Smart Cities, intelligent energy networks and the decarbonisation of built environments: do these climate change adaptations keep 1.5 alive?

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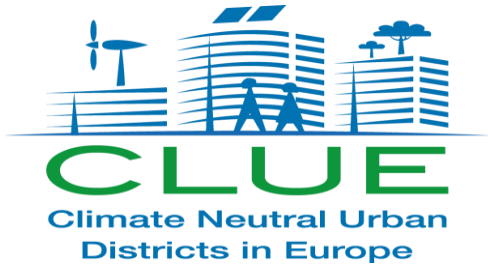
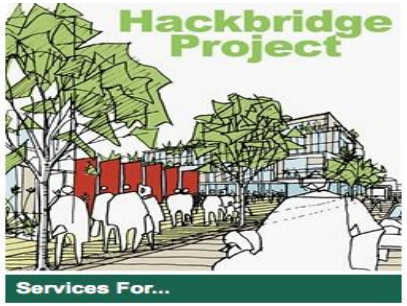
Abstract

This talk on smart cities shall reflect on the plan-led experiments they are conducting to develop intelligent energy networks. Exploring the planning of these networks, it shall review: (1) how cities are deploying such intelligence to transition away from carbon-based energy and towards renewables: (2) the smart grids that are laid down as infrastructures to support the management of this decarbonisation strategy and: (3) net zero status of the built environments which they develop a platform for. In going on to interrogate the status of these platforms, the talk shall examine whether the built environments emerging from this adaptation to climate change do keep “1.5 alive”.

Smart City research
Funding bodies 2010-2022





Underlying SmartGreen influences

- *The Natural Step*
- *BEQUEST (Building Environmental Quality for the Evaluation of Sustainability and through Time}*
- *Smart Cities*
- *Intelligent City platforms*
- *The Triple Helix model of smart cities and sustainable development of regions*
- *One Planet Living*
- *Ecological footprints and bio-productive capacity*
- *Bio-regional and the industrial ecology of city-regions*
- *UNs Sustainable Development Goals (SDG 7, 10, 11, 12 and 13)*
- *Scoping the Science-based Targets of climate change adaptation*
- *Transition away from carbon-based energy and towards renewables*
- *Leading case-study*
- *Other case-studies*
- *Energy saving measures, carbon emission reductions, sequestration and offsets*
- *The morphology of net zero: smaller footprints and bigger capacities*
- *Keeping 1.5 alive – the transparency, accountability and helices of good governance*
- *Prosperity for everyone on the planet (the promise of Industry 4.0)*
- *Climate smart adaptations of sustainable cities*
- *the sustainable development of ecological footprints and bio-productive capacity*

..the headline issues

- *The Natural Step*
- *BEQUEST (Building Environmental Quality for the Evaluation of Sustainability and through Time}*
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- ***the sustainable development of ecological footprints and bio-productive capacity***

..smart cities exist when

Following the line of reasoning adopted by Shapiro (2006), Caragliu, et al. (2011:70), suggest smart cities exist when:

> *"… modern (ICT) communication infrastructure, **fuel** sustainable economic growth and a high quality of life [by way of and through], the **wise management of natural resources** and **participatory governance** [of business-to-citizen applications]."*

..state-of-the-art

Bibliometric analysis reveals three emerging accounts of smart cities. Listing them chronologically, they are accounted for by way of: ***Smart City Rankings, Future Internet developments*** *and through a* ***Triple Helix Model*** *of smart cities. The latter providing the scientific basis and technological foundation for studying the transition to sustainable development.*

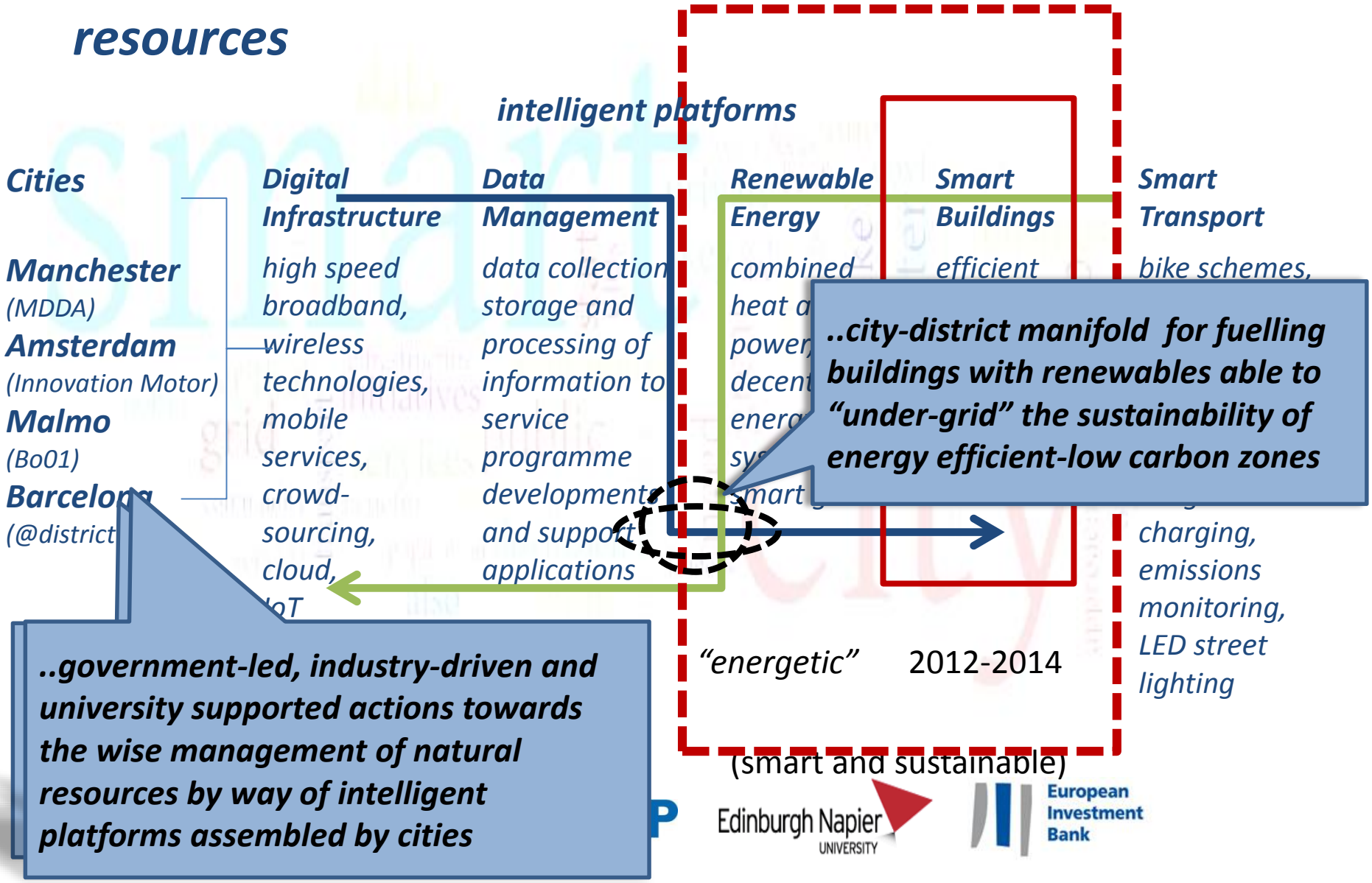
Mora, L., Bolici, R. and Deakin, M. (2017). The First Two Decades of Smart-City Research: a Bibliometric Analysis. *Journal of Urban Technology*, 24(1), 3-27.

