The Future of Urban Energy Systems: A Global Energy Assessment

Imperial College Laing O'Rourke Centre Distinguished Lecture

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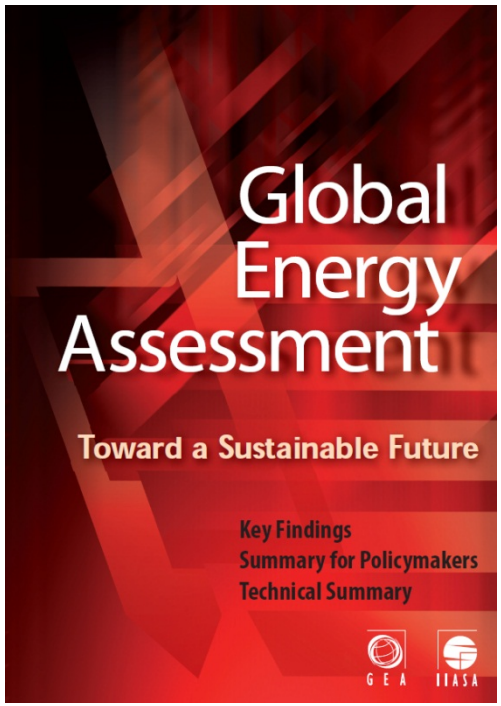
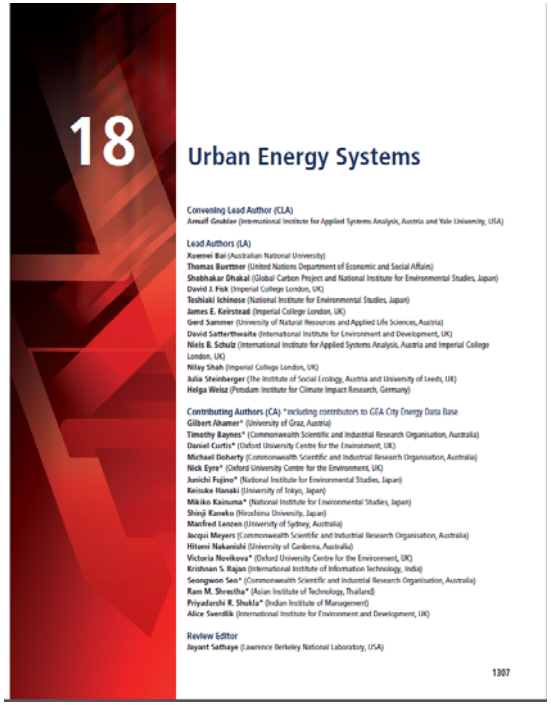
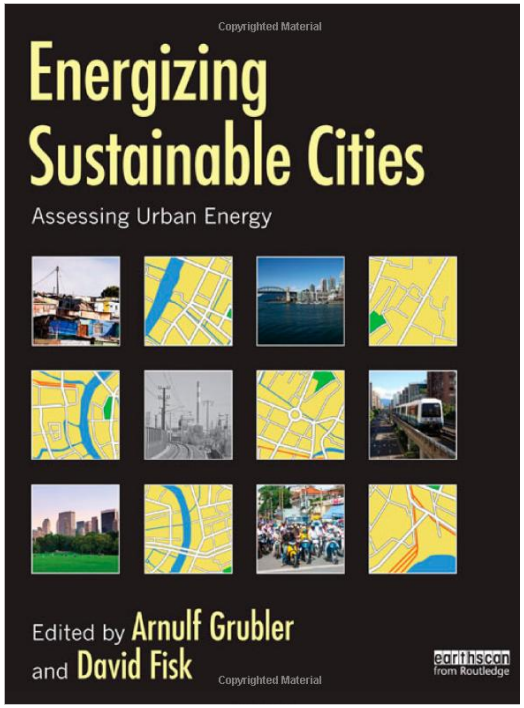
GEA KM18 Urbanization







Global Energy Assessment

Multi-stakeholder “IPCC of energy” 2008-2012
Focus on energy challenges, options, transitions
Assess linkages: access/poverty, development, security, health, climate
Policy guidance (normative scenarios)
First ever energy assessment of urbanization: KM18

Main Messages

1. **The world is already today predominantly urban (~3/4 of final energy)**
2. **Rural populations are likely to peak at 3.5 billion and decline after 2020 (all long-term energy growth will be urban)**

3. **City dwellers have often lower direct energy and carbon footprints**
4. **Important deficits in urban energy and carbon accounting (embodied energy, import/export balance) jeopardize effective policies**

5. **Cities have specific sustainability challenges & opportunities (high density enables demand/supply management but calls for low waste/~zero-impact systems)**

6. **Vast improvement potentials (>x2), but most require management of urban form and systemic change (recycling, cascading, energy-transport, land-use-transport systems integration,..)**
7. **Governance Paradox:**
   - **largest leverage from systemic change,**
   - **but requires overcoming policy fragmentation and dispersed, uncoordinated decision taking**

