

*Presentation at the third annual meeting of LCS R Net
Transition towards low carbon societies in a changing world*

Global patterns of Urban Energy use – challenges and progress

Results from the global energy assessment, chapter 18: Urbanization

Session 3.2; 2: Domestic and international drivers of urban dynamics

Niels B. Schulz

International Institute for Applied System Analyses (IIASA)

Venue: College des Bernardins, 20 rue de Poissy 75005 Paris

Date: October 13th-14th 2011,

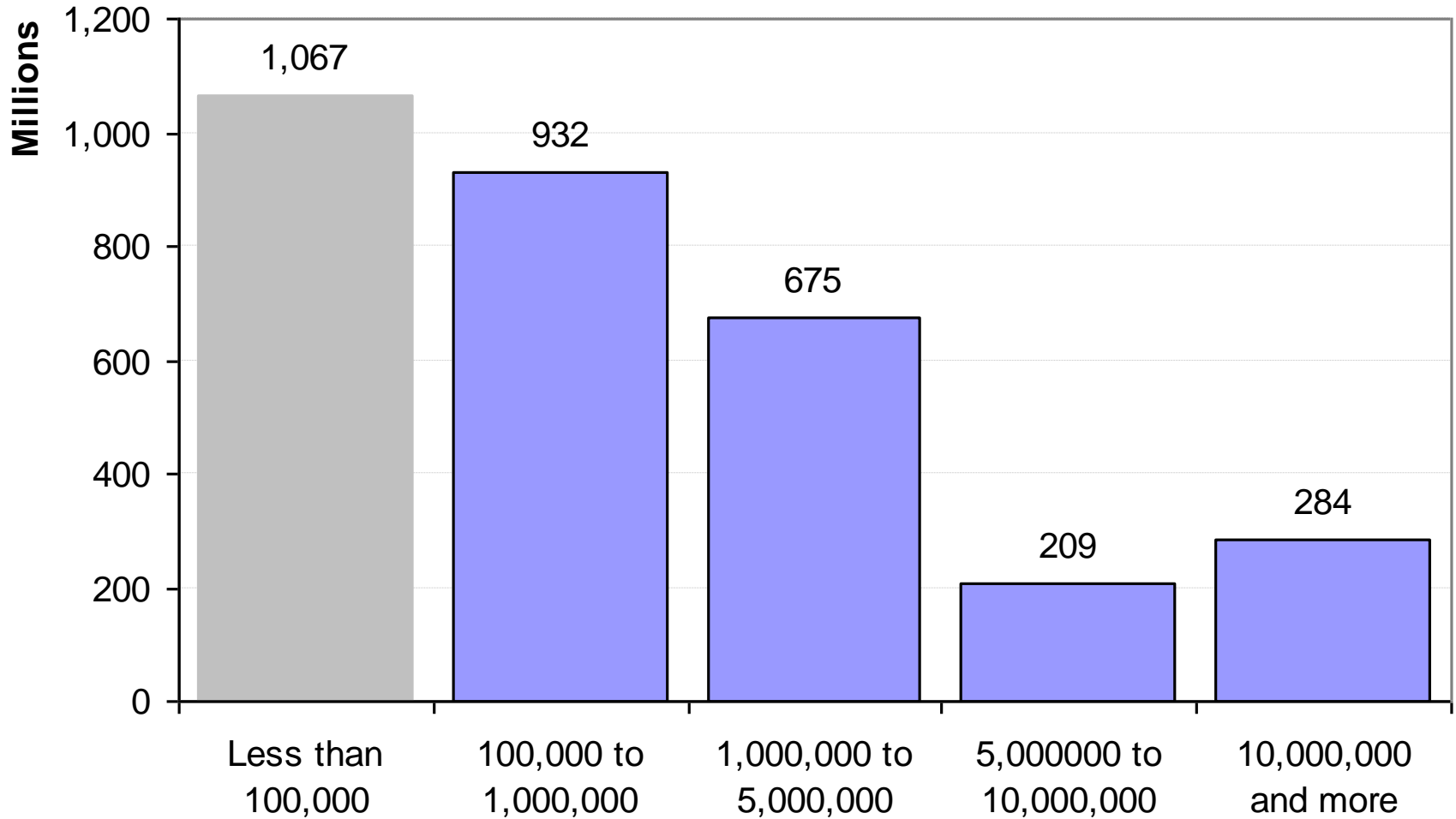
LCS • **R**Net



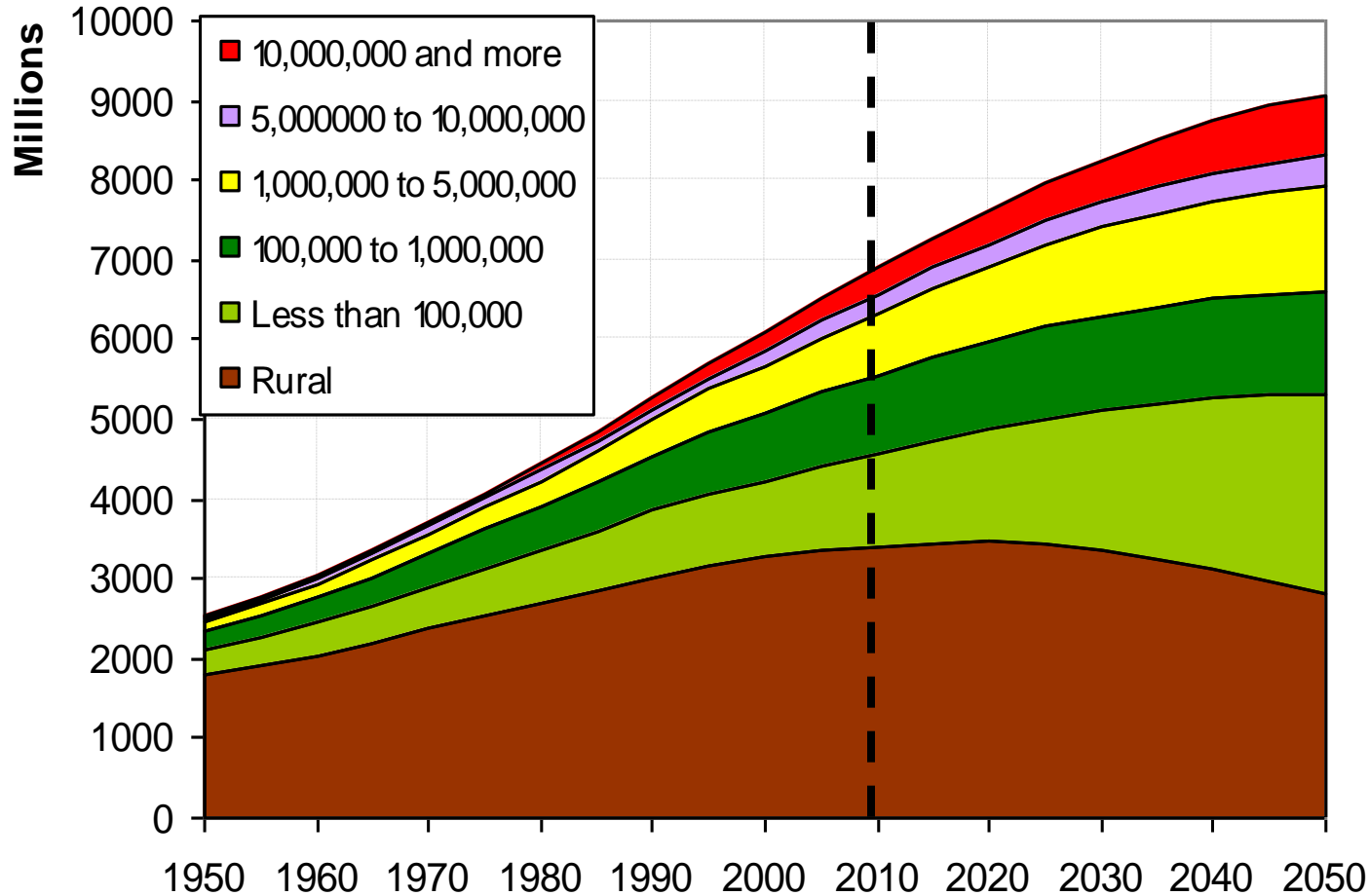
outline

- Challenges of
 - Defining urban areas
 - Defining urban energy use
- Empiric patterns of urban energy use based on available literature data
- Conclusions for global climate mitigation strategies at the urban scale

Urban Population by City Size Class in 2005



Urban Population und Settlement Size



Nr of urban settlements
in 2005

13
30
340
3192
??

- Urbanization is projected to rise fastest in small centers

- They are less constrained by already existing infrastructure and other land use conflicts

- But the capability of such settlements to act & implement is also weak.

Varying definitions for urban areas

Constraints and limitations

- Dependence on national definitions of urban areas and urban locations

Criterion	Countries
Administrative	83
Economic	1
Population size	57
Urban characteristic	4
Any combination	48
Entire population	6
No urban population	3
Unclear definition	1
No definition	25
Total	228

