10th-11th June 2014 **ARCC Network Assembly, Birmingham, UK**

The Development of a Local Urban Climate Model and its Application to the Intelligent Development of Cities (LUCID)

and

The Unintended Consequences of Decarbonising the Built Environment

Complex Built Environment Systems group The Bartlett School of Graduate Studies, UCL

TODAY

LUCID

- Background and overview
- Urban climate models
- Impact assessment models
- Key messages
- Ongoing work

Unintended consequences

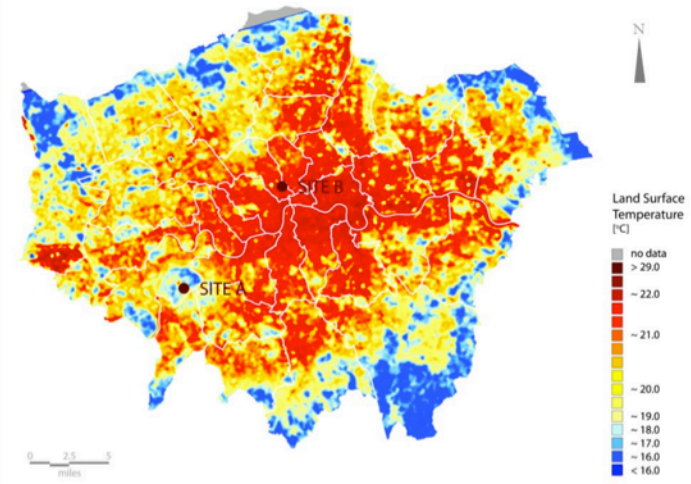
- Background and overview
- Collaborative mapping
- System dynamics
- Ongoing work

LUCID OVERVIEW

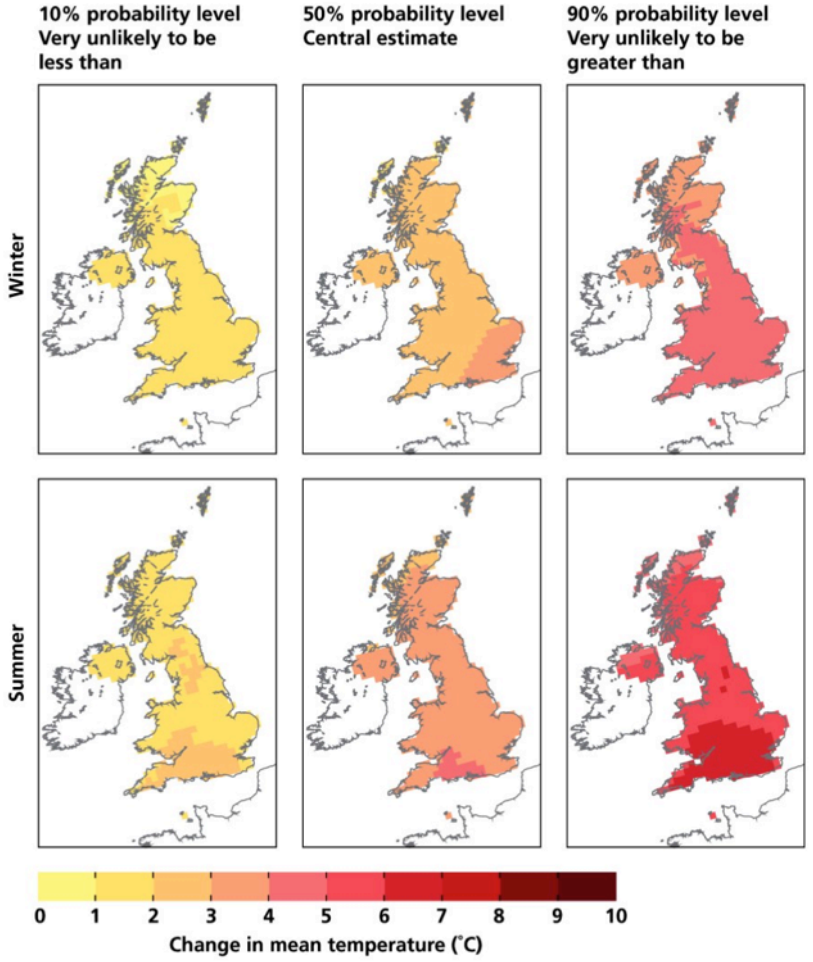
Future projections

Our **climate is changing** due to humanmade greenhouse gas emissions.