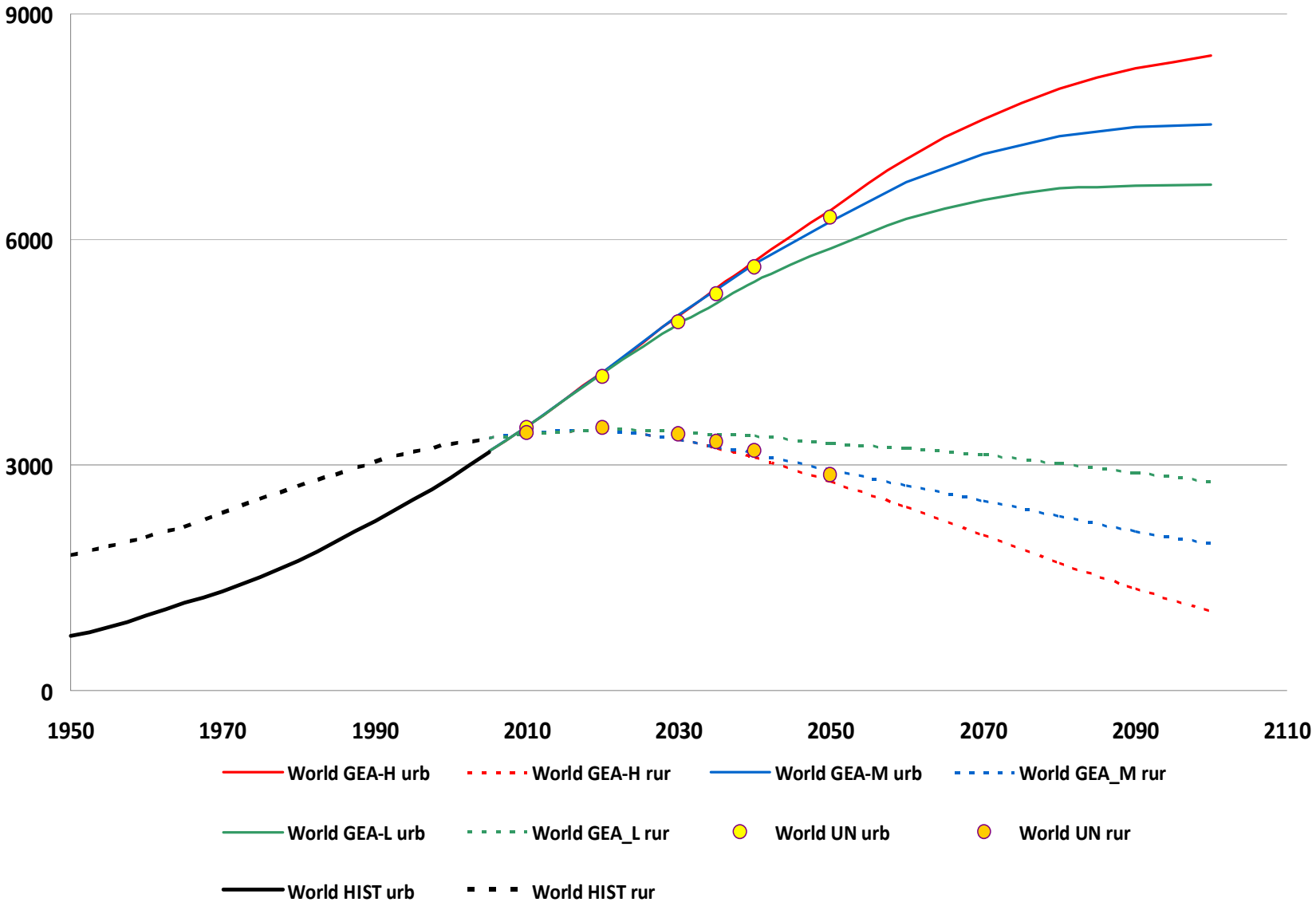
How Urban is the World AD2000?

Indicator			Data Source	Range	References for uncertainty range
Area	**(1000 km2)**	2929	1	313-3524	Schneider et al., 2009
	% of total	***2.2***		*0.2-2.7*	range of GlobCover-GRUMP data
Population	**(million)**	2855	2	2650-3150	Uchida&Nelson, 2008
	% of total	***47***		*44-52*	size threshold: 50,000-100,000
GDP (MER 2005$)	**(billion)**	32008	1		
	% of total	***81***		??	not available
Final energy use	**(EJ)**	239	1	176-246	this assessment
	% of total	***76***		*56-78*	(see Section 18.4.1)
Light luminosity	**(million NLIS)**	33	3,1		
	% of total	***57***		*50-82*	KM18 estimate
Internet routers	**(number in 1000)**	592	4,1		
	% of total	***96***		*73-97*	KM18 estimate

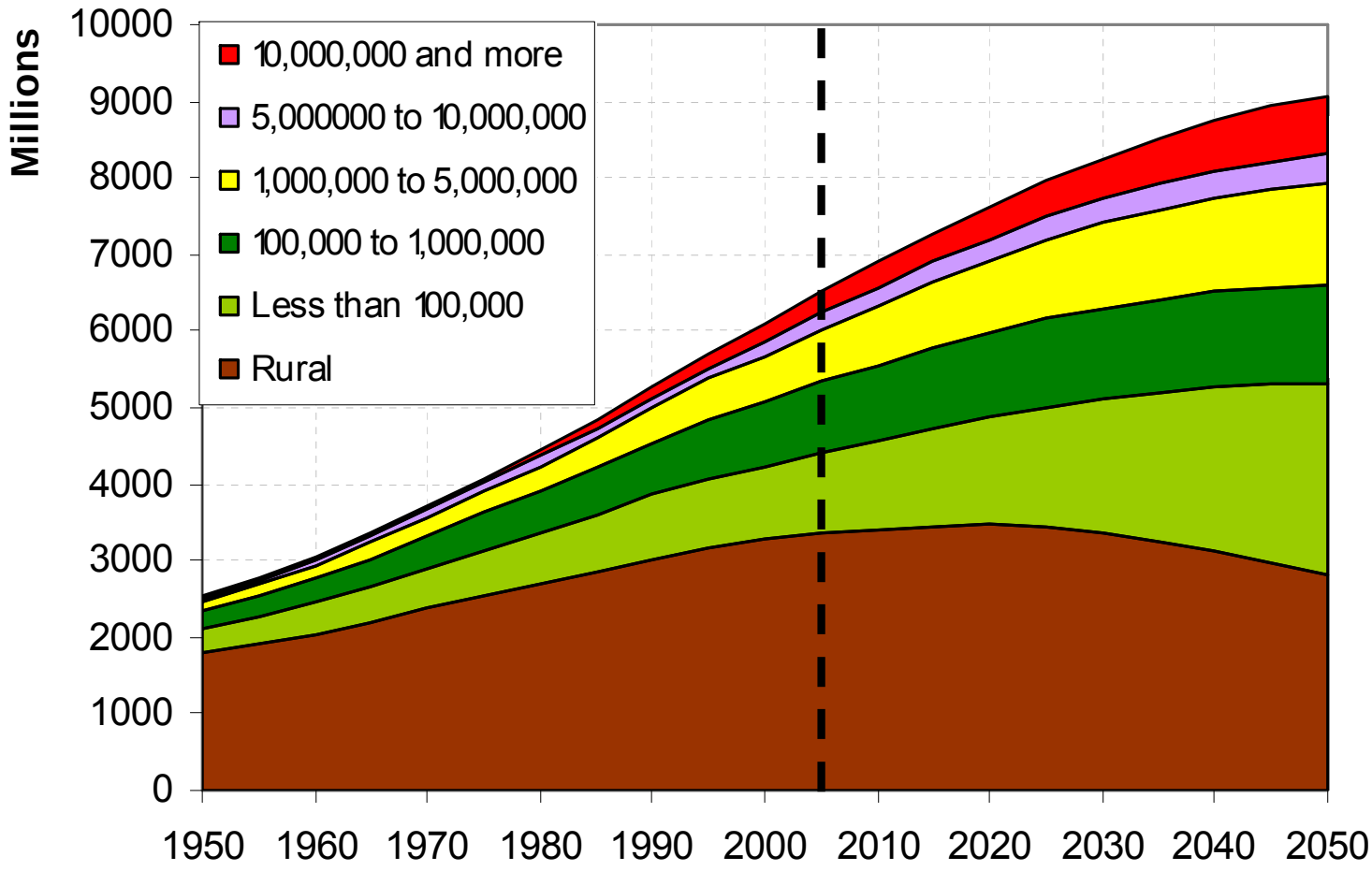
Notes: MER: Market Exchange Rates, NLIS: Light Luminosity Intensity Sum (index)