Giffinger, R., Kramar, H and Haindl, G. (2008) The role of rankings in growing city competition, XI EURA Conference, Milan, OCTOBER 9-11

Komninos, N., Pallot, M. and Schaffers, H. (2013) Special issue on smart cities and the future internet in Europe, *Journal the Knowledge Economy*, vol. 13, (2): 119-134.

Deakin, M. and Leydesdorff, L. (2013) The triple helix of smart cities: a neo-evolutionist perspective, in M., Deakin (ed) *Smart Cities: Governing, Modelling and Analysing the Transition*, Routledge, Oxon.

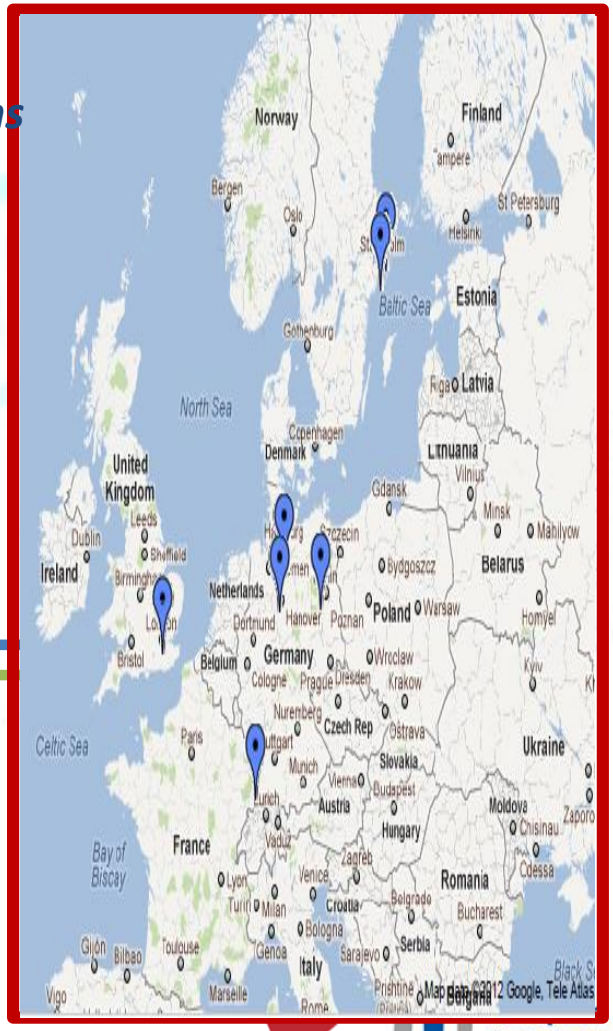
..smart cities as intelligent energy platforms for renewables: fueling the wise management of natural resources



..intelligent energy systems for the renewables of city-districts

Platforms

City-districts	Digital Infrastructure	Data Management	Smart Transport
Vauban & Rieselfled Hammarby Kronsberg Royal Sea Port Hackbridge	high speed broadband, wireless technologies, mobile services, crowd-sourcing, cloud, IoT	data collection storage and processing of information to service programme developments and support applications	bike schemes, real time bus timetable information, electric vehicle car pools, congestion charging, emissions monitoring, LED street lighting

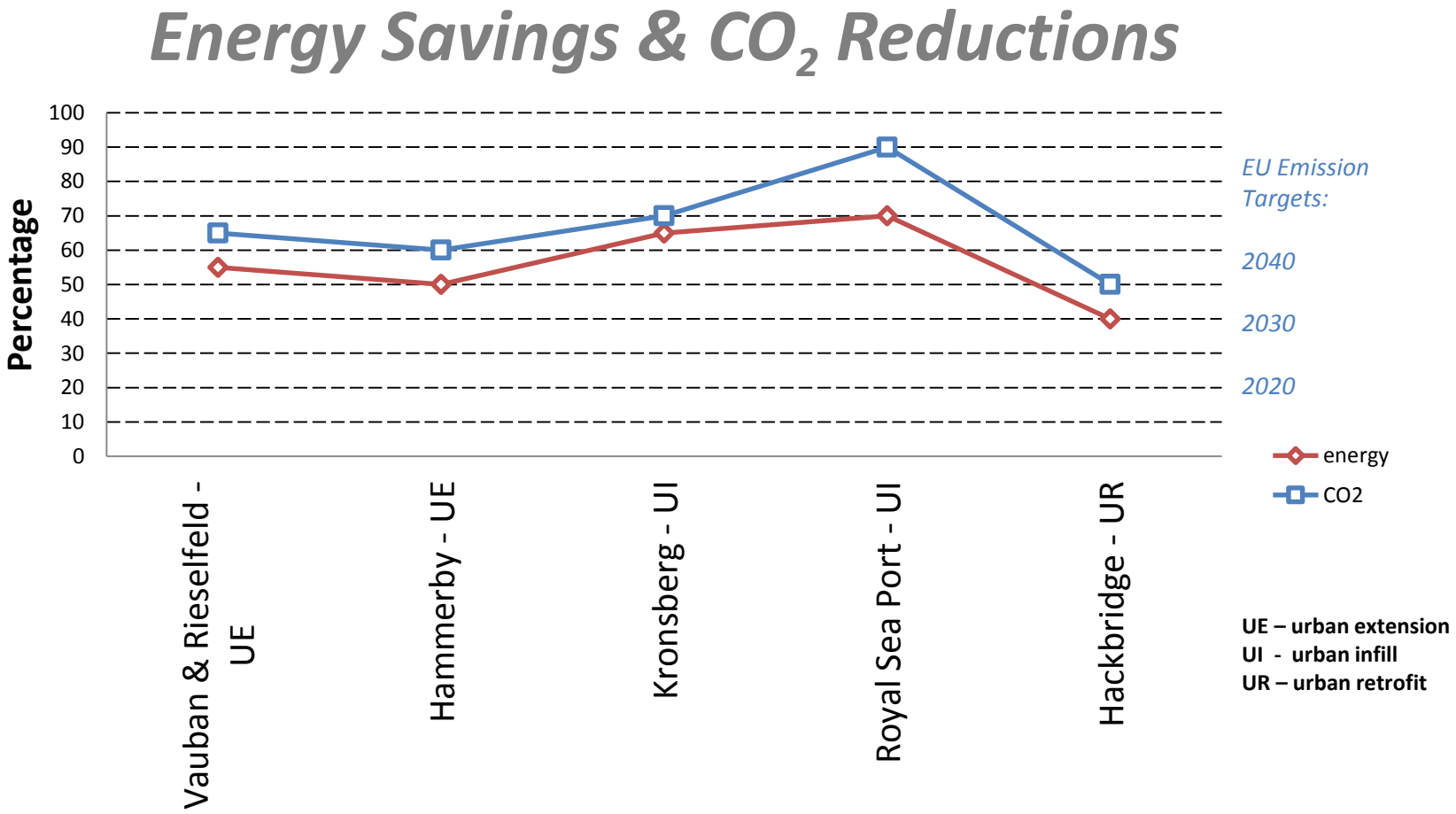


"informatic" 2009-2011

(smart)

