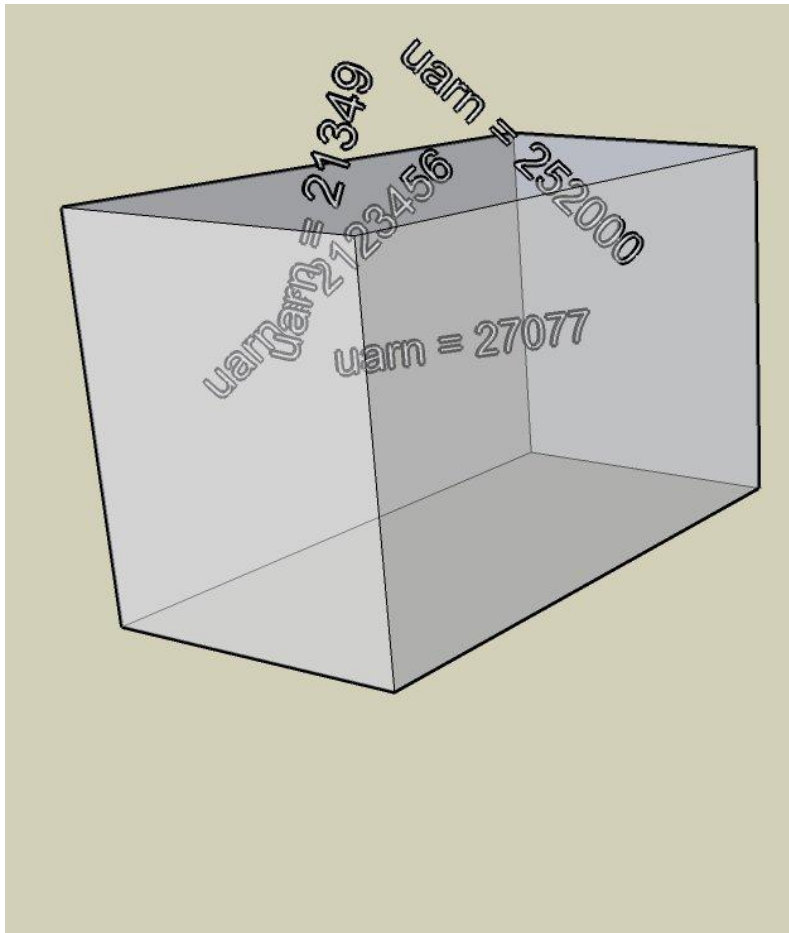- UCL / CEE focus on modelling NDB stock in detail using available datasets…….

# 3DStock as previously presented

# Layering the non-domestic activity

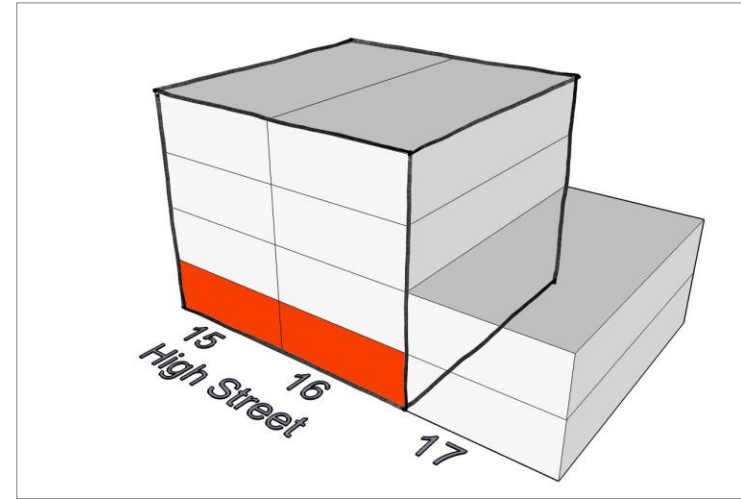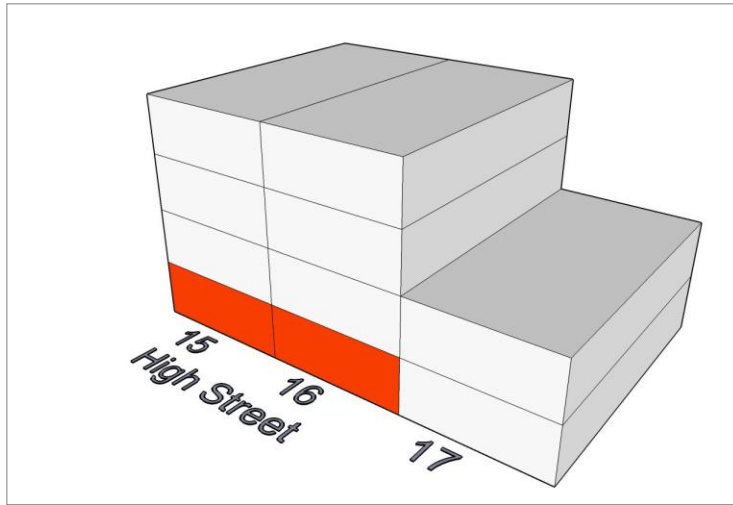## Locating hereditaments on floor levels