Overheating in cities will be exacerbated due to the **urban heat island** effect.



Source: LUCID project



2080s, Medium Emissions scenario
Source: UKCP09

LUCID OVERVIEW

Project title

- The development of a Local Urban Climate model for the Intelligent Development of cities (LUCID)

Timescale

- 2007-2010

Focus

- London

Scales

- City
- Neighbourhood
- Street
- Building

Team

- UCL
- University of Reading
- MetOffice
- Brunel University
- LSHTM
- CERC
- Arup
- GLA

LUCID LOCAL URBAN CLIMATE MODELS

LSSAT

ANN model for 77 fixed temperature stations.

Features:

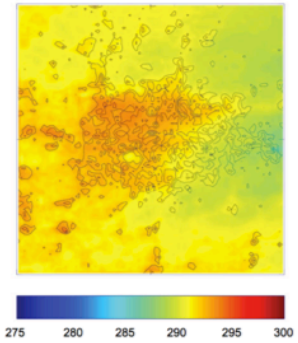
- Site specific hourly air temperature

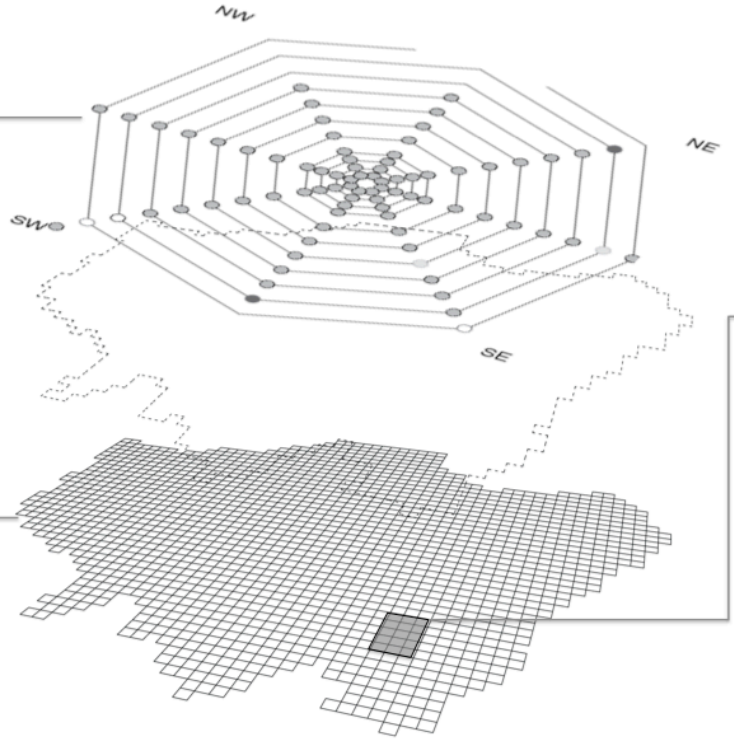
LondUM

Atmospheric model at 1km grid.

Features:

- 1.5m height surface temperatures



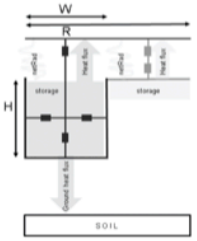


Arup Outdoor Room

Urban canyon radiative exchange model. Linked to LondUM

Features:

- Air & surface temperature

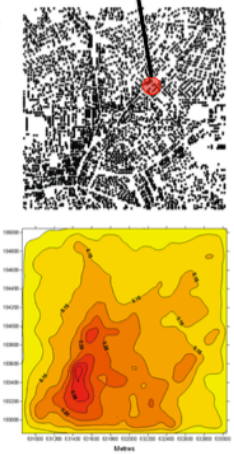


ADMS

Atmospheric dispersion model. Linked to LondUM

Features:

- Perturbations on temperature & humidity

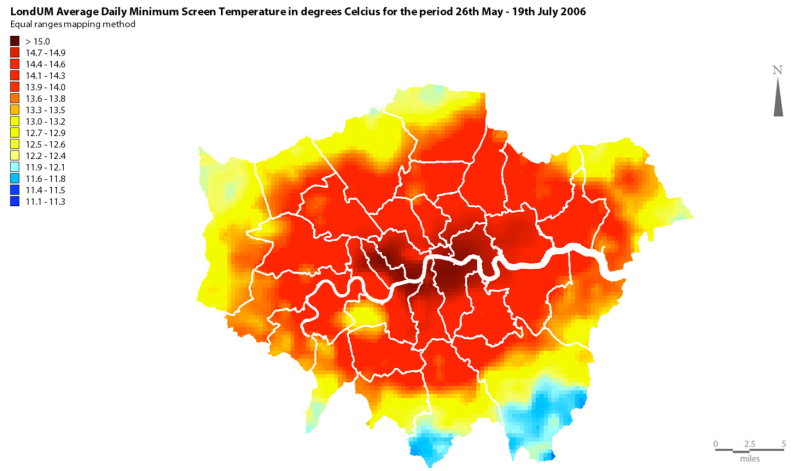


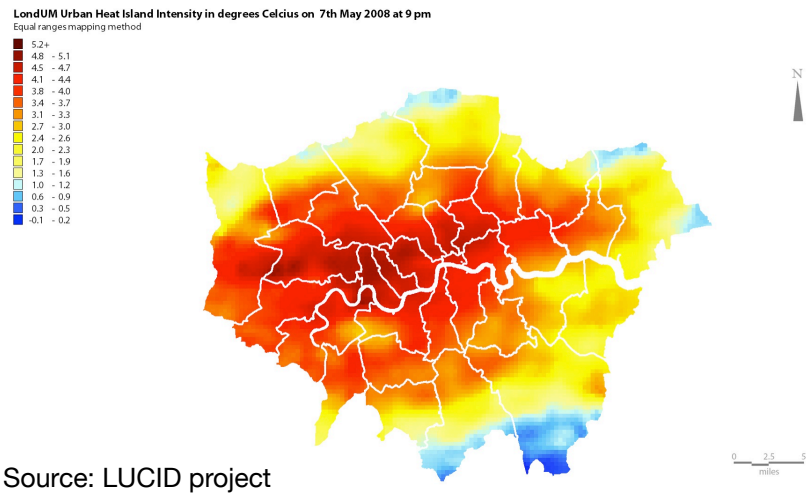
Source: LUCID project

LUCID LOCAL URBAN CLIMATE MODELS

Characteristics of the London heat island

- London experiences a significant heat island. Temperatures may vary considerably (3-4 °C) over relatively short distances due to the different **thermal properties** of the land use types, as well as the varying **morphology**.
- **Building form** has the potential to change the urban heat island up to 1 °C when altered at the city-scale.
- The **current greening** in London reduces night-time temperatures by up to 2-3 °C.
- **Anthropogenic heat** emissions appear to increase the magnitude of the urban heat island at the city scale - up to 2 °C at night.
- The most intense heat island is observed on calm nights with clear skies. **Advection** of cool rural air changes the urban heat island pattern on windier days and distributes heat within London.