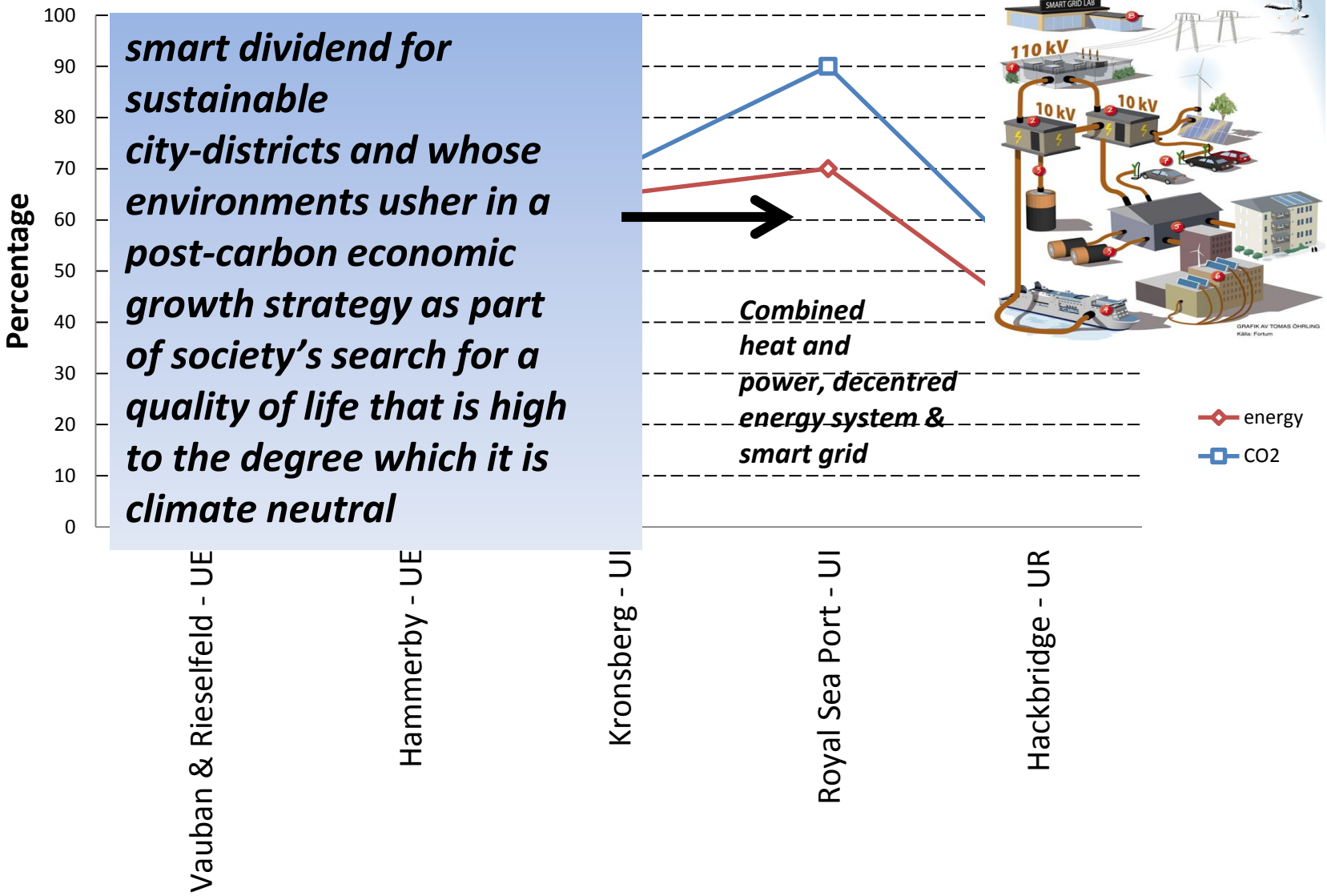
MAZARS WSP Edinburgh Napier UNIVERSITY Investment Bank