Urbanization,
Development
Pathways
and
Carbon
Implications

Tsukuba, 2007

unpopulation.org

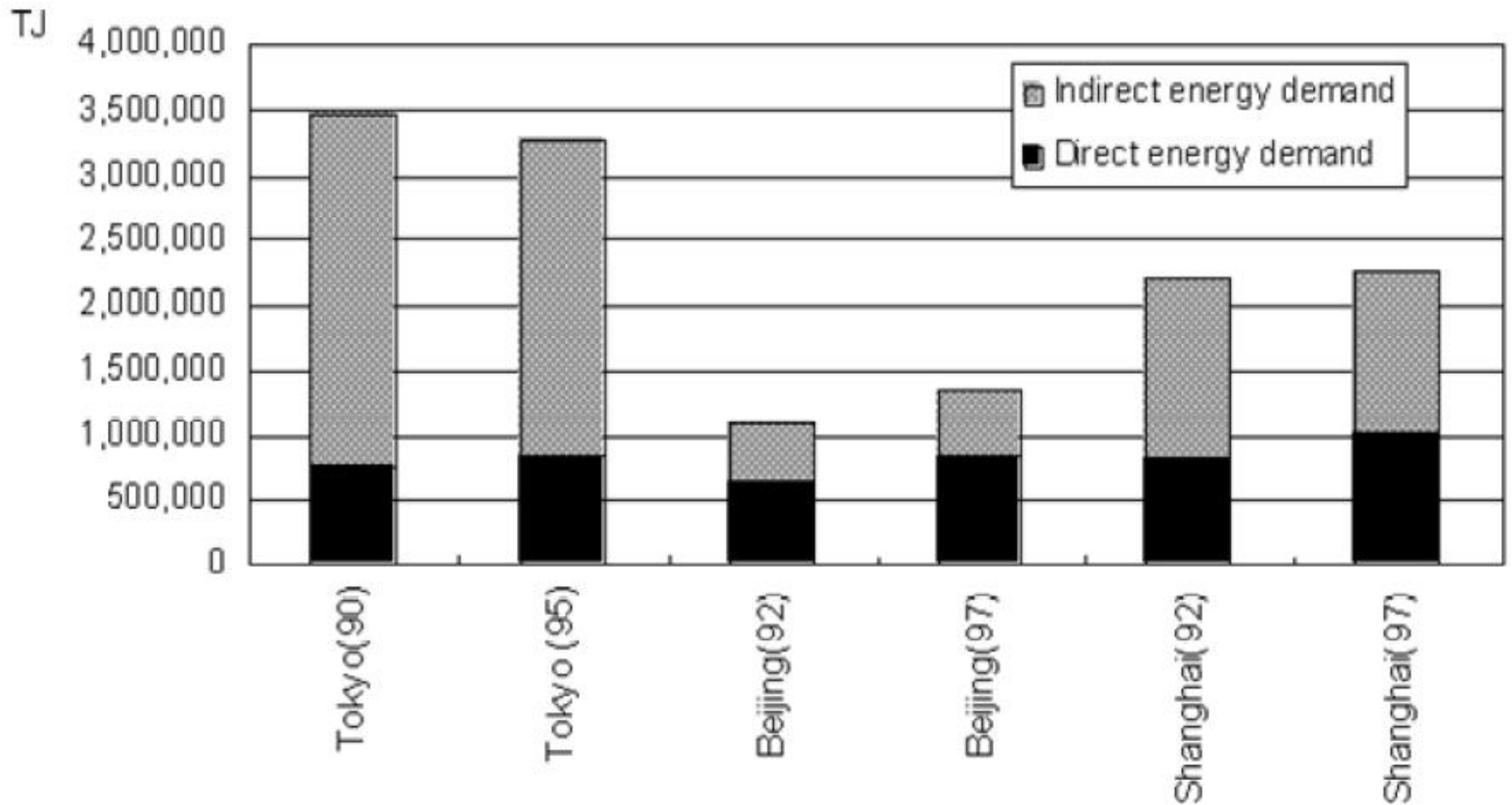
United Nations
Population
Division

Thomas Buettner
UN Population Division

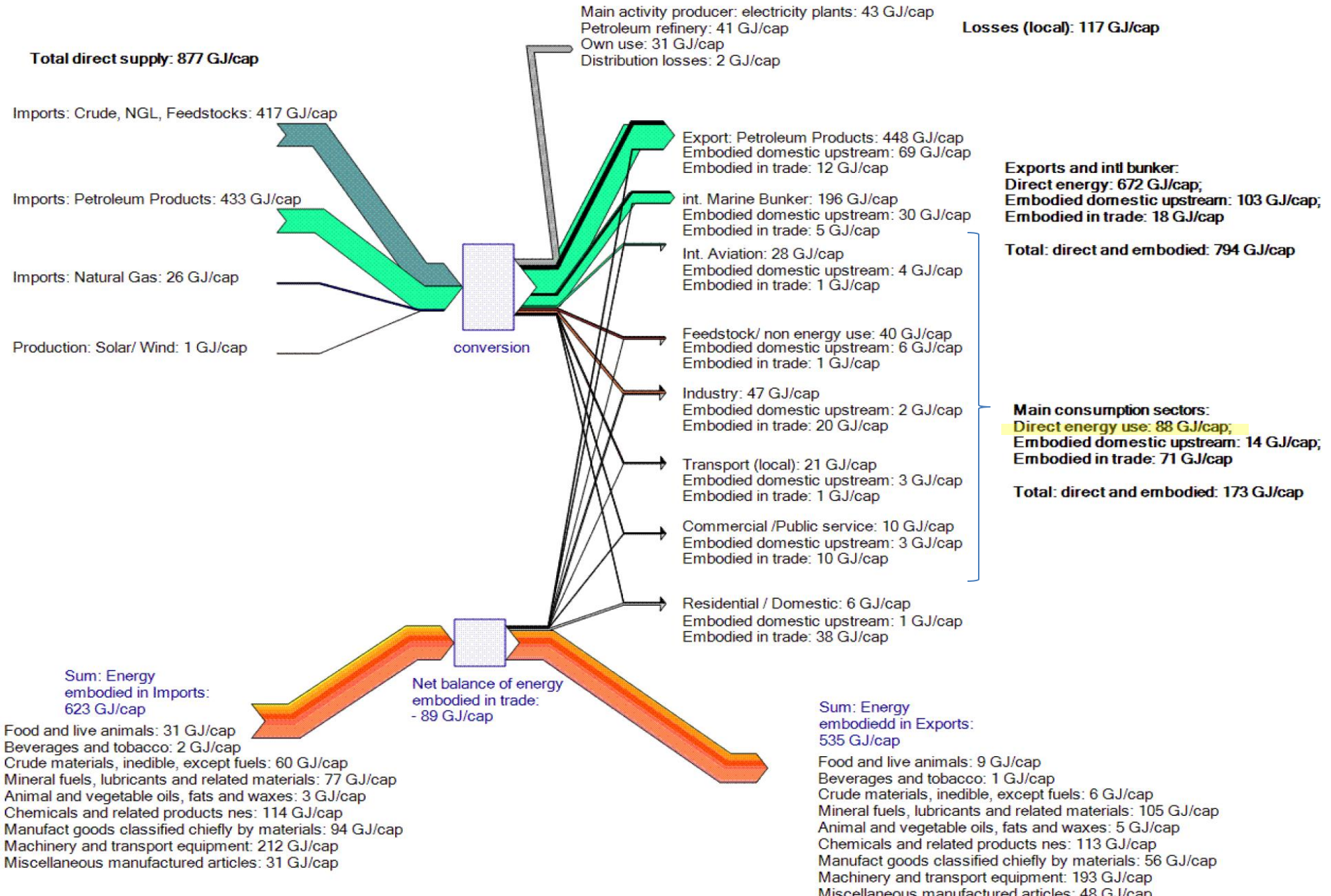
- a globally harmonized and comparable database of urbanization is needed
- Spatially explicit projections as well

(Source: Thomas Buettner, 2007)

Urban Energy Use (TJ) in Asian Cities: The Importance of Systems Boundaries



Direct and indirect energy consumption of Singapore



How Urban was the World AD 2000?