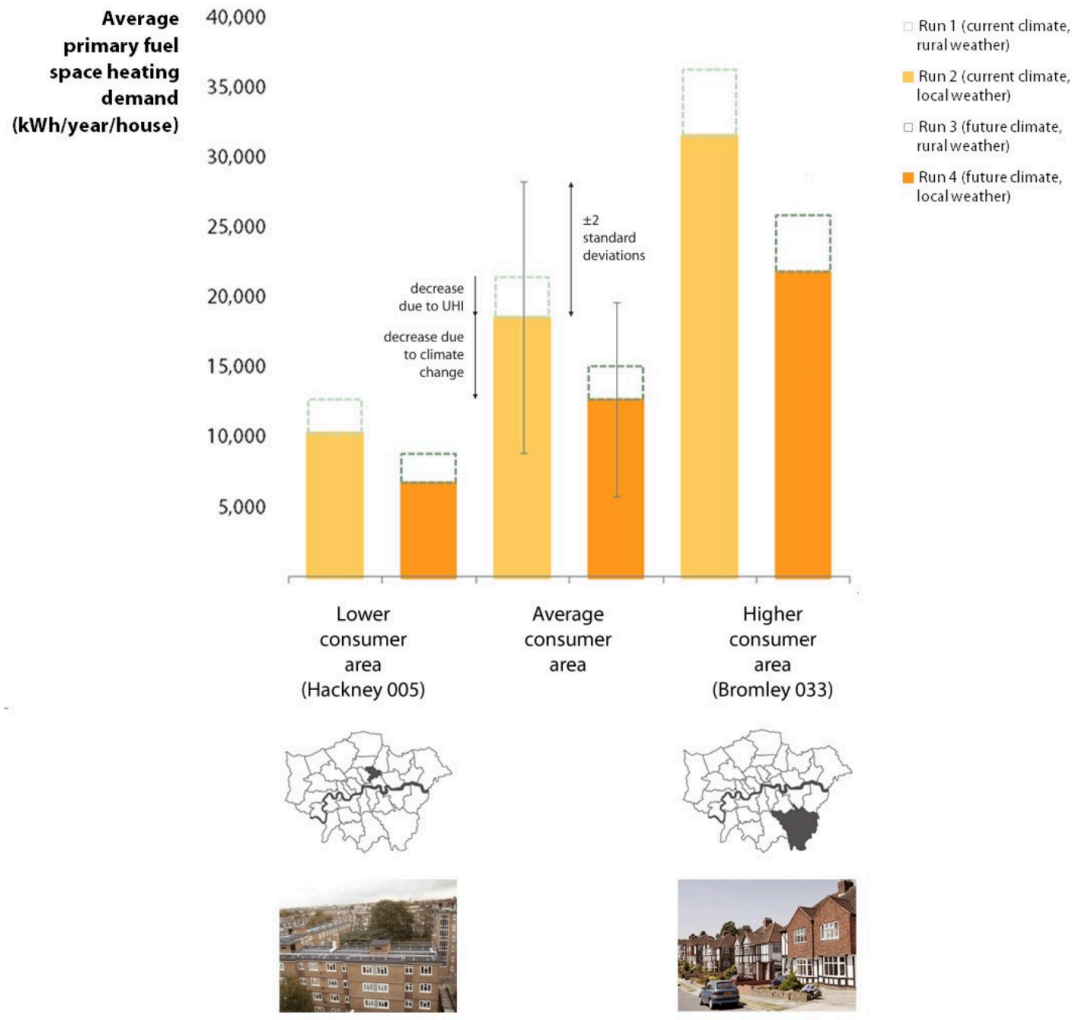


Source: LUCID project

LUCID IMPACT ASSESSMENT MODELS

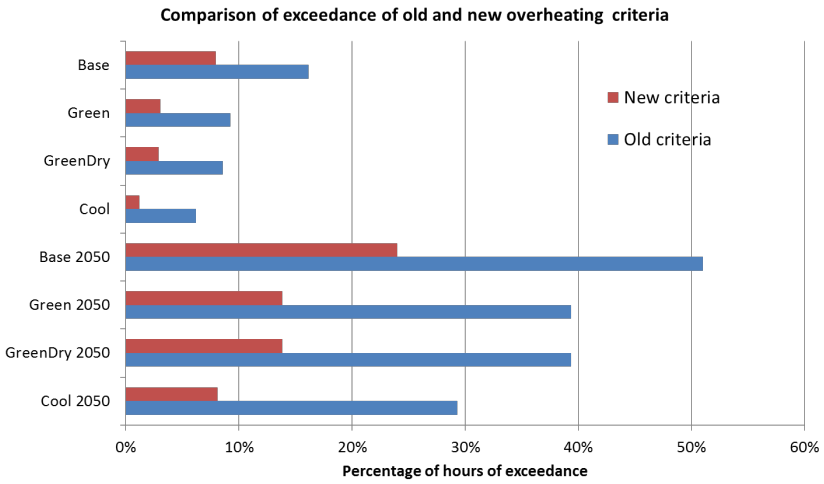
Urban heat island impact on energy use and thermal comfort

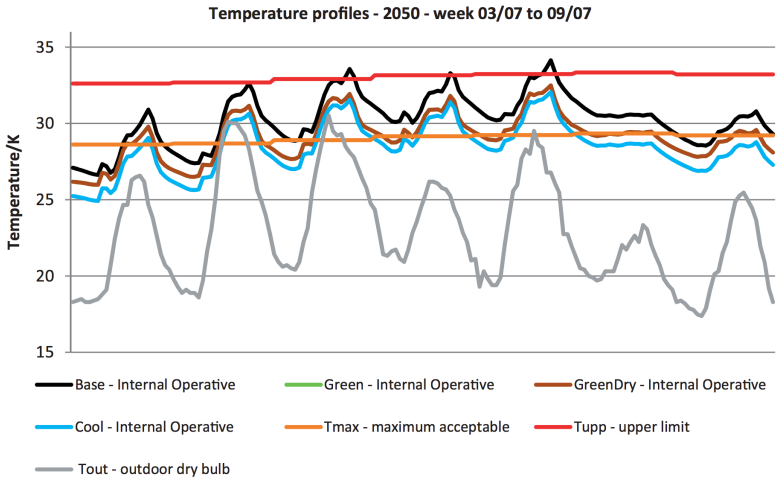
- The urban heat island was found to **decrease domestic space heating loads** by 14% in the urban areas compared to a rural reference site.
- This energy balance will depend critically on future uptake of **air conditioning**.
- The **thermal quality** of dwellings seems more important than the location in the urban heat island in terms of influencing internal temperatures.