Before 'stratifying' the hereditaments    After 'stratifying' the hereditaments

*(this is for a single extruded building polygon attached to a single address)*

## Self-contained units (SCUs) (Taylor et al, 2014)



A self-contained unit is a 3D spatial entity with a well-defined envelope (exposed walls and roof) suitable for assessing energy use for heating and cooling.

Hereditaments are not broken between contiguous SCUs.

But a SCU is not (quite) the same as a 'building'

# A self-contained unit (SCU) in Camden



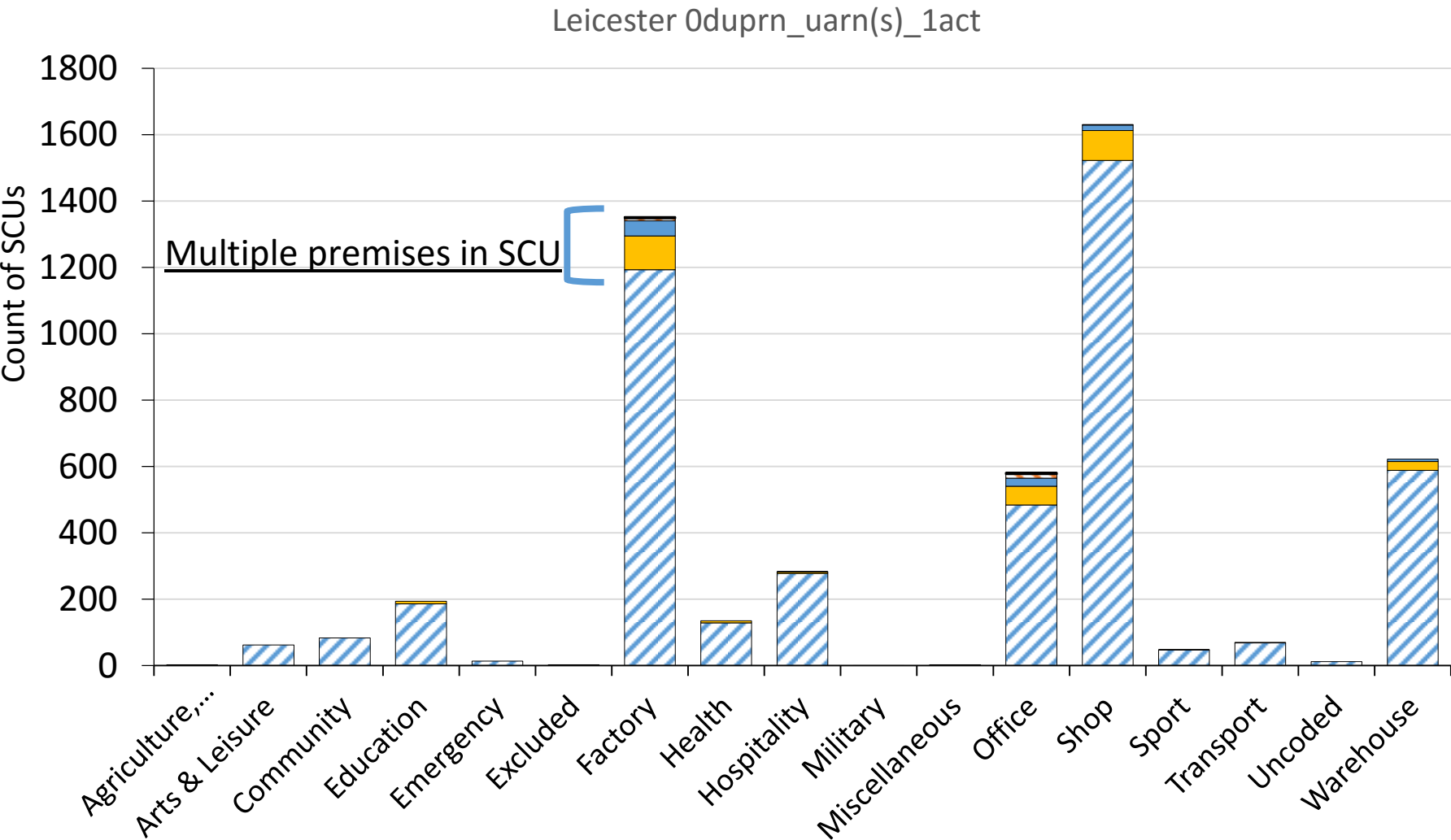This contains two buildings (red and yellow)