Indicator		Source	Range	Ref. Range	
Area	(1000 km2)	2929	1	313-3524	Schneider et al., 2009
	% of total	2.2		0.2-2.7	GlobCover-GRUMP
Population	(million)	2855	2	2650-3150	Uchida&Nelson, 2008
	% of total	47		44-52	size threshold: 100,000-50,000
GDP (MER 1990\$)	(billion)	21991	1		
	% of total	81		??	
Final energy use	(EJ)	239	1	176-246	GEA KM18, forthcoming
	% of total	76		56-78	
Light luminosity	(million NLIS)	33	3,1		
	% of total	57		50-82	IIASA, unpubl.
Internet routers	(number in 1000)	592	4,1		
	% of total	96		73-97	IIASA, unpubl.

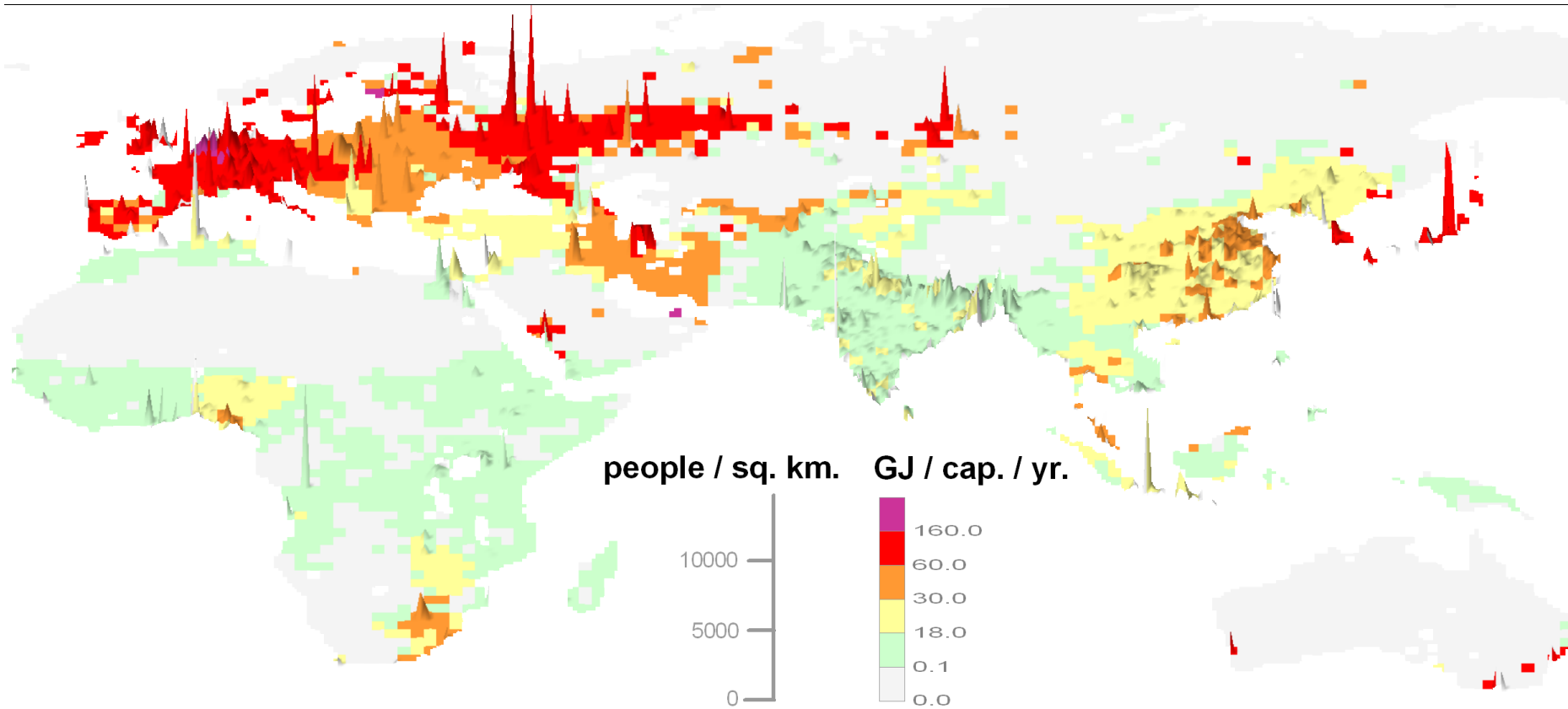
1 IIASA

2 UN 2010

3 NOAA 2008

4 M. Crovella 2007

Final Energy Use per Capita vs. Population Density



Empiric observations from literature reviews

- Collection of urban scale **final energy** consumption data from various sources
- Economic GRP/ Regional value added data from Price Waterhouse Coopers rank distribution of urban GDP, Eurostat GVA data at NUTS3 level and other sources.