Source: Mavrogianni et al. 2009

LUCID IMPACT ASSESSMENT MODELS





Source: Virk et al. 2014

Local urban climate modelling at the neighbourhood scale

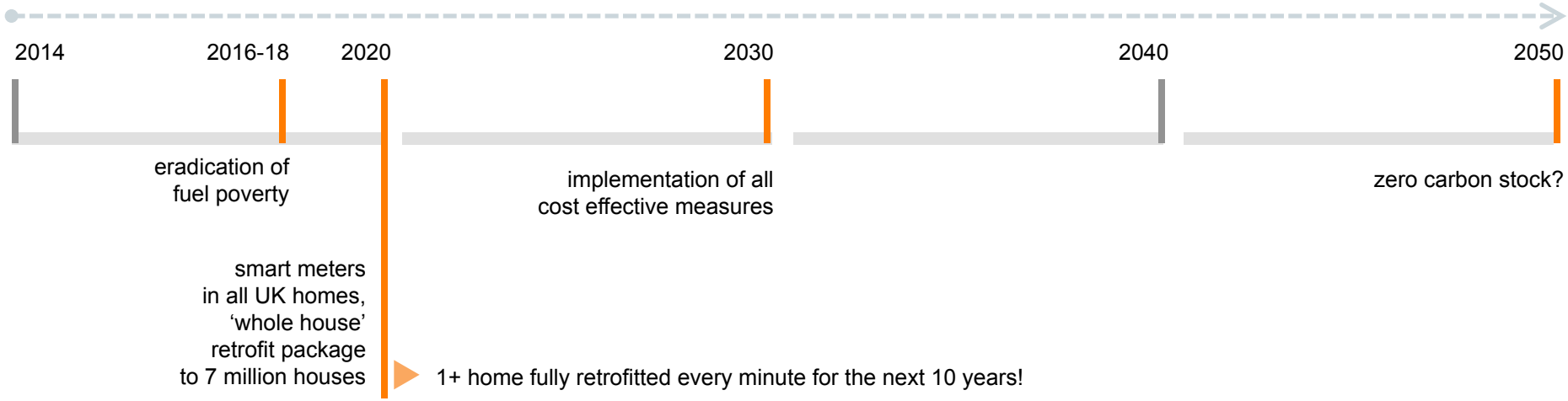
- A **cool roof** was most effective at reducing air temperature during the day, when solar energy is greatest, whereas a **green roof** reduced air temperatures mostly during the evening.
- Dried-out roof plants provide less cooling than **irrigated** ones, which may be a disadvantage in possible drier summers of the future.

UNINTENDED CONSEQUENCES OVERVIEW

The facts

- 80% UK legally binding decarbonisation target by 2050
- 27% of UK energy consumed in dwellings
- 85% of existing dwellings will still be standing in the 2050s
- only 1% of which have adequate thermal performance

The challenge



UNINTENDED CONSEQUENCES OVERVIEW

Project title
- Platform Grant Renewal Bid: The Unintended Consequences of Decarbonising the Built Environment

Timescale
- 2011-2016

Focus
- UK

Partners
- Anne Thorne Architects Partnership
- Ceravision Ltd
- DCLG
- DCMS
- GLA
- Johns Hopkins University
- Max Fordham LL
- Metropolitan Housing Trust Ltd
- (CNR)
- Queen's University of Belfast
- Smithsonian Institution
- The Library of Congress
- Thorn Lighting Ltd
- University of East Anglia
- WSP
- Xicato

UNINTENDED CONSEQUENCES MAPPING

Integrated decision-making about Housing, Energy and Wellbeing (HEW)