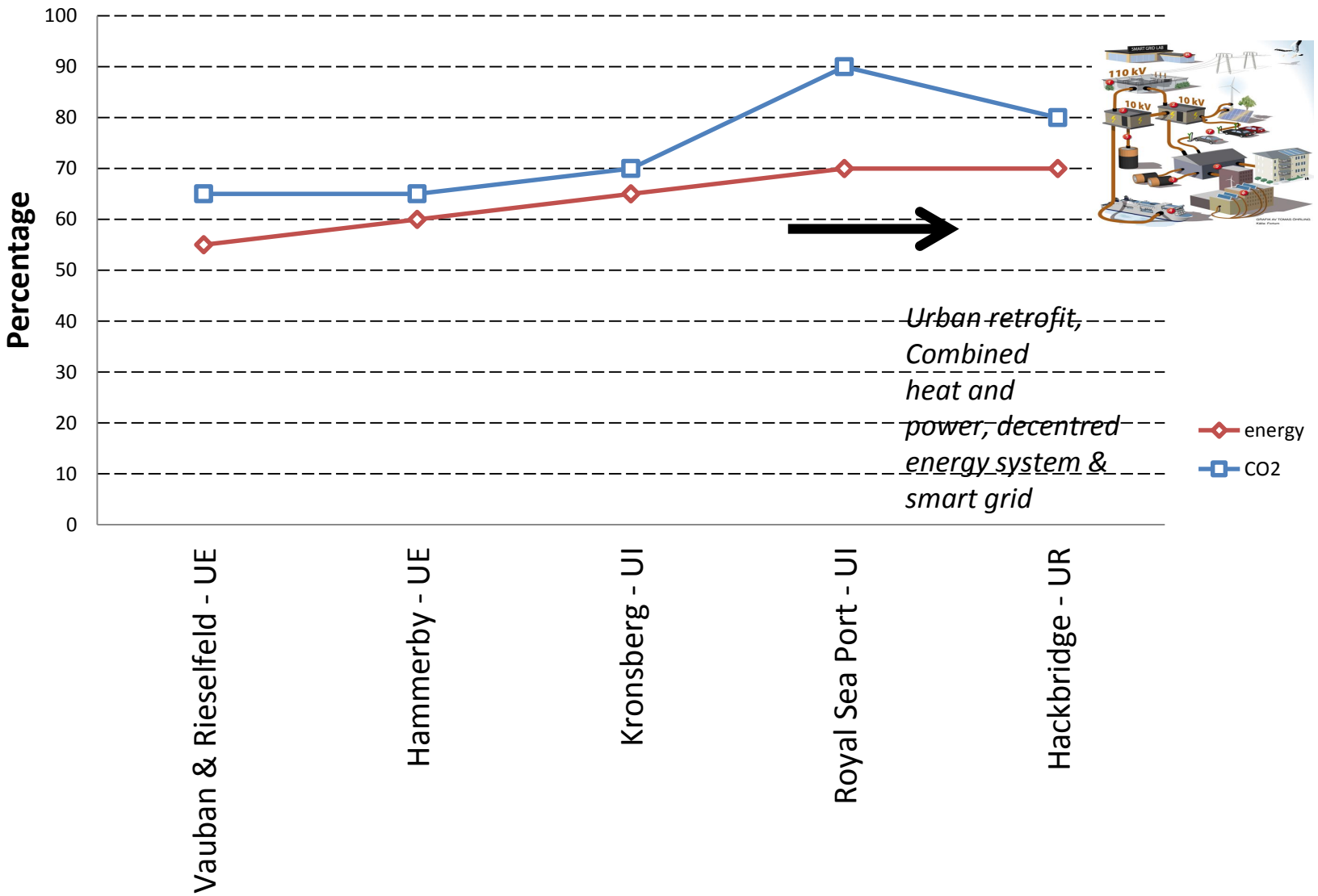
..the headline savings and reductions



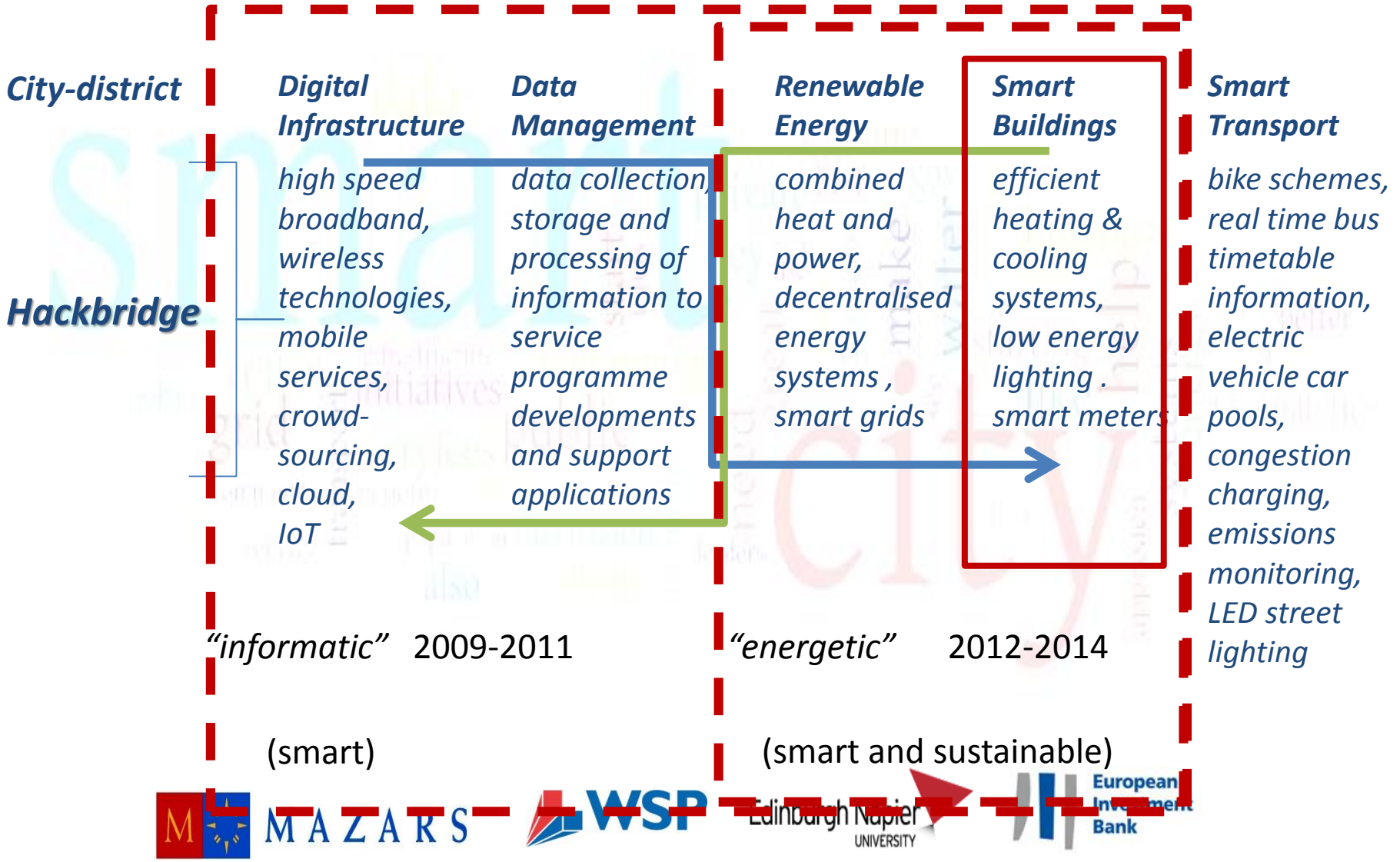
…the dividend

smart dividend for sustainable city-districts and whose environments usher in a post-carbon economic growth strategy as part of society's search for a quality of life that is high to the degree which it is climate neutral




Percentage
100
90
80
70
60
50
40
30
20
10
0
Vauban & Rieselfeld - UE
Hammerby - UE
Kronsberg - UI
Royal Sea Port - UI
Hackbridge - UR
Urban retrofit, Combined heat and power, decentred energy system & smart grid
energy
CO2
110 kV
10 kV
10 kV

..a leading city-district



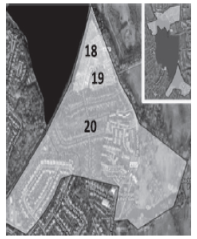
Hackbridge: mass-retrofitting methodology

Stage 1: performance-related assessment:

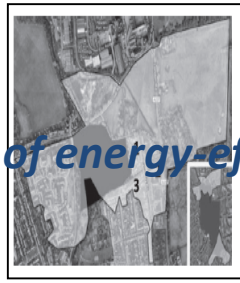
1. *3-DEM modelling of **ecological footprint***
2. *3-DEM of heat maps*
3. ***Environmental** profiling of buildings*
4. ***Economic cost** of mass retrofit*
5. ***Social-baseline** of the demographic cohort*
6. *Transversal analysis of the social ecology*
7. ***Stage 2: Under-gridding the sustainability of energy-efficient-low carbon zones:***
8. *District energy network*
   - *bio-gas CHP (biomass/arboricultural)*
   - *solar energy (poly-voltaic)*
   - *wind power*

Stage 3: Smart (micro) Grid

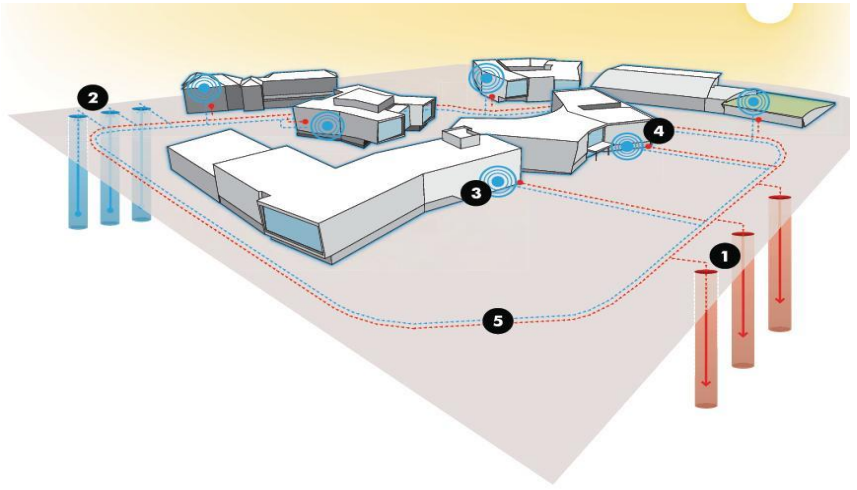
9. *Smart grid*
   - *ESCO (Energy Services Company)*
   - *Peak-load management*
   - *Dynamic pricing*
10. *Action Planning/implementation*