# Analyses of activities in Self-contained Units (SCUs)

- Four UK billing authorities:
  - **Leicester:** Medium sized city (~330,000 population), significant industrial & storage
  - **Tamworth :** Small 'market town' (~77,000 population), some industrial & storage
  - **Swindon:** Large town (~210,000 population) very mixed
  - **Camden:** Large (~200,000) borough of London, mostly retail, office and public sector
- Analyses classify by dominant activity, according to count of UARNs
- *y* axes are counts of SCUs, not UARNs
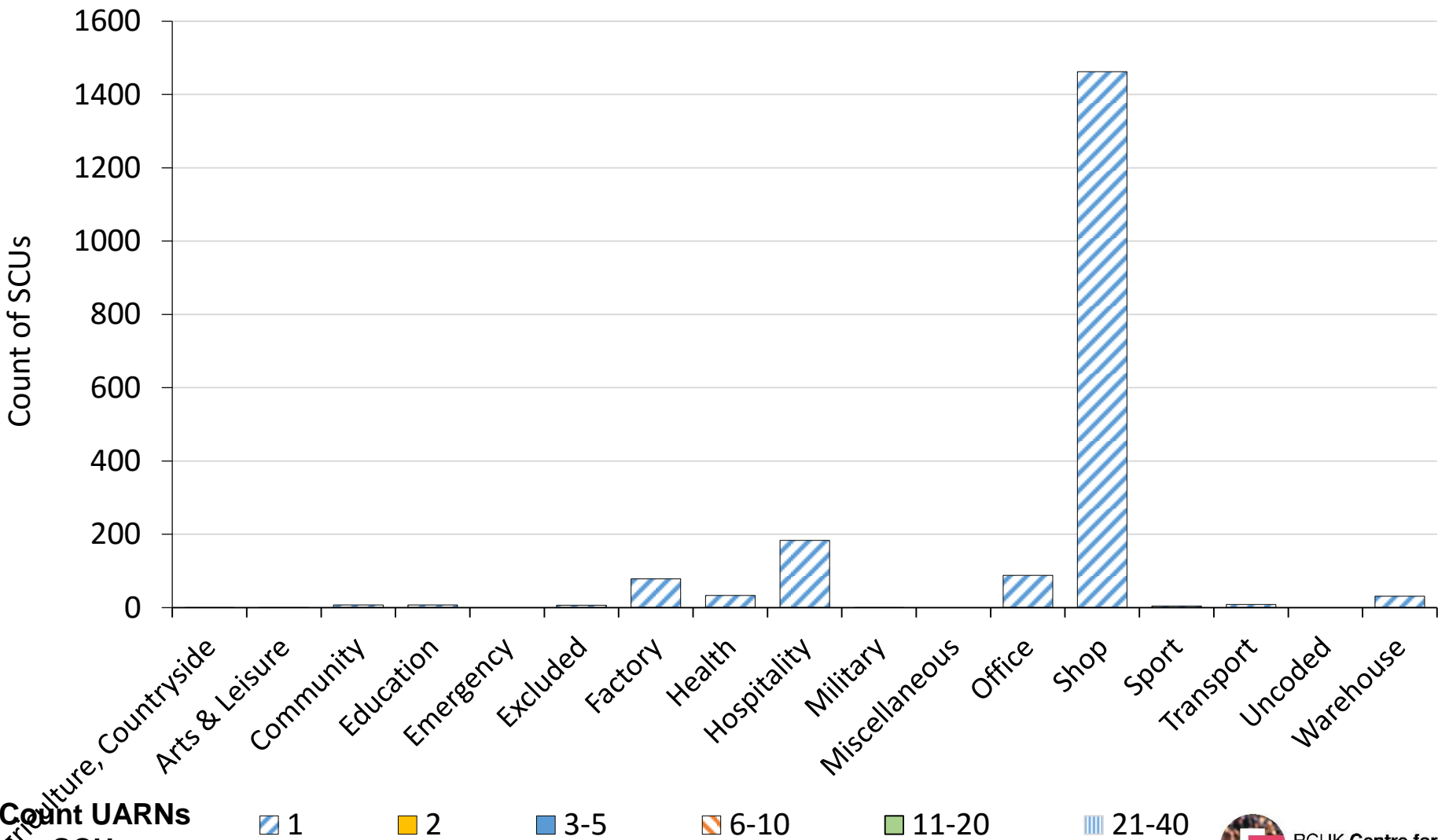- Analyses performed on SCUs with/without domestic addresses (duprns)