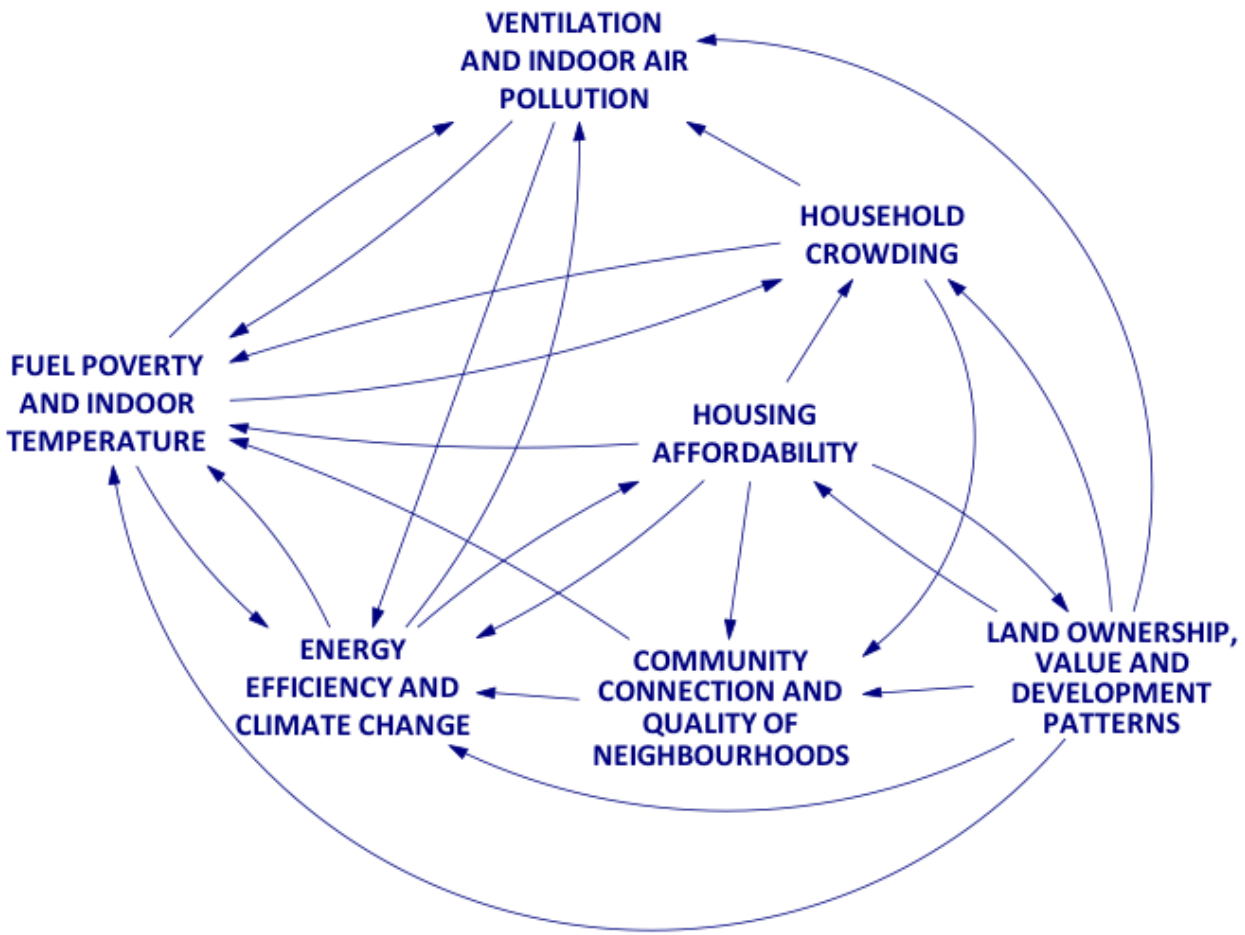
- Systems thinking
- Cognitive maps from interviews
- Collaborative mapping for stakeholders
- Causal maps, reinforcing and balancing loops

Affinity Sutton
ageUK
BME national
ARUP
CIBSE
Sheffield Hallam University
Centre for Sustainable Energy
EDF ENERGY
UWE BRISTOL University of the West of England
Good Homes Alliance
Consumer Futures
CORE CITIES
HBF HOME BUILDERS FEDERATION
nef economics as if people and the planet mattered