Type	Age	HA	Energy (kWh/p.a.)	CO^2 (kWh/p.a.)	Tenure (%)		
					Owner Occupied	Private Rented	Social Rented
B	1896-1913	18	31204	7807	87	10	3
L	1990s	19	13791	4618	87	10	3
F	Late 1930s	20	20783	5927	85	3	12
Total			65778	18352			
Average			21926	6117			

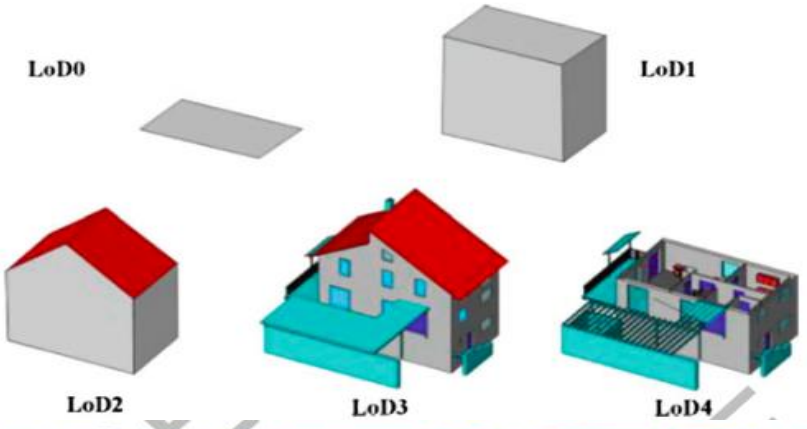


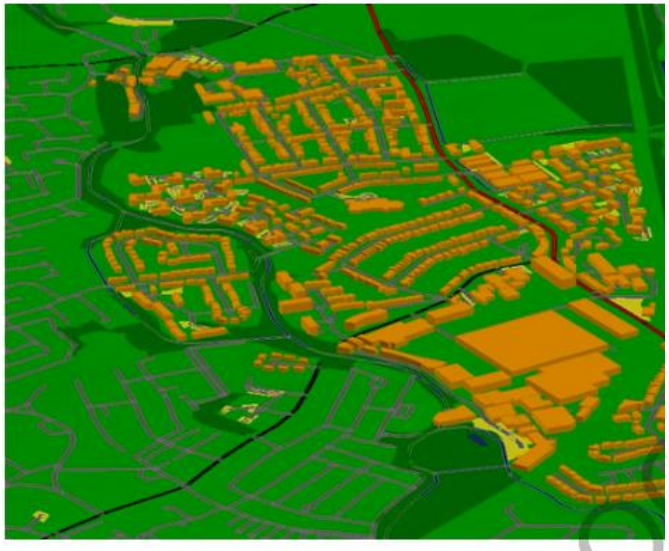
Type	Age	HA	Energy (kWh/p.a.)	CO^2 (kWh/p.a.)	Tenure (%)		
					Owner Occupied	Private Rented	Social Rented
I	1990s	1	13631	5861	80	12	8
[illegible]	1930s	2	19248	5841	29	15	56
B	1896-1920	3	31204	7807	80	12	8
Total			64083	19509			
Average			21361	6503			

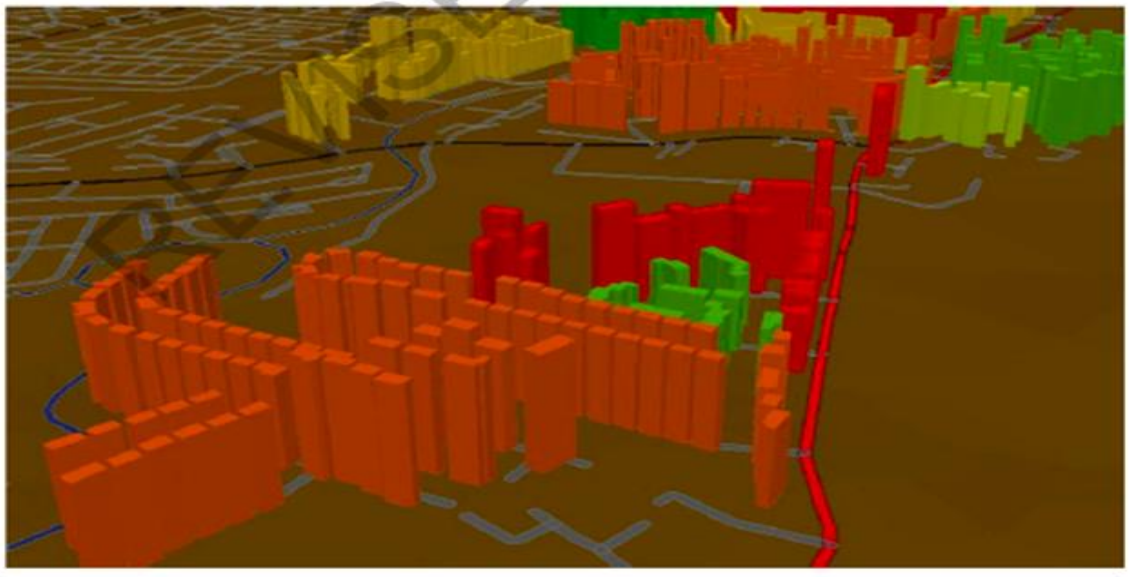


3-DEModelling (LoD1)

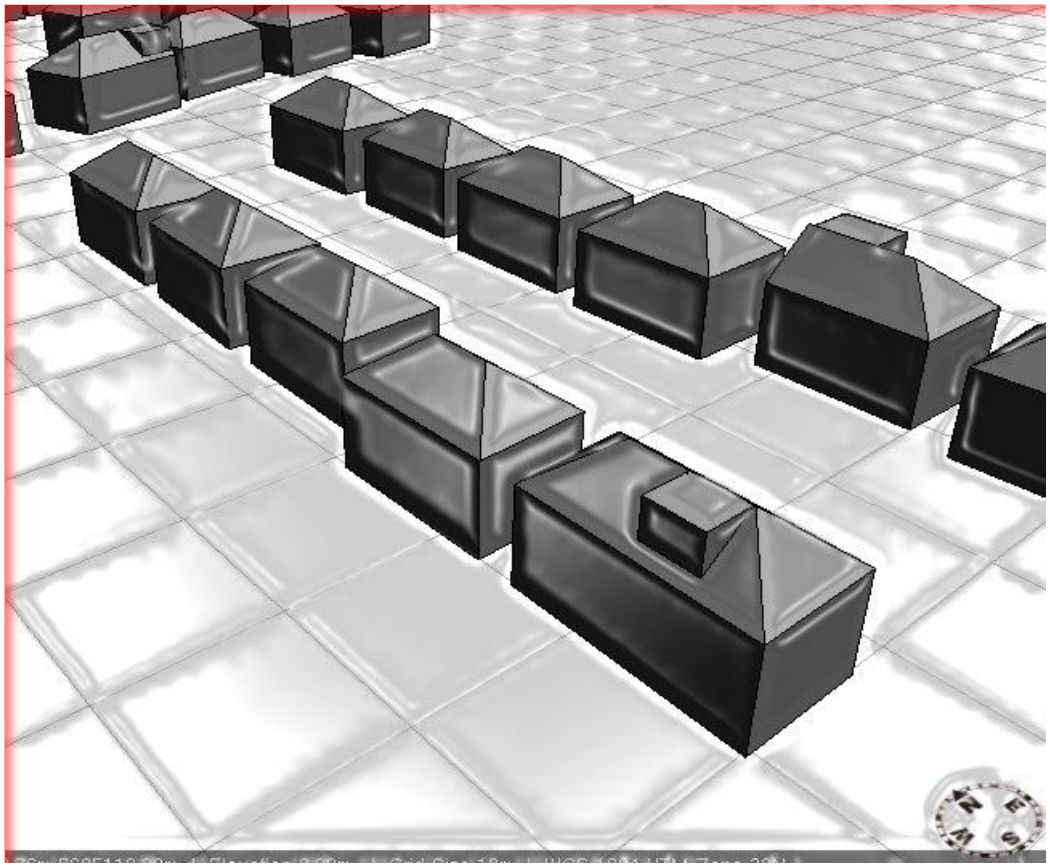
- LOD 0—regional, landscape
- LOD 1—city, region
- LOD 2—city-districts, projects (with explicit roof structure)
- LOD 3—architectural models (outside), landmarks
- LOD 4—architectural models (interior)