Urban and Rural Population Projections (Millions)

GEA-H, GEA-M, GEA-L and UN WUP, 2010



Population by Settlement Type/Size



Number of agglomerations in 2005

13

30

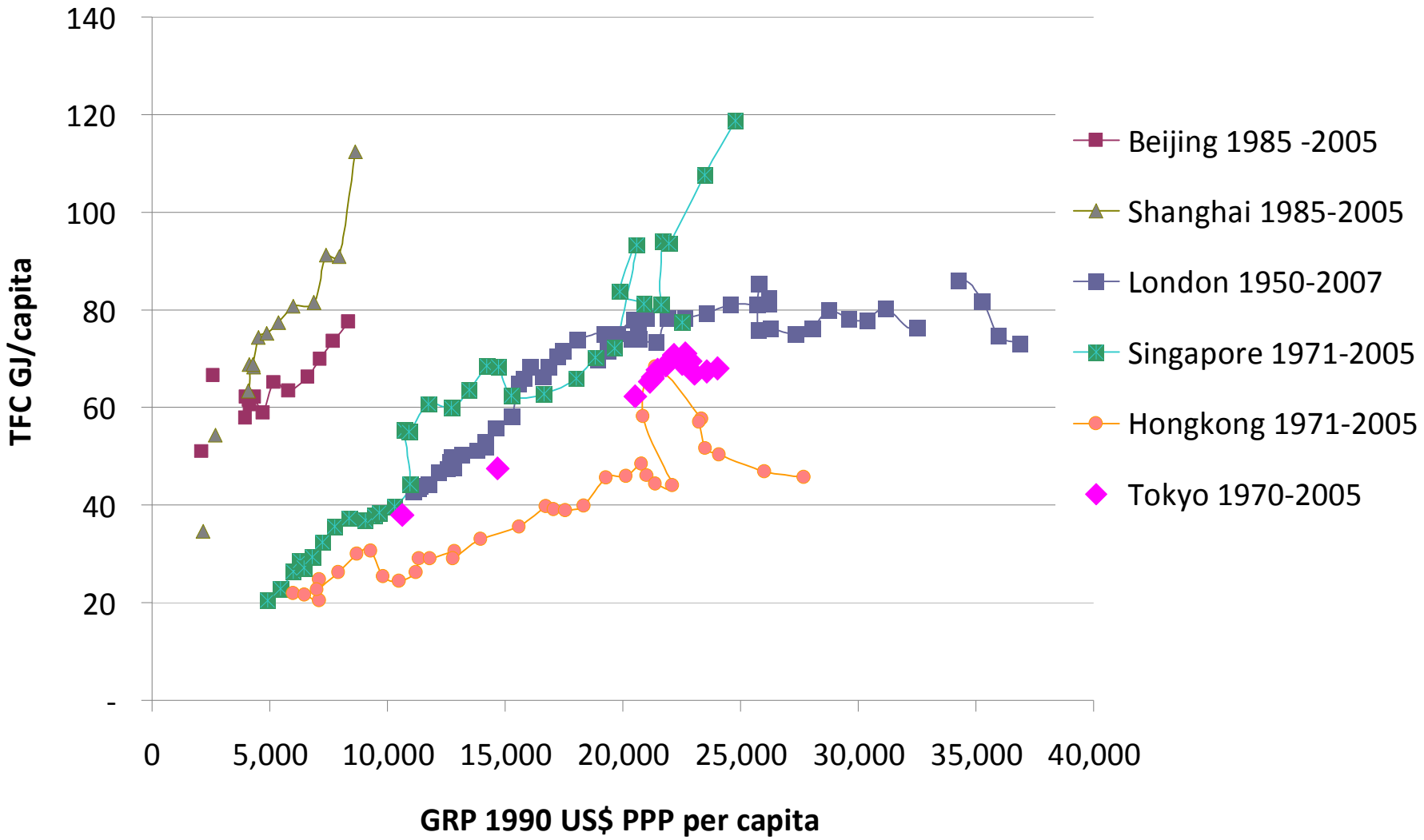
340

3192

??

growth dominated by small & medium sized cities!