Department for Business Innovation & Skills
Department for Communities and Local Government
Department of Energy & Climate Change
Department for Environment Food & Rural Affairs
Department of Health
HM Treasury
Public Health England

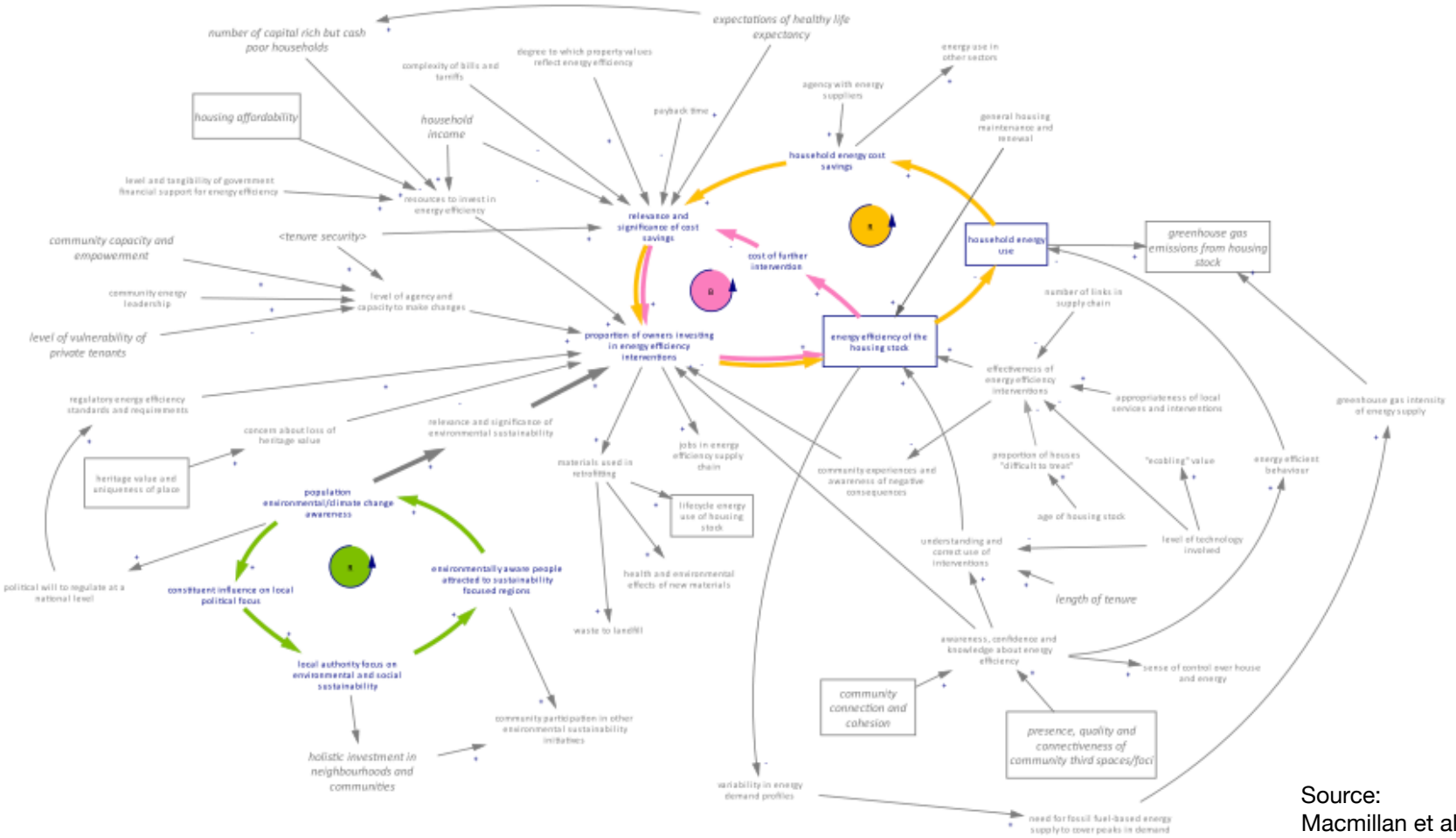
LEEDS METROPOLITAN UNIVERSITY Leeds Sustainability Institute
UNIVERSITY OF OXFORD
MAYOR OF LONDON
PositiveMoney
parity projects
Sheffield City Council
Shelter
sustainableBYdesign
Sustainable Development Foundation
UCL ENERGY INSTITUTE
UBT Usable Buildings Trust
UKCIP
WILLMOTT DIXON SINCE 1852
ZERO CARBON HUB