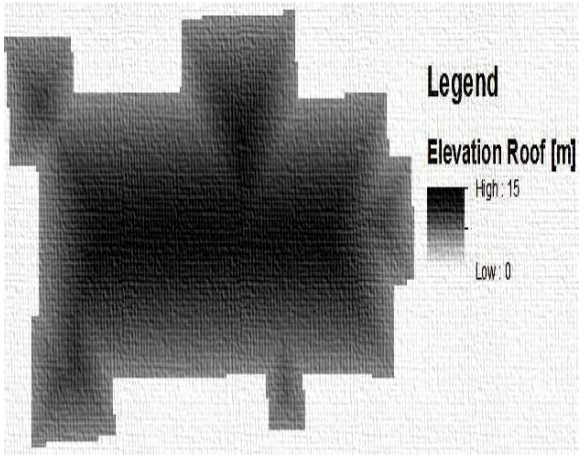


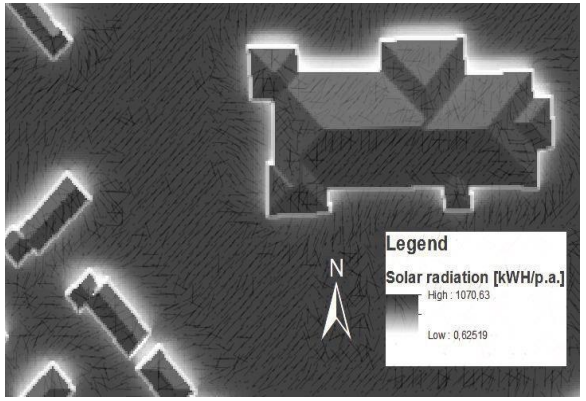




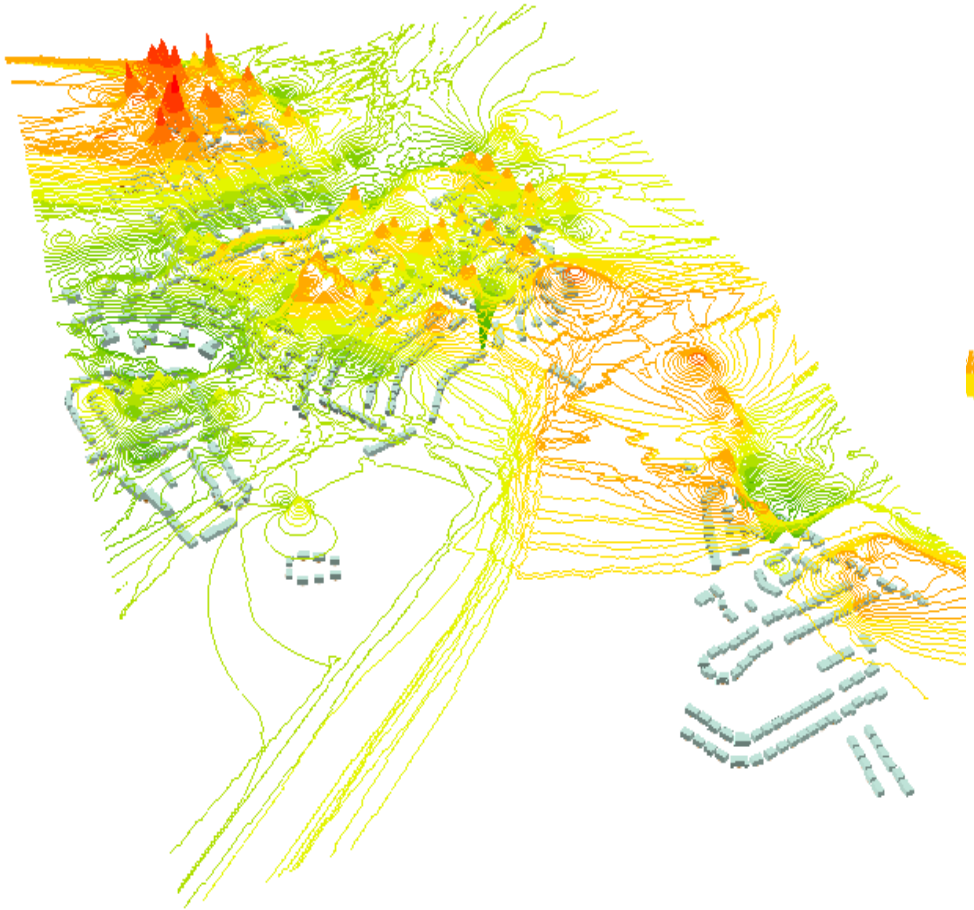
3-DEModelling (LoD2)