Path Dependent Urban Energy – Incomes



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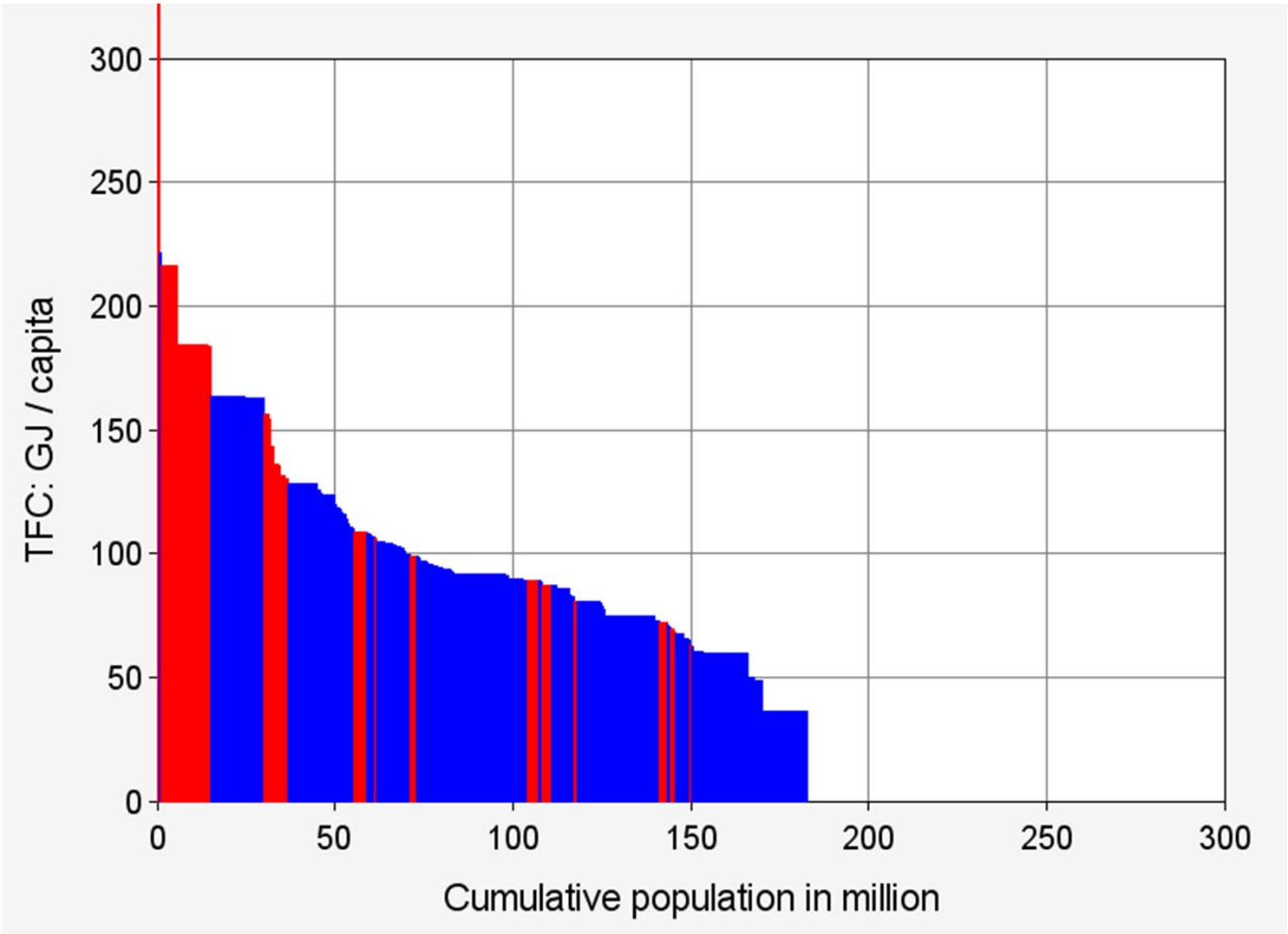
Annex-I: Per Capita Urban Direct Final Energy Use

(red= above national average, blue = below national average)



