Metabolism of Megacities

A Global Perspective

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Calidad del aire, Salud Pública y Movilidad Sostenible
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UAM
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Centro para la Formación Cafetera
Regional Caldas
SENNOVA
Investigación Aplicada
Apoya SUMA

Mexico City

Population 23,400,000

Prof. Chris Kennedy
Civil Engineering
UNIVERSITY OF TORONTO

Global Cities Institute

Global Network of Megacity Researchers

Enel Foundation
Energy for Knowledge

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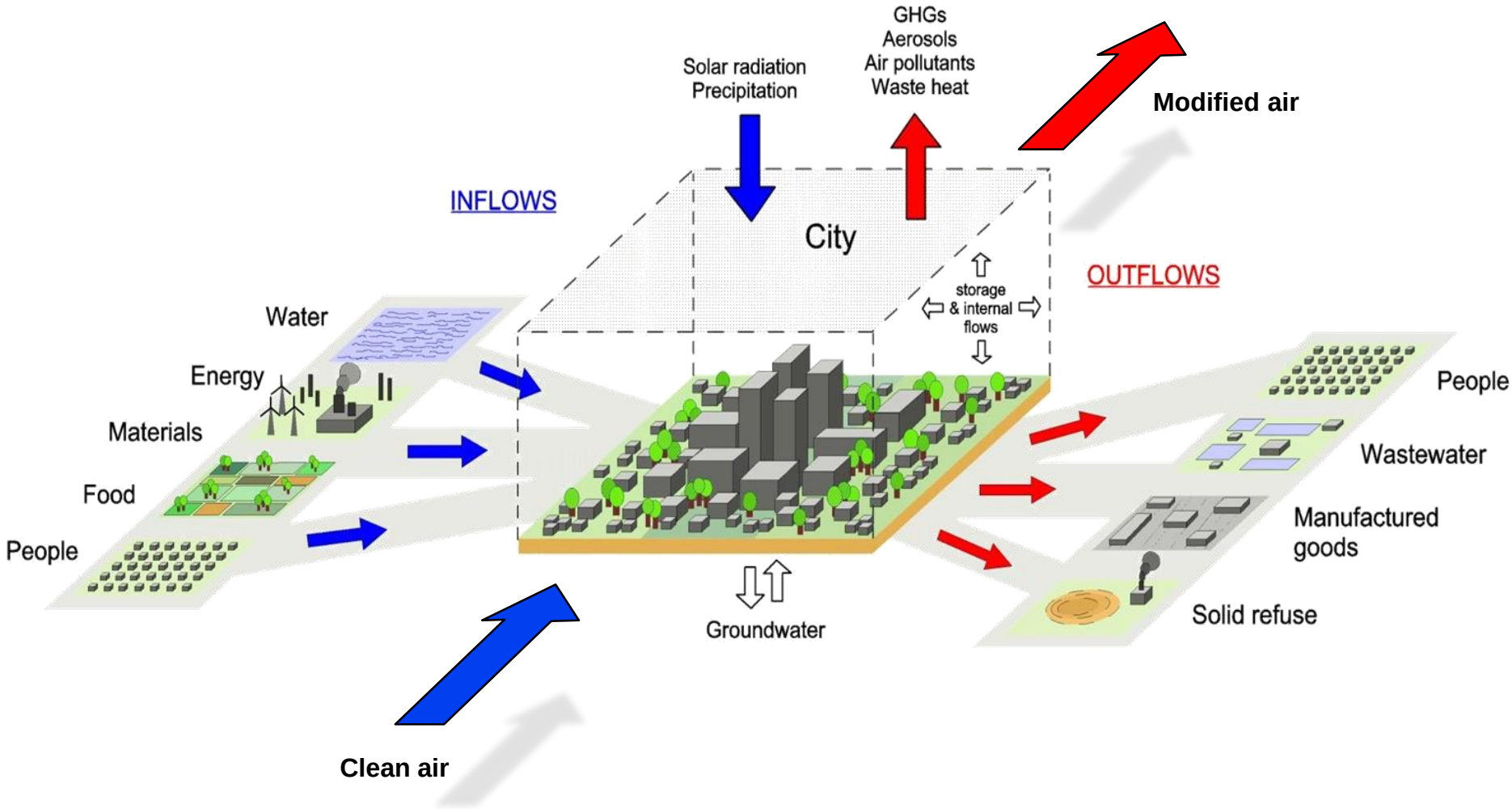
Setting the scene

In cities, resource consumption is increasing, economies are expanding, populations are growing, technologies are advancing, environments are deteriorating, climates are changing...

How can we study & compare the ecological performance of cities?