UNINTENDED CONSEQUENCES SYSTEM DYNAMICS



Source: Macmillan et al. 2014

UNINTENDED CONSEQUENCES SYSTEM DYNAMICS



Source:
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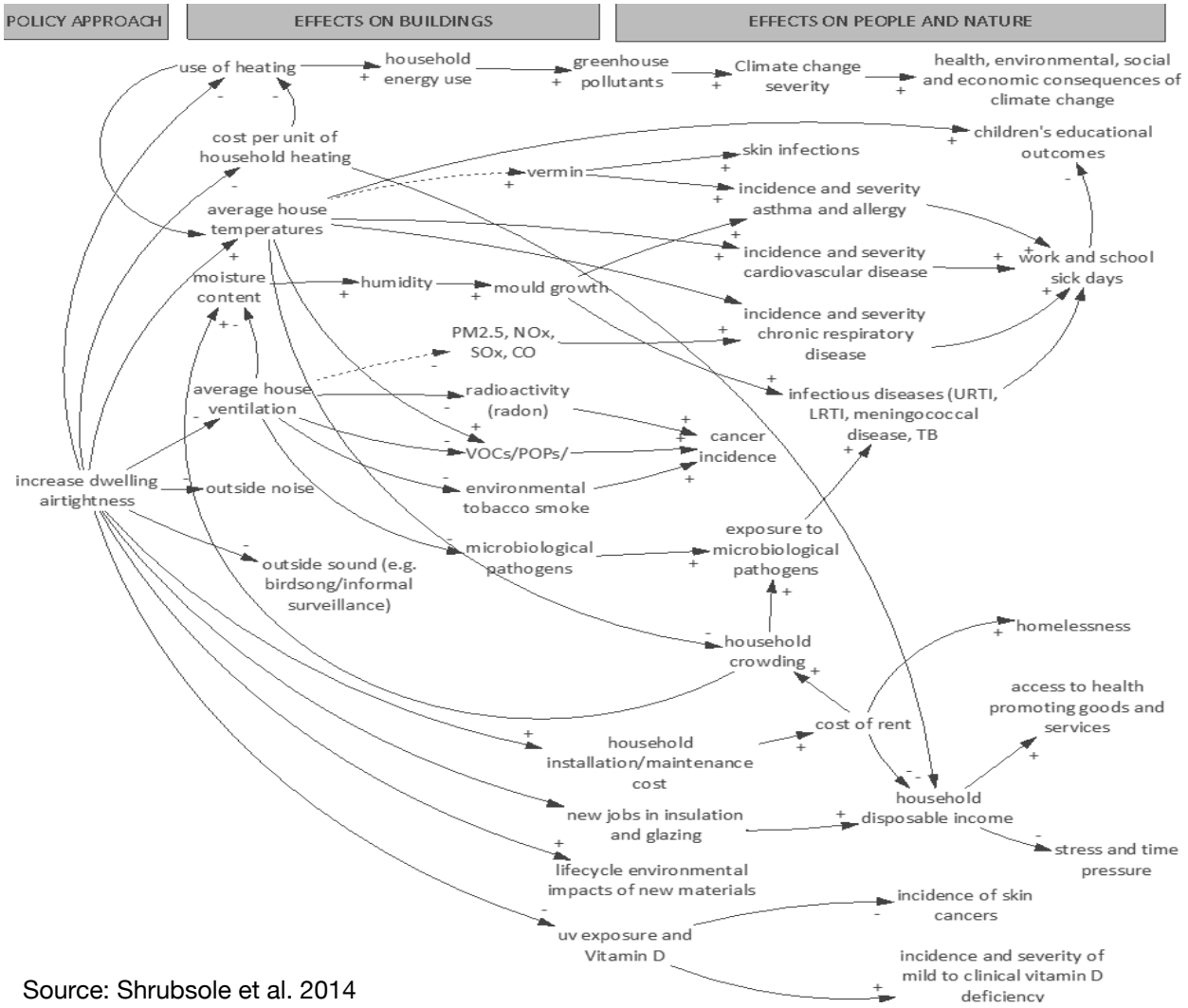
UNINTENDED CONSEQUENCES SYSTEM DYNAMICS



Source: Shrubsole et al. 2014

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Thank you!

Any questions?