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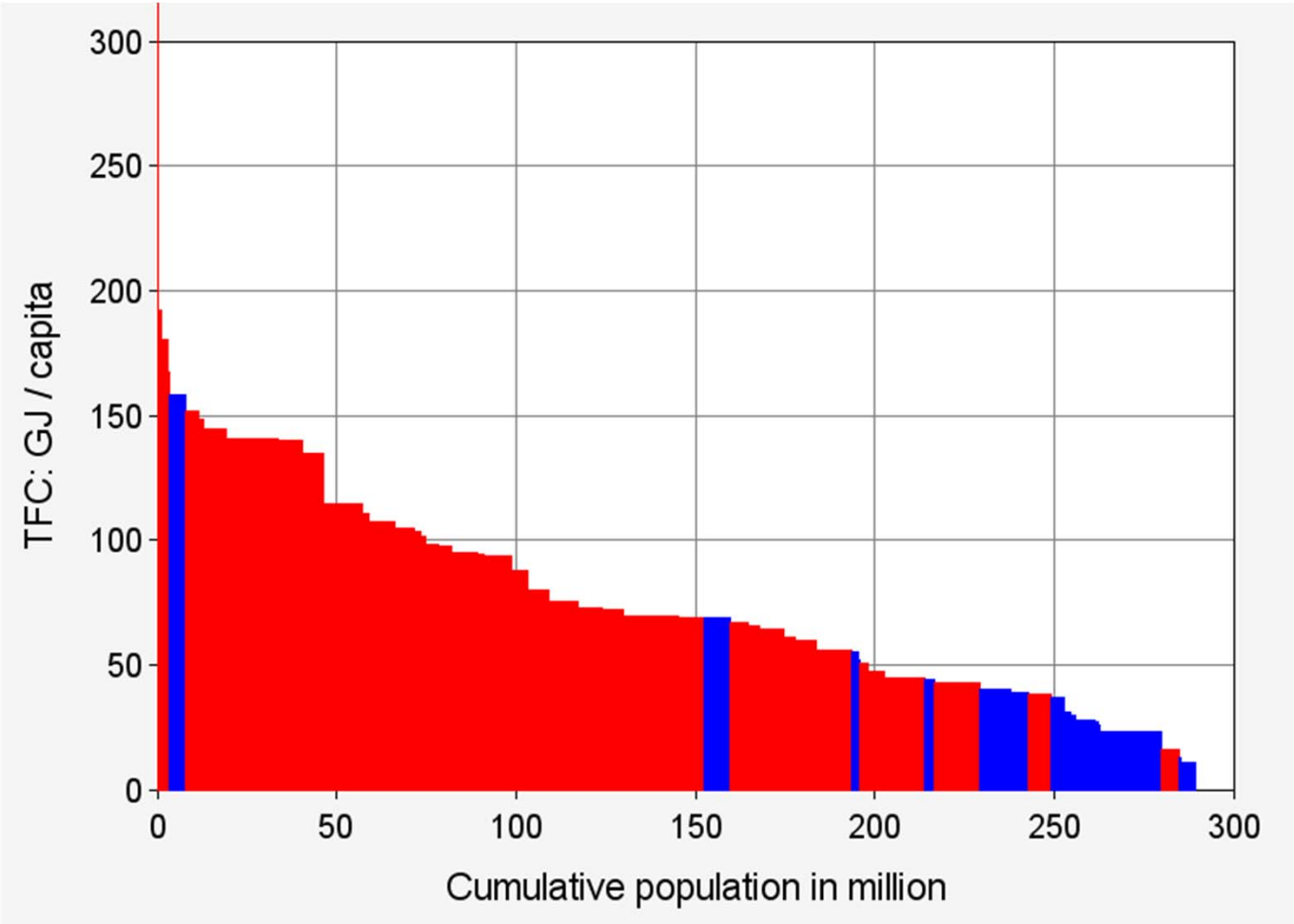
Non-Annex-I: Per Capita Urban Direct Final Energy Use

(red= above national average, blue = below national average)



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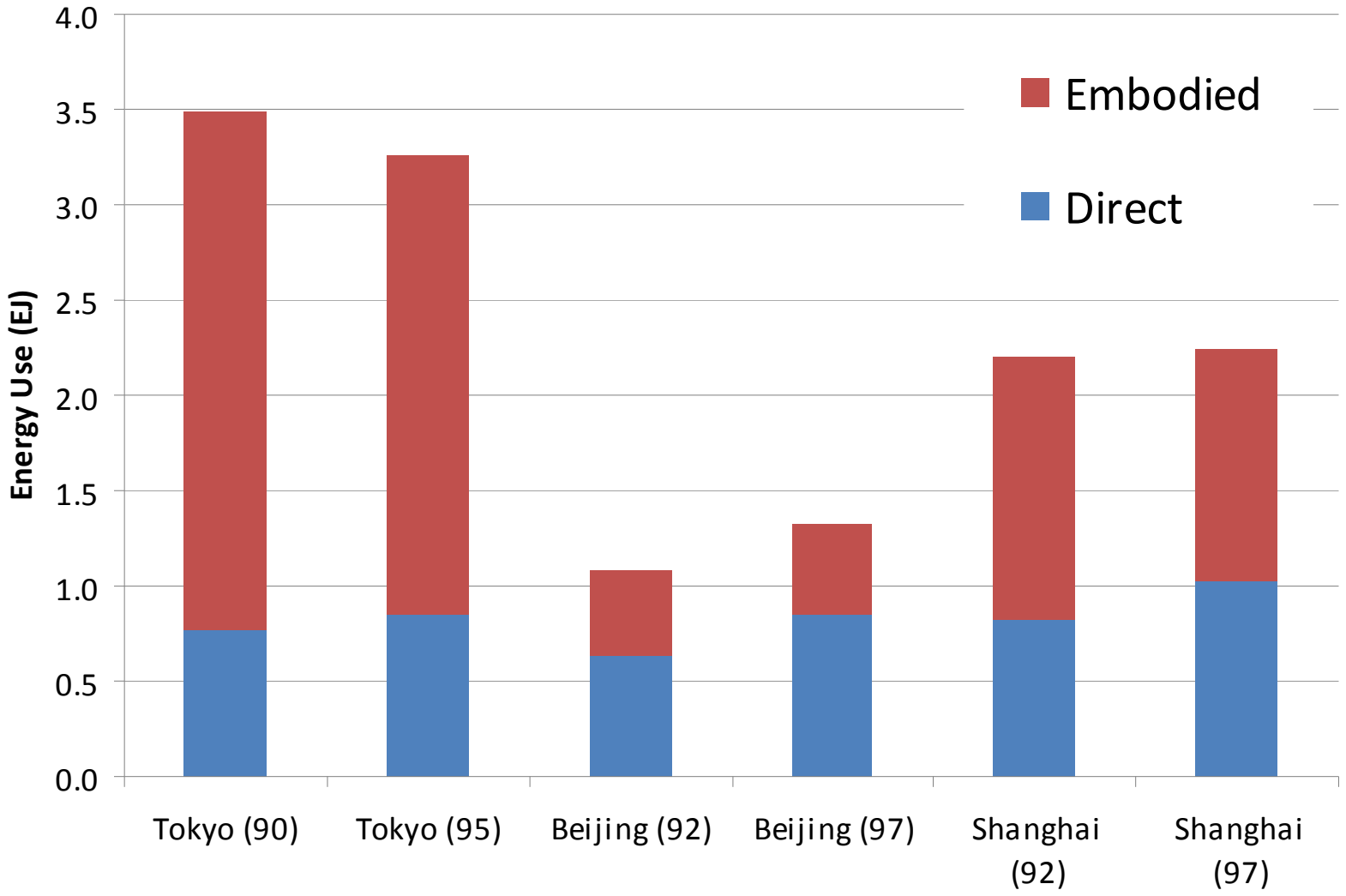
Direct and Embodied Urban Energy Use in Asian Cities