Urban energy consumption database and estimations of urban energy intensities

Total: (225 observations, population covered: 483 million)		
	UNFCCC Annex 1 Countries (160 observations, population covered: about 185 million)	
		OECD 90 (147 observations, population covered: 156 million)
		REF countries (joined OECD since 1990 – 13 observations, population covered: 33 million)
	Non -Annex 1 Countries (65 Observations, population covered: about 292 million)	
		Non OECD Asia (43 observations, population covered: 247 million)
		Africa and Latin America (22 observations, population covered: 47 million)

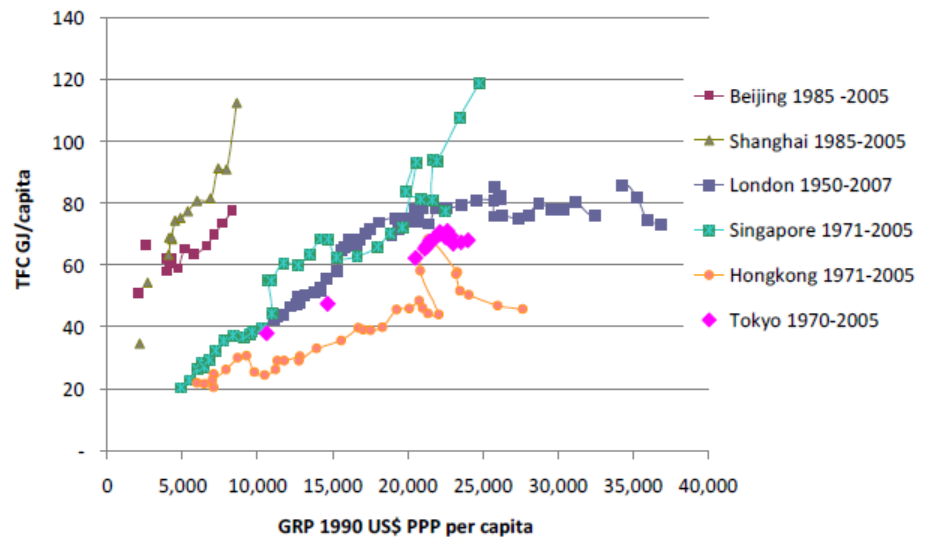
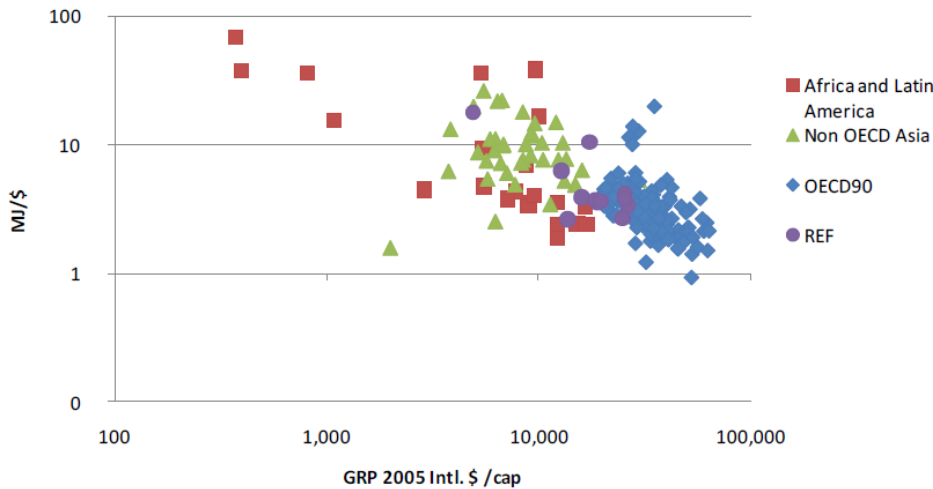
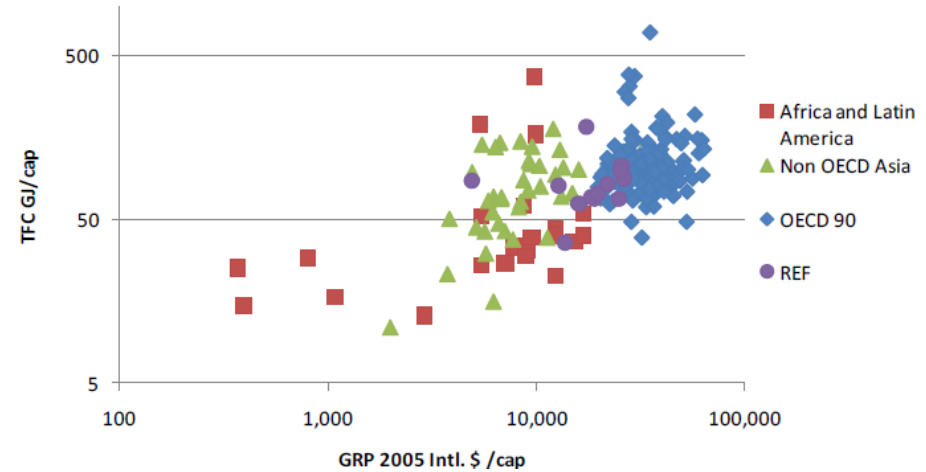
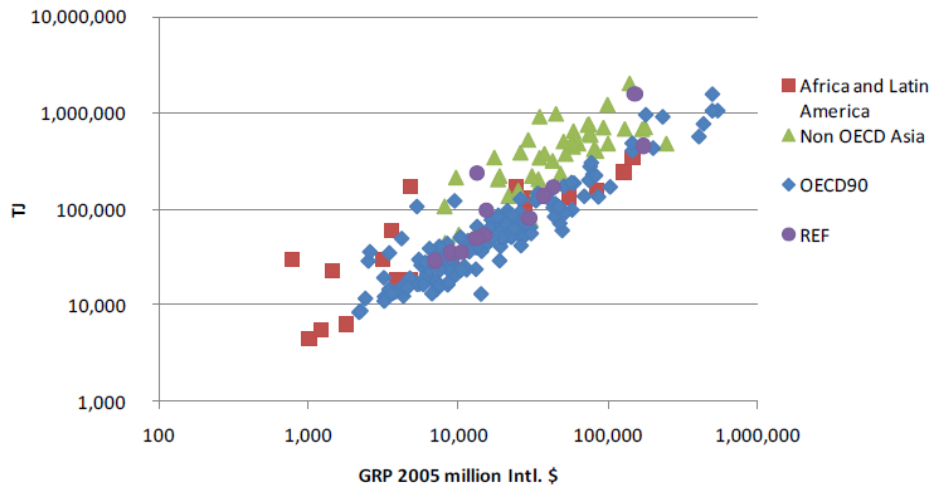
Covering in total about