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# Multi-premises, one activity, no domestic, Leicester

Leicester 0duprn_uarn(s)_1act



Count of SCUs (y-axis, 0 to 1800)

Multiple premises in SCU

Categories (x-axis): Agriculture,..., Arts & Leisure, Community, Education, Emergency, Excluded, Factory, Health, Hospitality, Military, Miscellaneous, Office, Shop, Sport, Transport, Uncoded, Warehouse

**Count UARNs per SCU** — 1, 2, 3-5, 6-10, 11-20, 21-40, >40

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# Single-premises, one activity, with domestic, Leicester

Leicester with duprn(s)_1uarn_1act



**Count UARNs per SCU**

Legend: ▨ 1 ▨ 2 ▨ 3-5 ▨ 6-10 ▨ 11-20 ▦ 21-40

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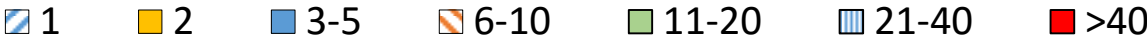Multi-premises, multi-activity, with domestic, Leicester

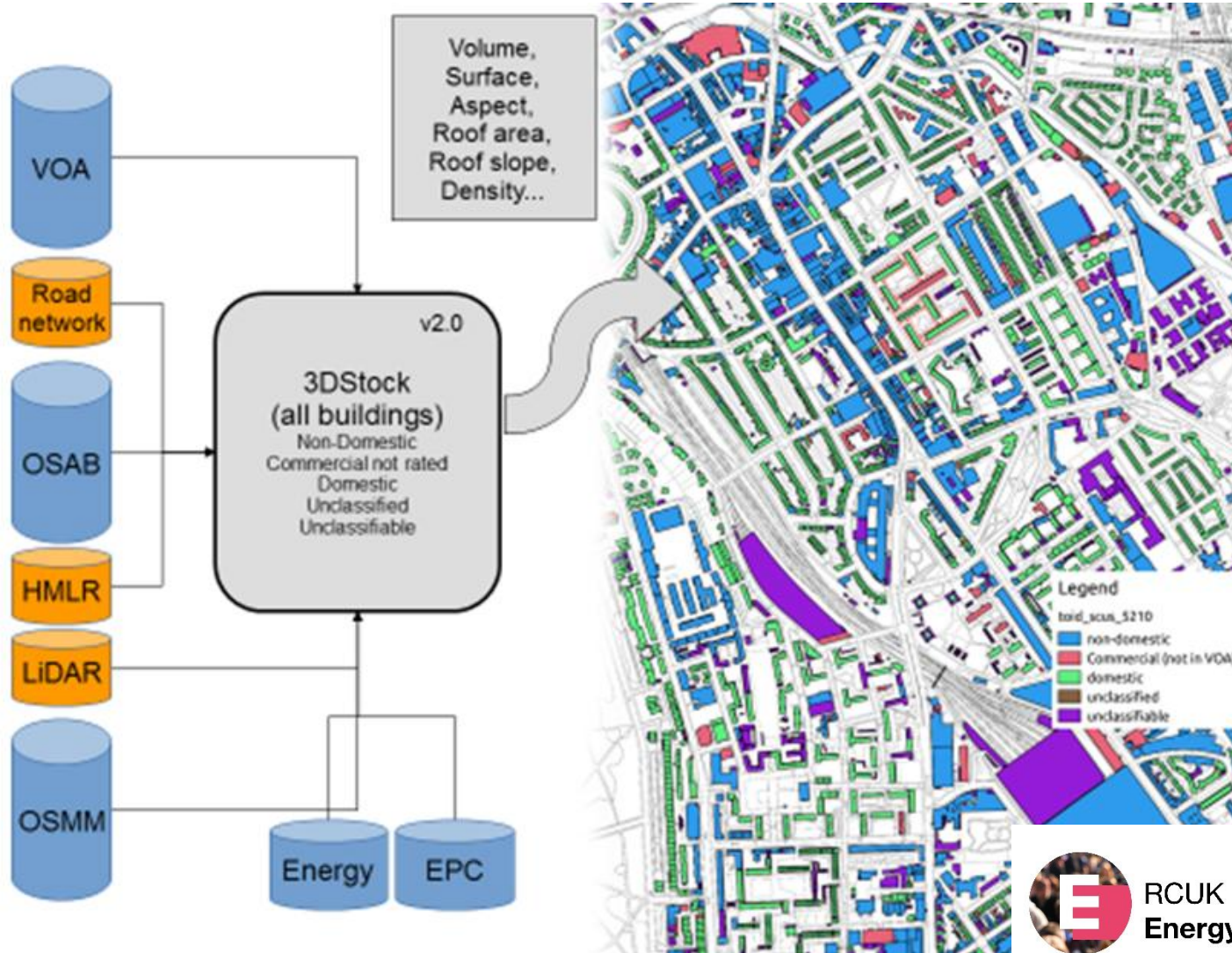Leicester with duprn(s), >1_act, >1_uarn
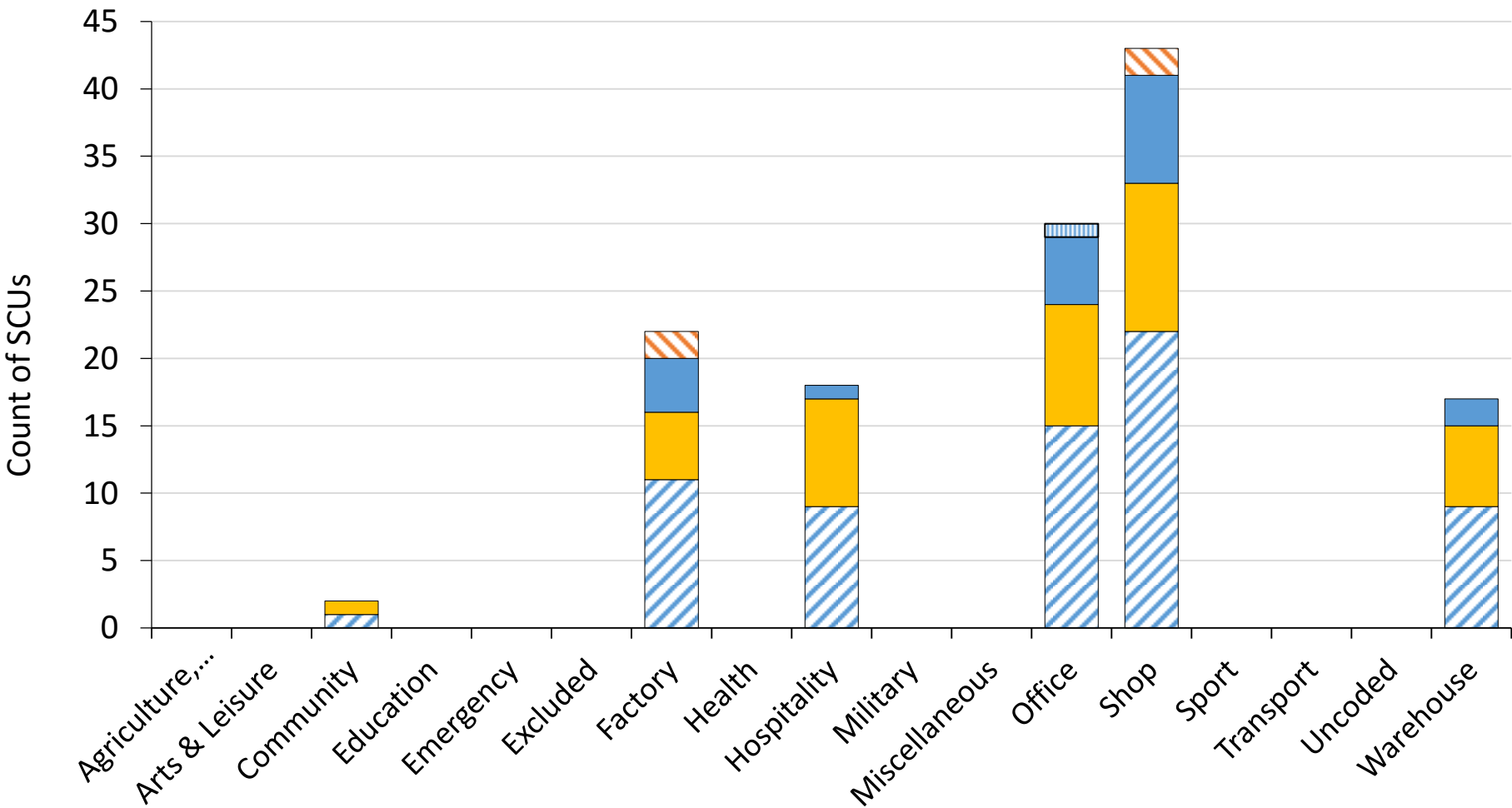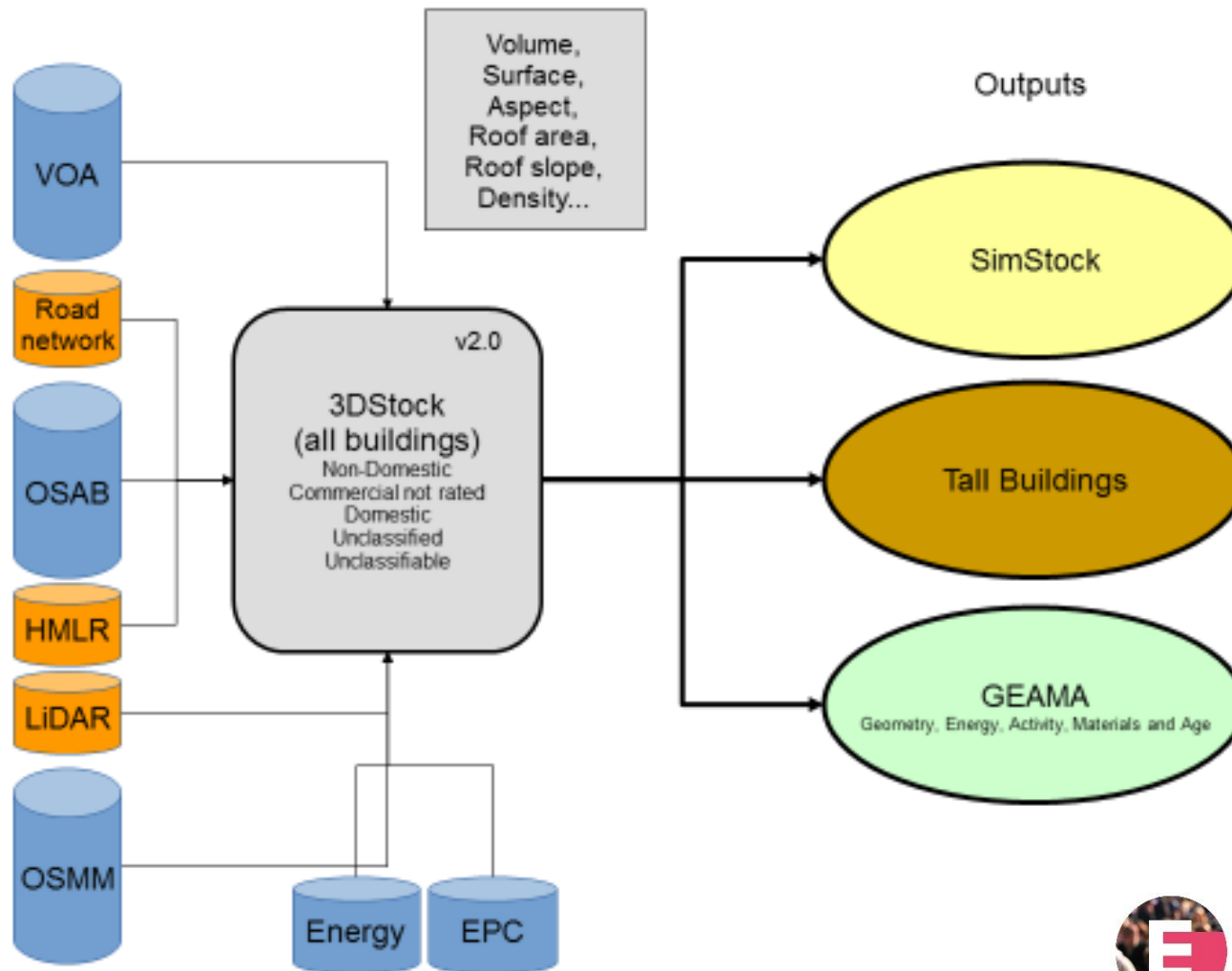
# 3DStock with recent additions