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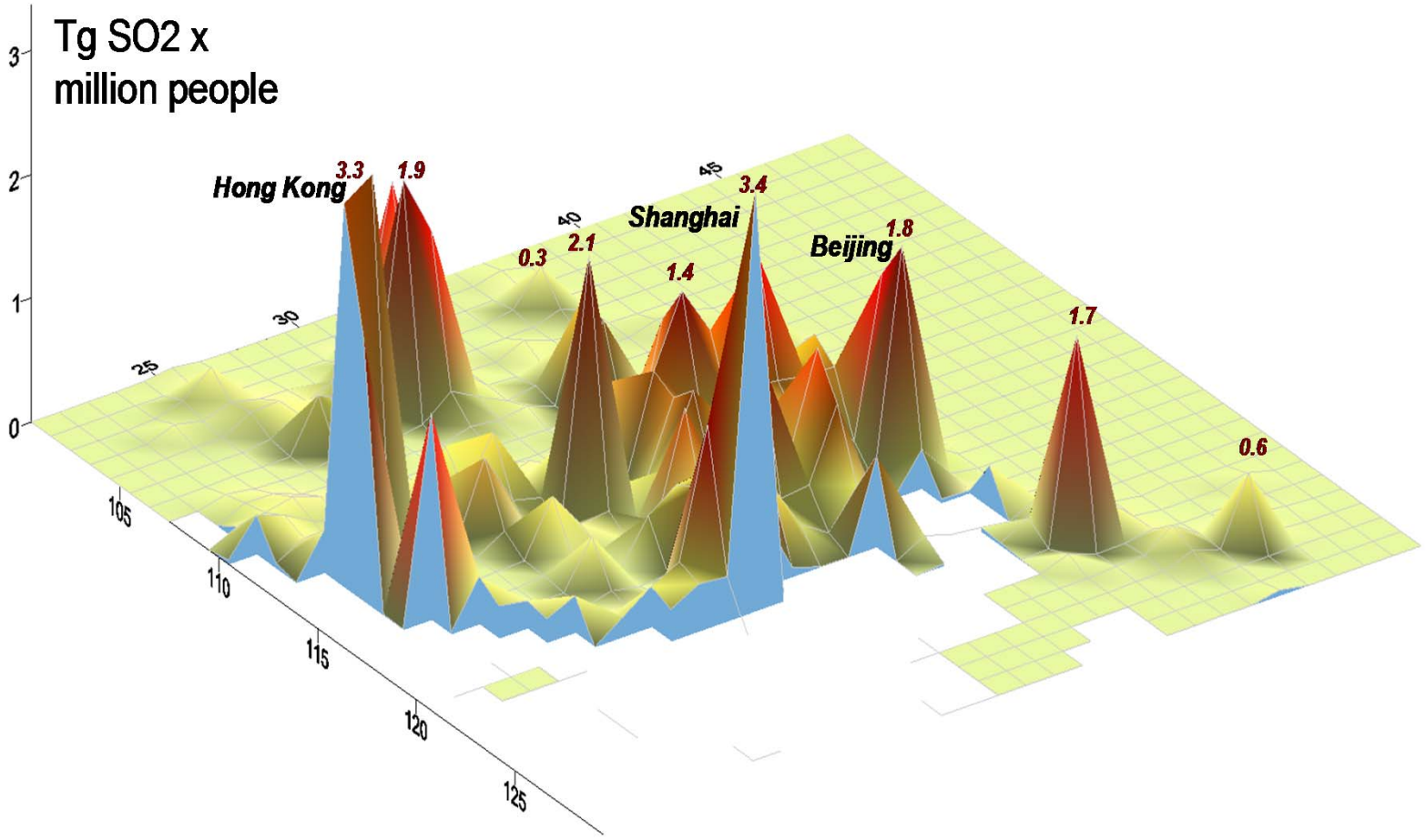
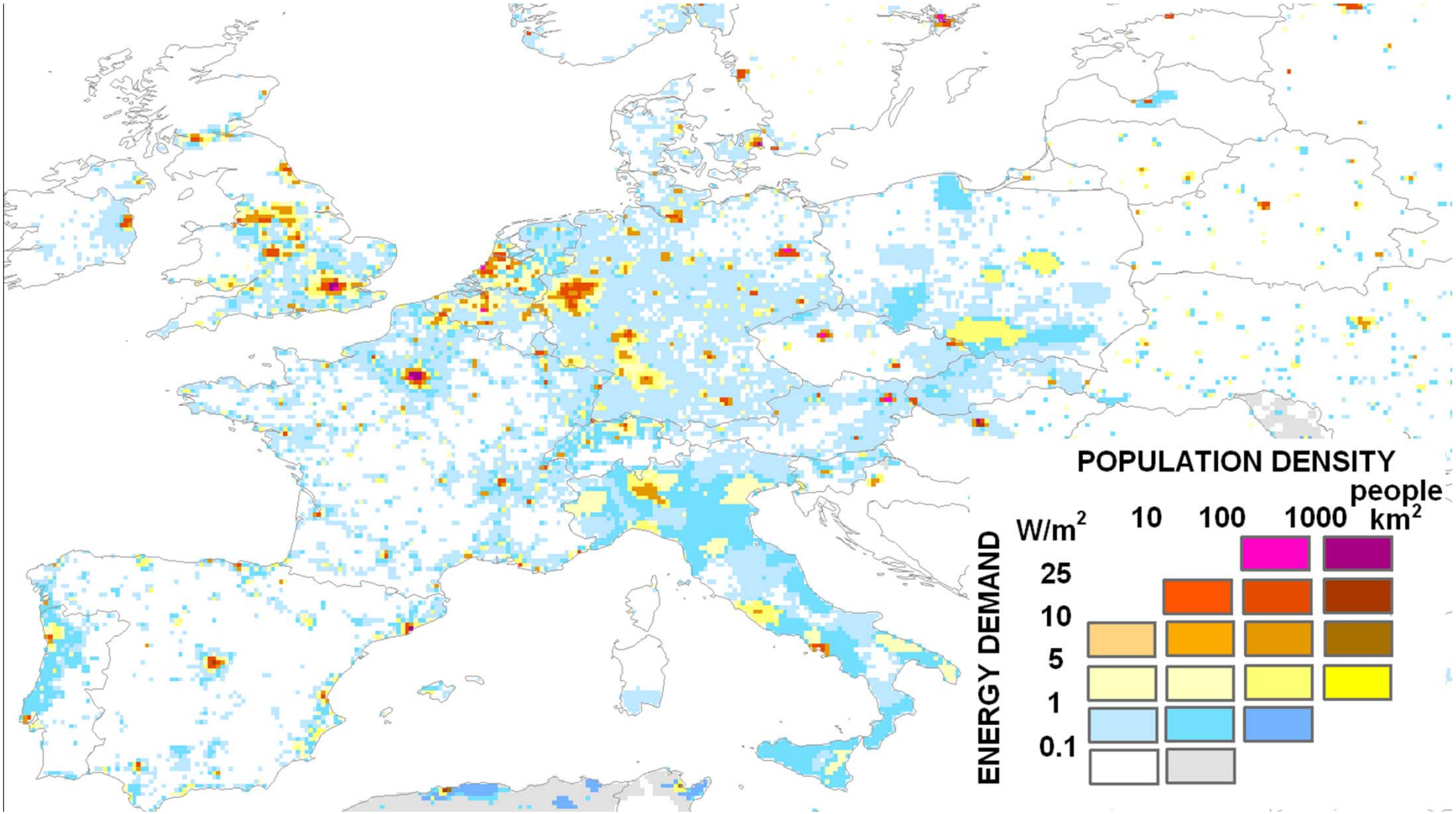
China - Air Pollution (SO_2) Exposure