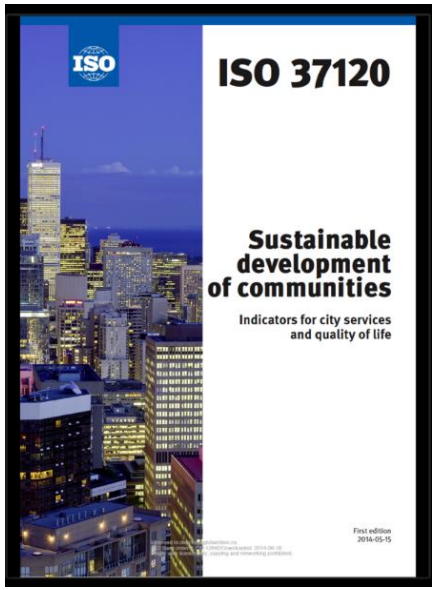
The urban metabolism framework



What can we learn from an urban metabolism study?

- GHG emissions
- Pollution effects
- Policy solutions
- Quality of life

Metabolism data can support municipal and national sustainability goals



ISO 37120 Indicators for City Services and Quality of Life

United Nations Sustainable Development Goals (SDGs)

17 themes in ISO 37120

100 indicators

- Economy
- Education
- Energy
- Environment
- Finance
- Governance
- Health
- Recreation
- Safety
- Shelter
- Solid Waste
- Telecommunications
- Transportation
- Urban Planning
- Wastewater
- Water & Sanitation
- Fire & Emergency Response

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Conventional approach

Quantify the energy & material flows through an urban area for a calendar year — consider electricity use, fuel use, waste disposal, and water consumption.

- Difficult to obtain & compare data at city scale, especially for metropolitan areas
- Reporting practices differ among regions

Research aims

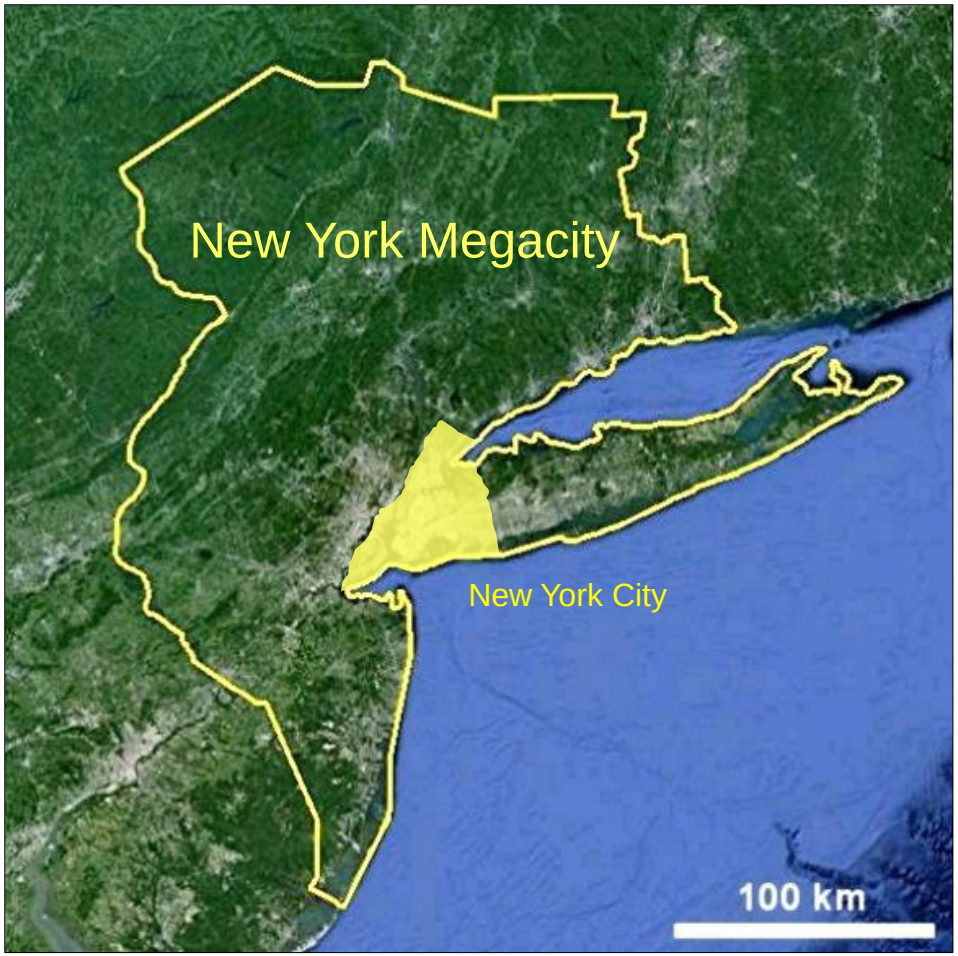
Collect and compare data on energy & material flows in the world's 27 megacities

- Investigate drivers & rates of change (2001–11)
- Relate urban metabolism to basic city services and quality of life

What is a megacity?