# 3DStock applications

# Notes on recent developments

- HMLR land registry boundaries, which bring the built stock: land relationship into play (e.g. what space is there for ground source heat pumps, through to more accurate measures of 'density') The European group will know this as cadastral mapping which is common place throughout Europe but due to very different property conveyancing laws in England this has never had a similar level of importance (or availability) until recently (due to INSPIRE).

- LiDAR gives us the chance to make more accurate building volume calculations and to create LoD 2 (Level of Detail) models with basic roof shapes rather than LoD 1 (extruded polygons) as was the case before.
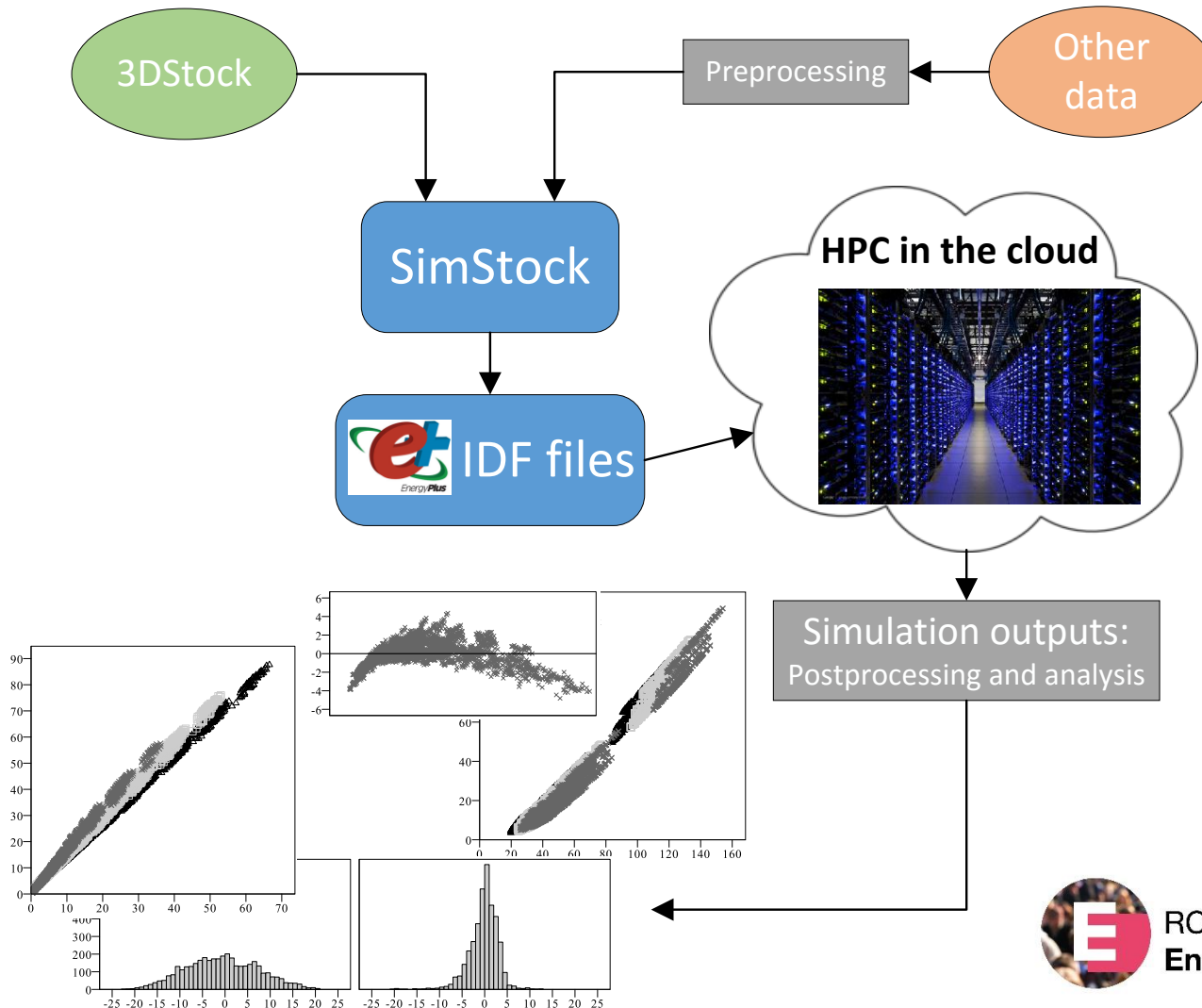
# Notes Cont'd