Europe – Energy Demand Densities

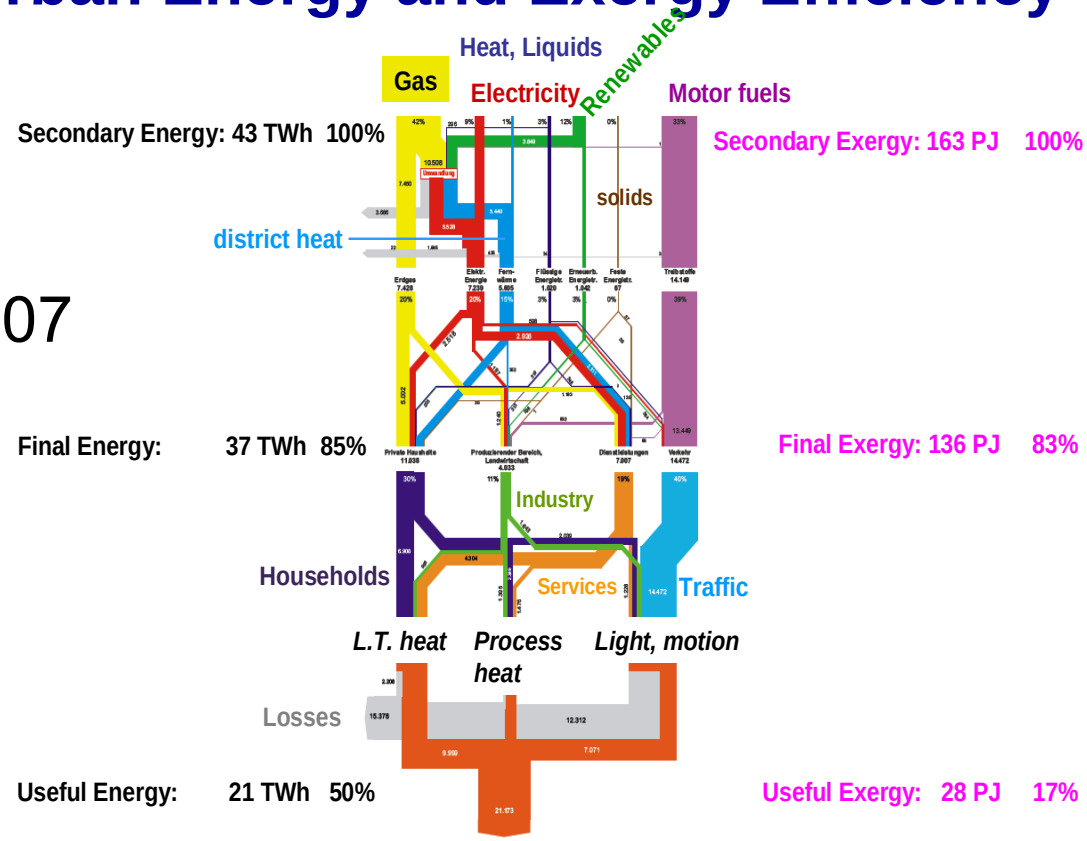
blue = renewable supply density threshold <0.5-1 W/m2

WEU >79% EEU >66% of energy demand



Urban Energy and Exergy Efficiency

Vienna 2007



	Useful exergy as % of secondary	primary
Geneva (CH)	23.2	15.5
Vienna (A)	17.2	
Malmo (S)	21.2	12.7
London (UK)	11.3	6.2
trad. Mexican village	5.7	