8% of the global population, 15% of the world urban population

42 EJ (13%) of global final demand,

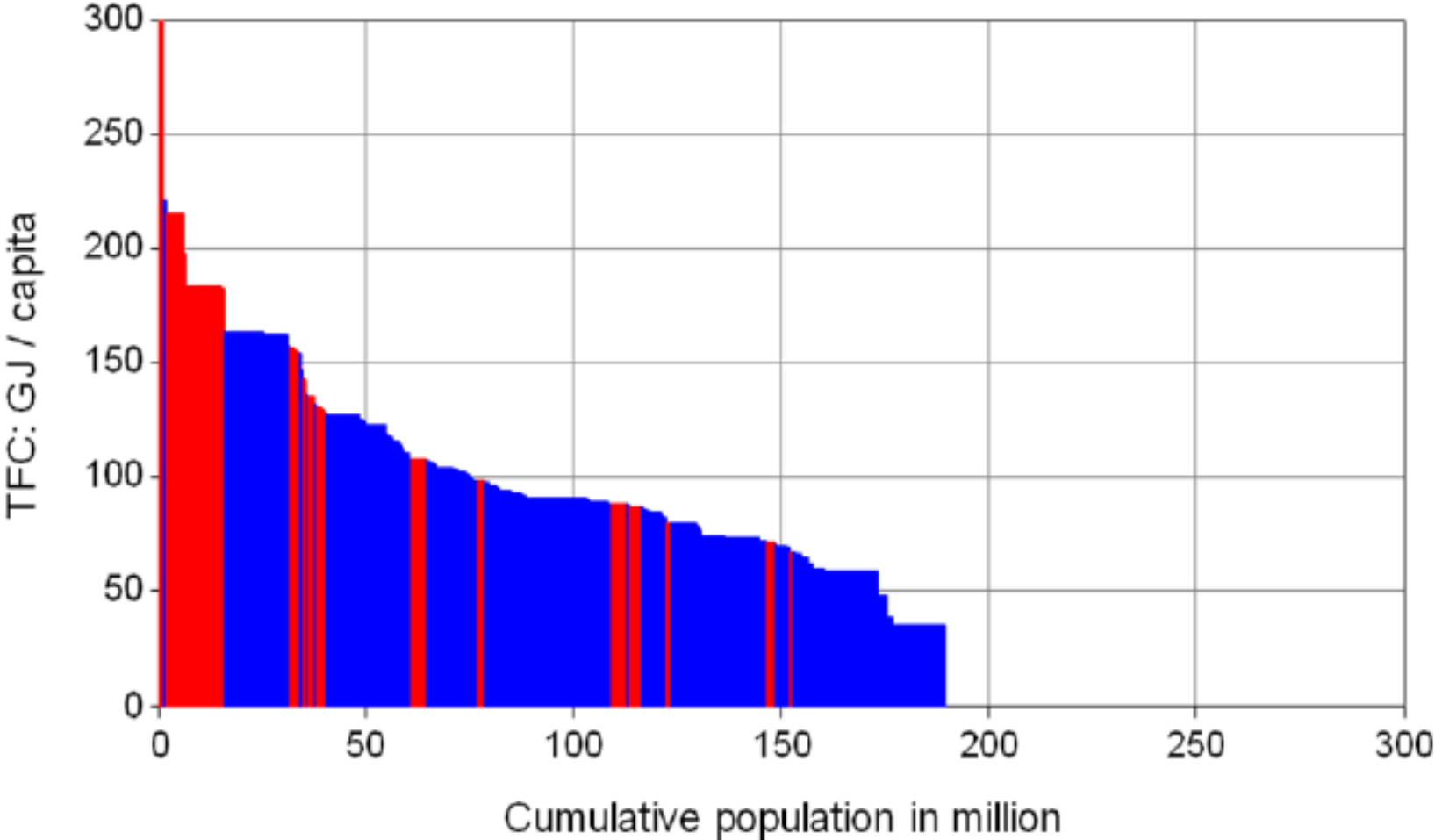
about 10 trillion\$ GRP (about 25% of global GDP)

Variable correlations with economic activity



Urban Energy use is in the range of Petajoules, GRP in the order of 100s of billion \$:
 = comparable to small or middle sized national economies