1. >10 million people
2. Polycentric form
3. Commutershed

Size & complexity of commutersheds



22 million people; 31 counties; 3 states

30,000 km^2 of land; 10,000 km^2 urbanized

Megacities are a global phenomenon

Collecting a standardized dataset

1. Definition of megacity
   - Spatial boundaries
   - Constituent cities
   - Population
   - Economy

2. Biophysical descriptors
   - Climate
   - Latitude
   - Population density
   - Building stock

3. Urban metabolism
   - Energy—all types
   - Food & water
   - Materials
   - Waste

4. Role of utilities
   - Access of households to basic services;
   - Potential to provide new services

Data sourced from 20 institutions

Sources	Institutions	
Statistical yearbooks	Beijing Normal University	**Universidad del Rosario, Bogota**
	TERI University, New Delhi	Trisakti University, Jakarta
Government reports	University of Lagos	University of Tehran
	De La Salle University, Manila	Bangladesh U. of Eng.& Tech.
Utility companies	Seoul National University	City University of New York
	Federal Uni. Rio de Janeiro	**Government of Buenos Aires**
Consultant reports	University of California LA	Environ. Solutions, Cairo
	Imperial College London	**Univ. Guanajuato, Mexico**
Personal interviews	NED University, Karachi	Istanbul Technical University
	City of Moscow	Université de Paris
Scholarly literature		