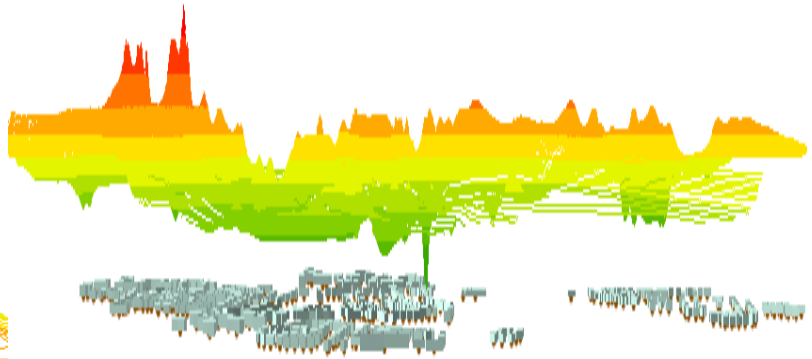




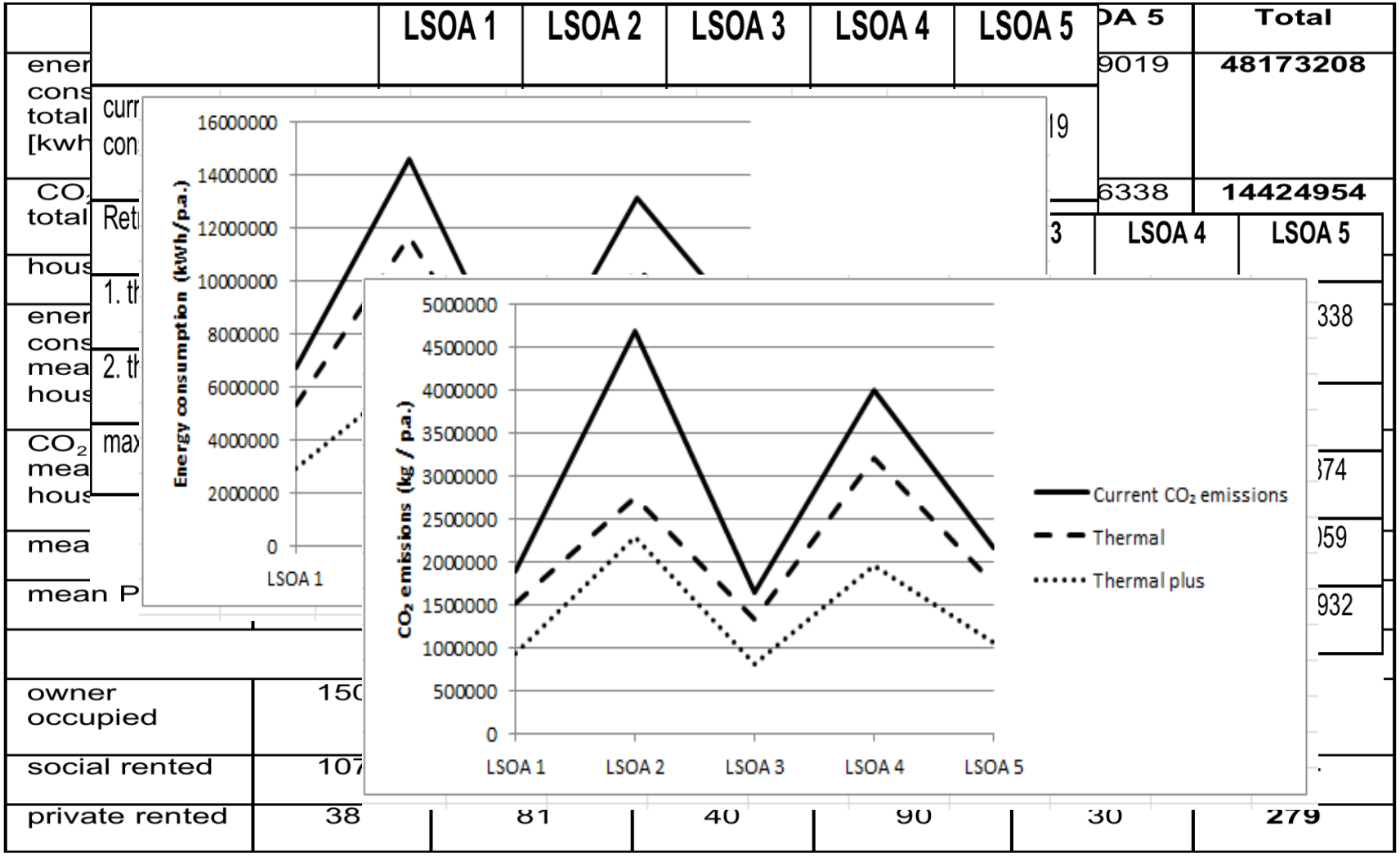


3-DEModelling of heat maps





..environmental profiling



.. economic composition

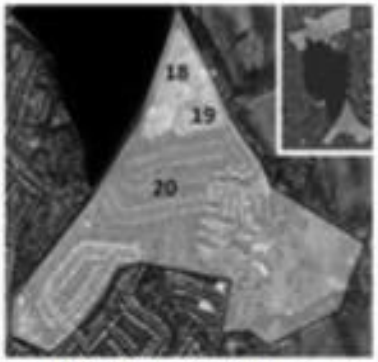
Stages	Cost (£ mill)	$C0_2$ tons/Savings	% CO_2 savings
Stage 1: performance-related assessment:			
• *Secondary Glazing*			
• *Solid Wall Insulation (Internal/External)*			
• *Under Floor Insulation*			
• *Heat Exchange Ventilation*			
• *Cavity Wall Insulation*			
• *Double Glazing/Triple Glazing*			
• *Boiler Replacement*			
• *Solar Water Heating*			
• *Solar Voltaic*	*120,000,000*	*3*	*50*
Stage 2: Under-gridding the sustainability of energy-efficient-low carbon zones:			
• *District energy network:*			
- bio-gas CHP (biomass/arboricultural)	*25,000,000*	*1*	*16*
- solar energy (poly-voltaic)	*4,000,000*	*0.35*	*6*
- wind power (turbines)	*1,000,000*	*0.35*	*6*
	150,000,000	***4.7***	***78***
Stage 3: Smart (micro) Grid:			
• *ESCO (Energy Services Company)*			
• *Peak-load management*		–	***5***
• *Dynamic pricing*			***83***

..social base-line

Energy consumption, CO_2 emissions and the structure of tenure.

Type	Age	HA	Average Energy Consumption (kWh p.a.)	Average CO^2 Consumption (Kg p.a.)	Tenure (%)		
					Owner Occupied	Private Rented	Social Rented
I	1990s	1	14,253	5,712	80	12	8
C	1930s	2	20,226	5,712	29	15	56
B	1890-1920	3	33,309	7,616	80	12	8
Total			67,789	19,040			
Average			22,596	6,347			

(deprived neighbourhood)