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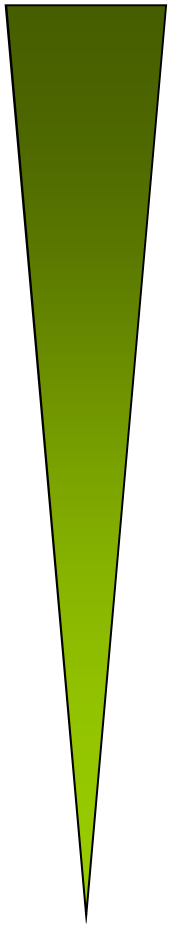
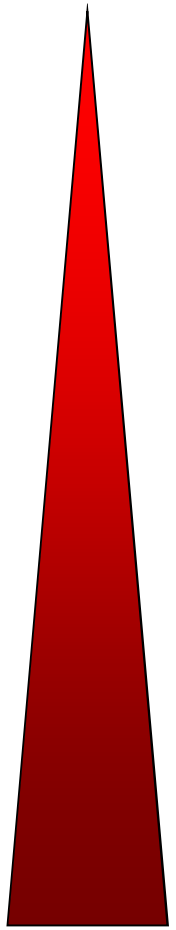
Stylized Hierarchy in Urban Energy/GHG Drivers and Policy Leverages



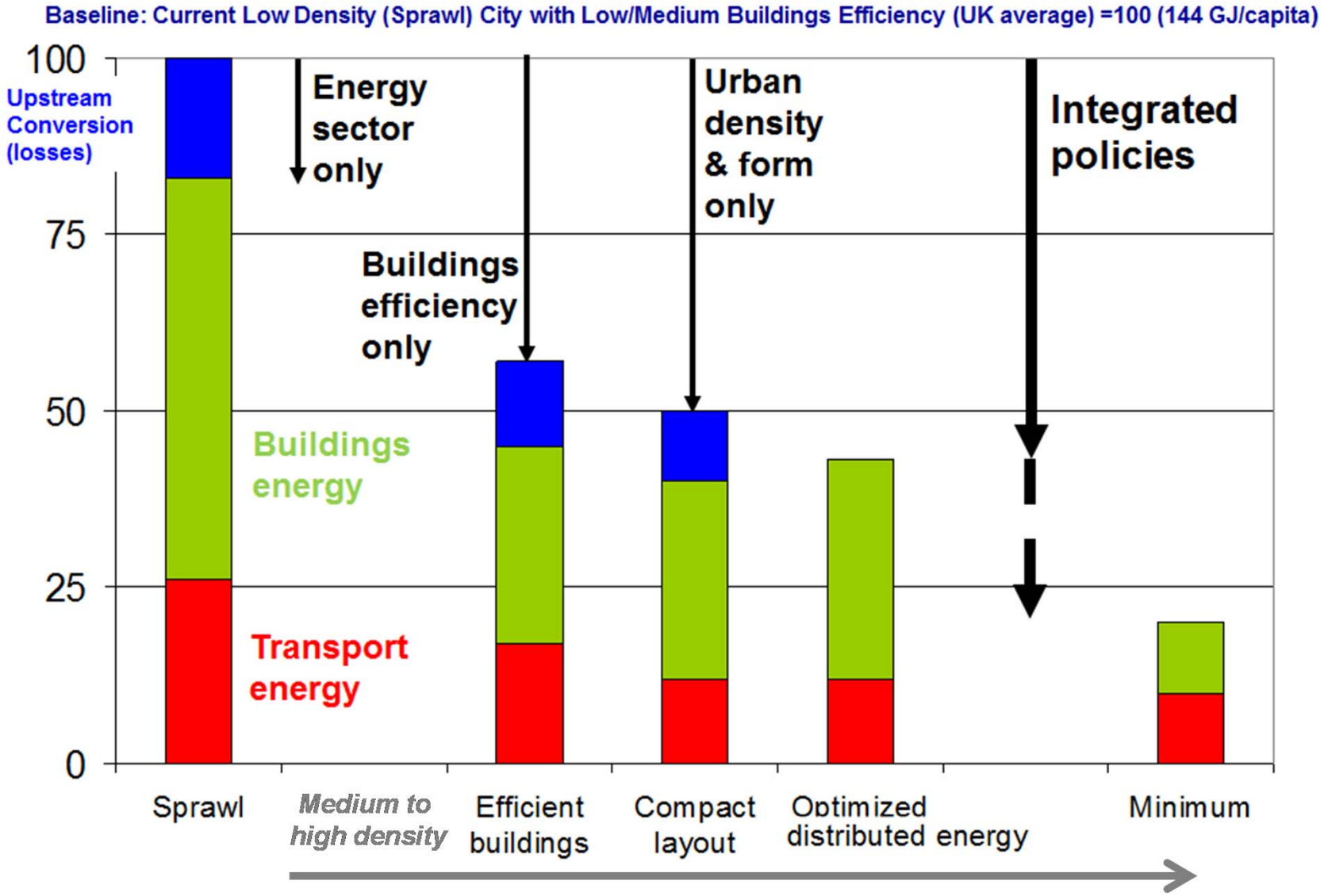
1. Spatial division of labor (trade, industry structure, bunkers)
2. Income (consumption)
3. Efficiency of energy end-use (buildings, processes, vehicles, appliances)
4. Urban form (density↔public transport↔car ownership↔functional mix)
5. Fuel substitution (imports)
6. Energy systems integration (co-generation, heat-cascading)
7. Urban renewables



Decreasing order of importance

Increasing level of urban policy leverage

SynCity Simulations of Urban Policy Leverages



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GEA KM18 Authors & Resources

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Resources:
Online: www.globalenergyassessment.org
Chapter 18 (main text)
Supporting material: GEA KM18 working papers and city energy data base

A. Grubler and D. Fisk (eds), *Energizing Sustainable Cities: Assessing Urban Energy*, Earthscan (2012)