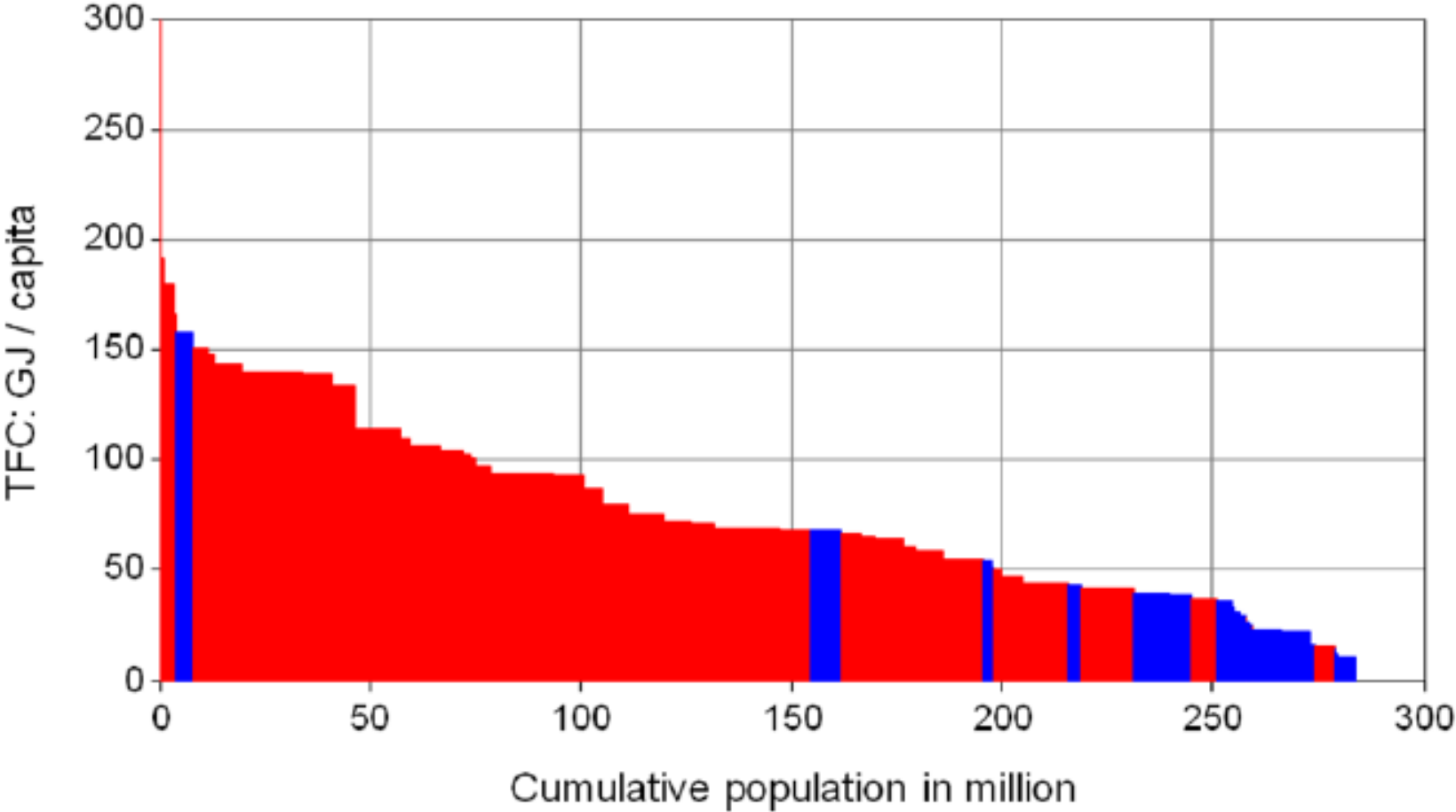
Final energy use per capita, annex 1 cities (compared to national consumption)



Blue: urban TFC/cap < national TFC/cap;