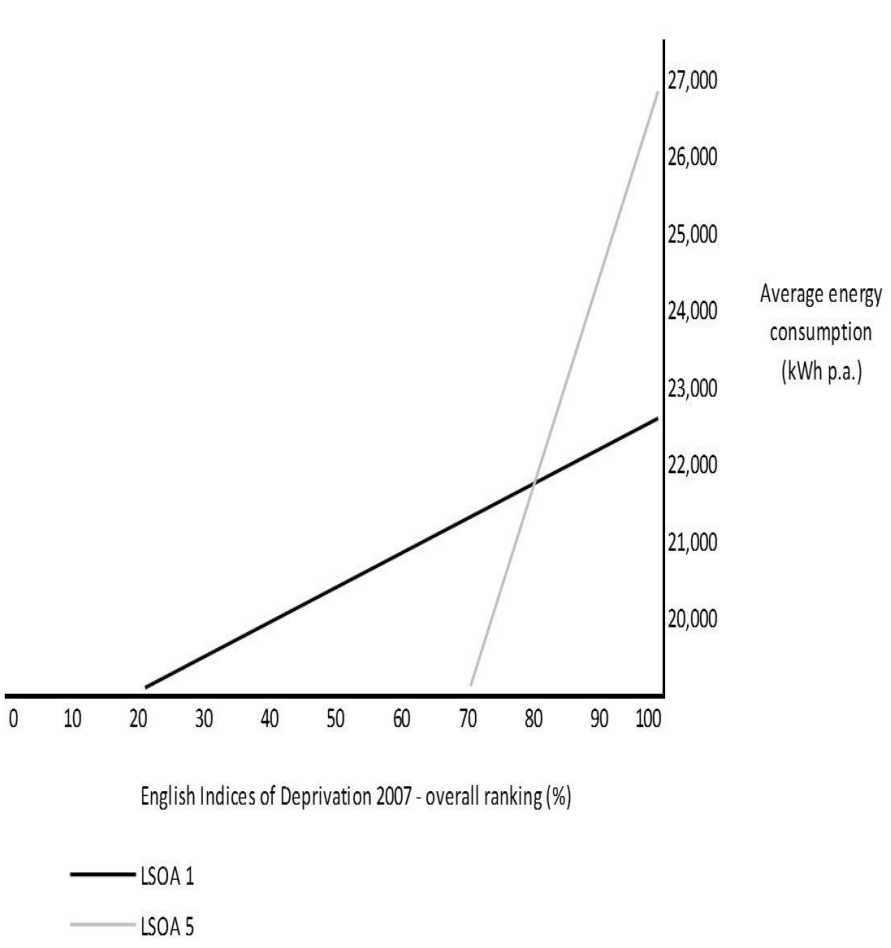


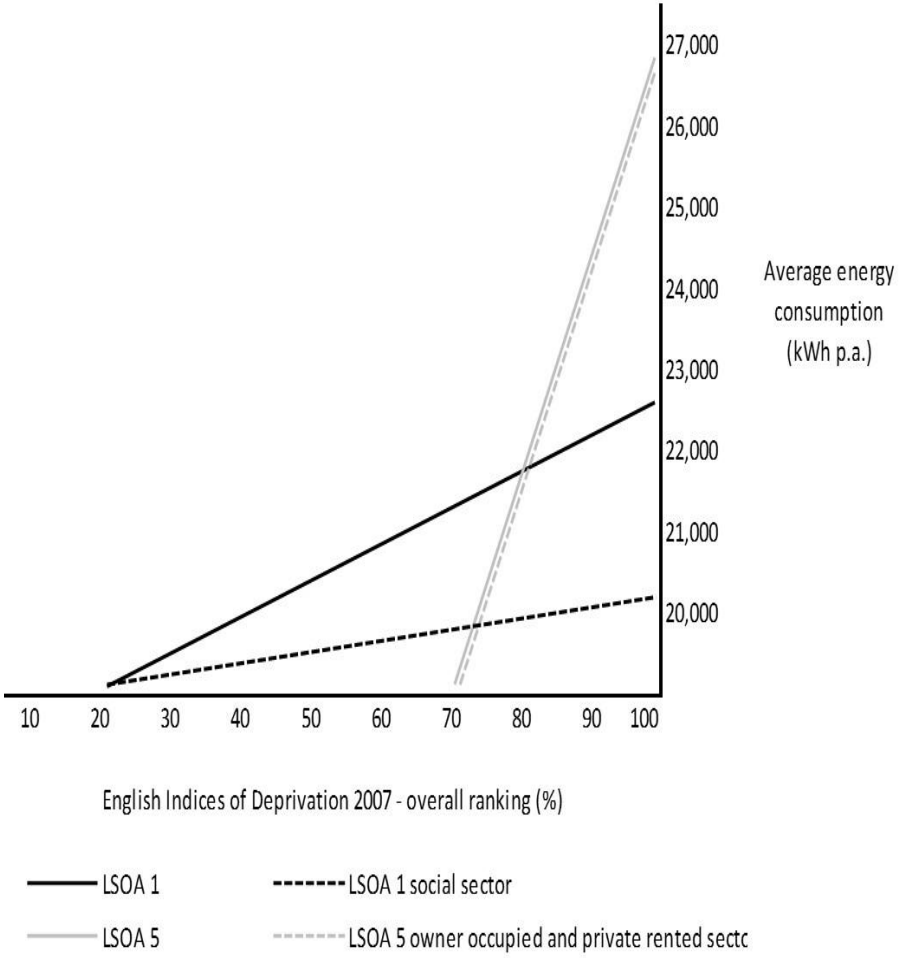
Type	Age	HA	Average Energy Consumption (kWh p.a.)	Average CO^2 Consumption (Kg p.a.)	Tenure (%)		
					Owner Occupied	Private Rented	Social Rented
B	1896-1913	18	37,972	9,358	87	10	3
L	1990s	19	16,965	5,440	87	10	3
F	Late 1930s	20	25,852	6,964	85	3	12
Total			80,789	21,762			
Average			26,930	7,254			

(affluent neighbourhood)

Notes: LSOA 1 (top); LSOA 5 (bottom). "Type" refers to the housing model applied in the London Borough of Sutton's (2008) Energy Options Appraisal. "Age" refers to the approximate year of build, as designated in the Energy Options Appraisal. "HA" refers to the designated localities of similar housing stock in the Hackbridge Study, as detailed in the Energy Options Appraisal. Twenty areas of similar housing stock are used to capture housing stock within the lowest-ranking Lower Super Output Area (EID, 2007) and the highest-ranking LSOA. Energy and CO_2 data is from the Energy Options Appraisal. "Tenure" data is taken from the Census 2001 at Output Area level; the HA (areas of similar housing) are smaller than Output Areas therefore exact counts for each area of HA cannot be provided.
Source: Deakin et al. (2014).

..transversal analysis





Source: Deakin et al. (2014)

..transversal analysis cont.

- *overall stages 1, 2 & 3 of the mass retrofit do have sufficient savings and reductions (approximately 80%) to be climate neutral and therefore **keep 1.5 alive**, but the benefits of this are appropriated disproportionately across the city-district so access to the life chances this offers are not equally distributed?*
- *for while the **intelligent platform cities assemble for buildings to be fueled by renewables may offer a wise management of natural resources**, the **participatory governance** of stage 1 is divisive in the sense the environmental profile is overly technical (based solely on the energetic of the built fabric). This results in the economic composition that is ill-informed in the sense which the environmental economics of the development serves to exclude the most deprived members of society from the savings and reductions sustaining the city-district as an energy efficient-low carbon zone.*
- *stages 2 & 3 do go some way to bridge this division in the morphological structure of the city-district, allowing the most environmentally benign to participate in the development by under-gridding the sustainability of the energy efficient-low carbon zone, with system wide changes whose inclusiveness cuts across the structure of tenure and allows everyone in society to appropriate a fair share of the respective savings and reductions.*

..some references

Leydesdorff, L. and Deakin, M. (2011) The triple helix of smart cities: a neo-evolutionist perspective, *Journal of Urban Technology*, vol. 18, (2): 53-63.

Deakin, M. and Al Wear, H. (2011) The transition from intelligent to smart cities, *International Journal of Intelligent Buildings*, vol. 3, (2): 140-152.

Deakin, M. (2012) Intelligent cities as smart providers: CoPs as organizations for developing integrated models of eGovernment Services, *Innovation: The Journal of Social Research*, vol. 23,(2): 115-135.

Deakin, M., Campbell, F. and Reid. A. (2012) Mass retrofit proposals, *Energy*, vol. 165, (4): 197-208.

Lombardi, P., Del Bo, C., Calagliu, A., Deakin, M. and Nijkamp, P. (2012) An Advanced Triple-Helix Network Model for Smart Cities Performance. In Information Resources Management Association ed. *Regional Development: Concepts, Methodologies, Tools, and Applications (3 Volumes),* IGI, Hershey.

Deakin, M ed. (2013) *Smart Cities: Governing, Modelling and Analysis the Transition*, Routledge, London.

Deakin, M., Reid, A., Campbell, F. and Orsinger. `J. (2014) *The Mass Retrofit of an Energy Efficient – Low Carbon Zone*, Springer, London.

Deakin, M. (2014) Smart cities: the state-of-the-art and governance challenge, *Triple Helix*, 1, (1): 1-16. Mora, L., Bolici, R. and Deakin, M., 2017. The First Two Decades of Smart-City Research: A Bibliometric Analysis. *Journal of Urban Technology*, 24(1), 3-27.

Deakin, M. and Reid, A. (2018) Smart cities: Under-gridding the sustainability of city-districts as energy efficient-low carbon zones*, Journal of Cleaner Production,* 173*,* 39-48.

Thank you.....