- The road network has significance on many levels, but is used primarily for helping to measure density and also to simulate the potential demand/length of pipeline of any potential District Heating schemes.

- The model now generates all buildings (rather than just non-domestic) and the outputs to Simstock, TallBuildings and GEAMA are updated to cope with this.

- Outputs to INSPIRE or CityGML would be relatively straightforward to produce

- Models exist for Camden, Leicester Tamworth and Swindon (and are just being completed for City of London and Westminster)

- More of London is being modelled as part of the Tall Buildings work in the next month

# SimStock modelling approach

3DStock

Other data

Preprocessing

SimStock

IDF files

**HPC in the cloud**

Simulation outputs:
Postprocessing and analysis

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# 3DStock data

- Self-Contained Units (SCU)
- SCU (Floor) SCUF
- SCUF activities: distribution of different activities (e.g. office apace, meeting rooms, corridors etc.) per SCUF based on VOA data
- Ordnance Survey (OS) data (polygon geometry)
- Properties height (LiDAR)
- All of these are used to define non-domestic thermal zone's boundaries.

# Other data required for simulation

- Construction elements specifications (walls, roofs, glazing, etc.)
- Glazing (type of glazing and window-to-wall ration (WWR))
- Building airtightness and ventilation strategies (natural, mechanical)
- Occupancy schedules
- Appliances power intensity and schedules (partially inherited from the 3dStock SCUF data)
- HVAC system types and control (temperature setpoints, part load efficiency, time of operation)

# Built block energy models

- Non-domestic thermal zones are created per SCUF wherever the VOA data is available

- All other buildings are treated as shading elements (future plan is to integrate domestic properties into the SimStock model and model all together. )
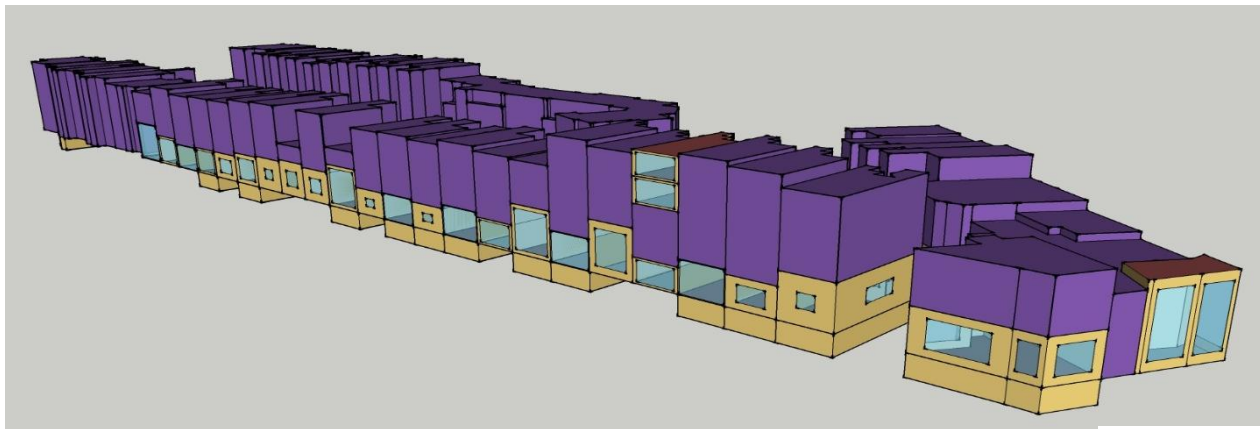
# Potential applications

- Scenario analysis:
  - Importance of heat in the NDB stock?
  - Efficacy of retrofit insulation measures for NDB stock?
  - Quick wins, eg: improved controls, LED lights, etc.

  (above all of interest to BEIS and should be informed by BEES reports when published)
- Other applications:
  - LA urban planning
  - Early stage predictions for new developments and regeneration

# 15 built blocks around the Camden high street