Red: urban TFC/cap > national TFC/cap

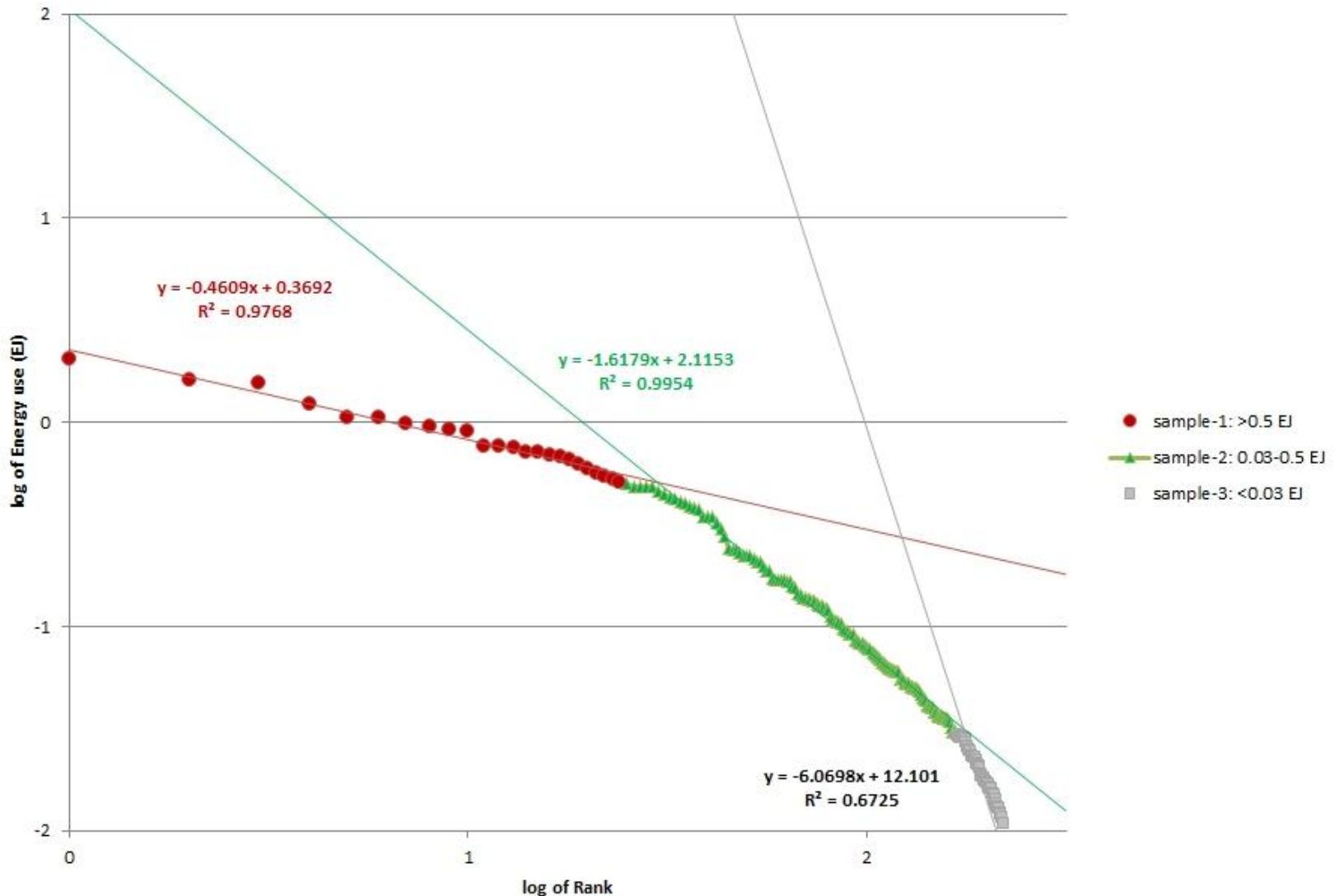
Final energy per capita, non annex 1 cities (compared to national consumption)



Blue: urban TFC/cap < national TFC/cap;

Red: urban TFC/cap > national TFC/cap

Rank Size of Urban Energy Use (direct final energy in EJ)



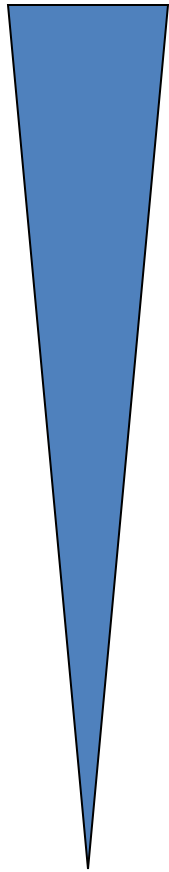
positive agglomeration economies of bigger urban centers, threshold effects.

Opportunities for climate change mitigation at the urban scale

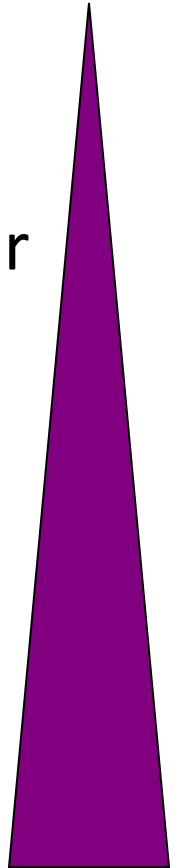
- Spatial coincidence of various energy demand patterns (quantity, quality, timing)
 - suitability for co-generation of cooling heat and power
- High metabolic density
 - Recycling systems (heat, material)
 - waste to energy systems
- High settlement density
 - High quality public transport systems are economical
- Network externalities
 - Urban centers as location of innovation “hubs”
 - Mobilization of capital and actors
 - Positive agglomeration effects

Hierarchy of urban climate mitigation opportunities

1. Spatial/geographic division of labor
(Trade, economic structure)
2. Urban form
(functional Integration, public transport, car density, alternatives...)
3. Energetic End use efficiency
(buildings, appliances, processes)
4. Energy system integration
(co-generation, use of waste heat)
5. Energy-mix, supply (e.g. renewables)



Decreasing importance



Rising capability of urban institutions to act and implement

KM18 Writing Team

Convening Lead Author: Arnulf Grubler

Lead Authors: Xuemei Bai, Thomas Buettner, Shobhakar Dhakal, David J. Fisk, Toshiaki Ichinose, James Keirstead, Gerd Sammer, David Satterthwaite, Niels B. Schulz, Nilay Shah, Julia Steinberger, Helga Weisz

Contributing Authors (*including contributors to GEA City Energy Data Base): Gilbert Ahamer*, Timothy Baynes*, Daniel Curtis*, Michael Doherty, Nick Eyre*, Yunichi Fujino*, Keisuke Hanaki, Mikiko Kainuma*, Manfred Lenzen, Jacqui Meyers, Hitomi Nakanishi, Victoria Novikova*, Krishnan S. Rajan, Seongwon Seo*, Ram Manohar Shrestha*, P.R. Shukla*, Alice Sverdlik

Contact: Schulz@iiasa.ac.at

www.globalenergyassessment.org



Global Energy Assessment

www.globalenergyassessment.org

The "IPCC of Energy"

An international, multi-stakeholder assessment