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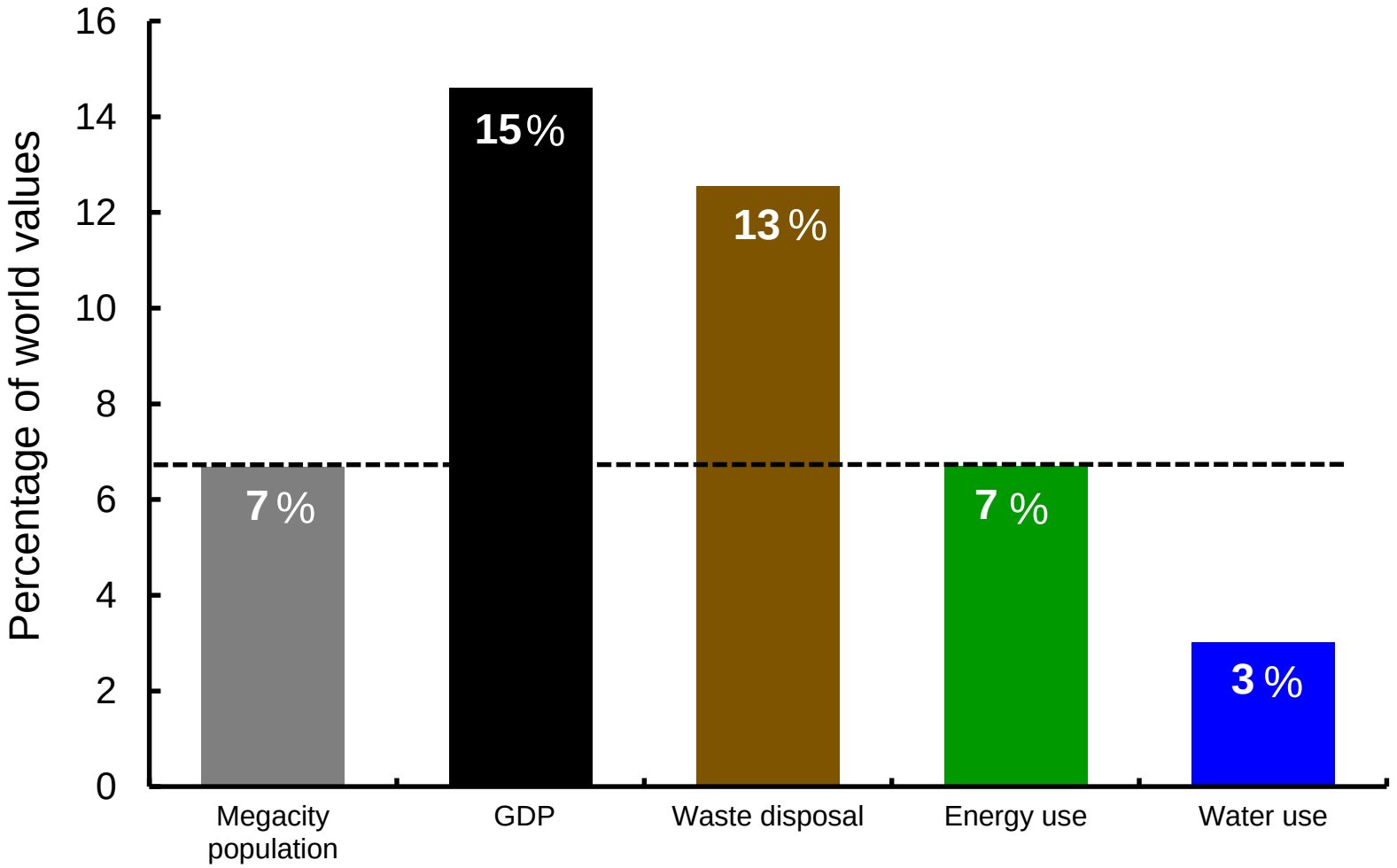
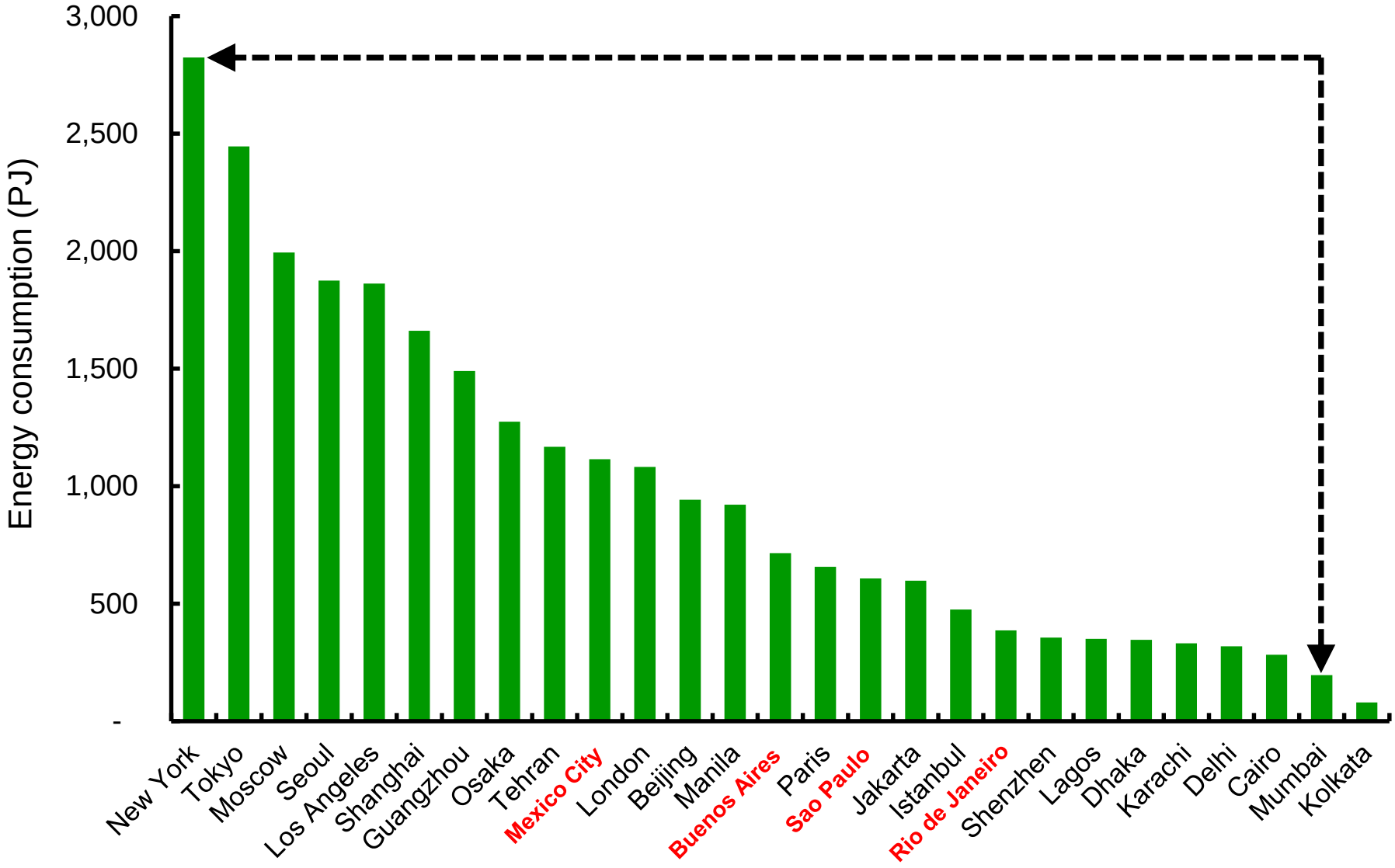
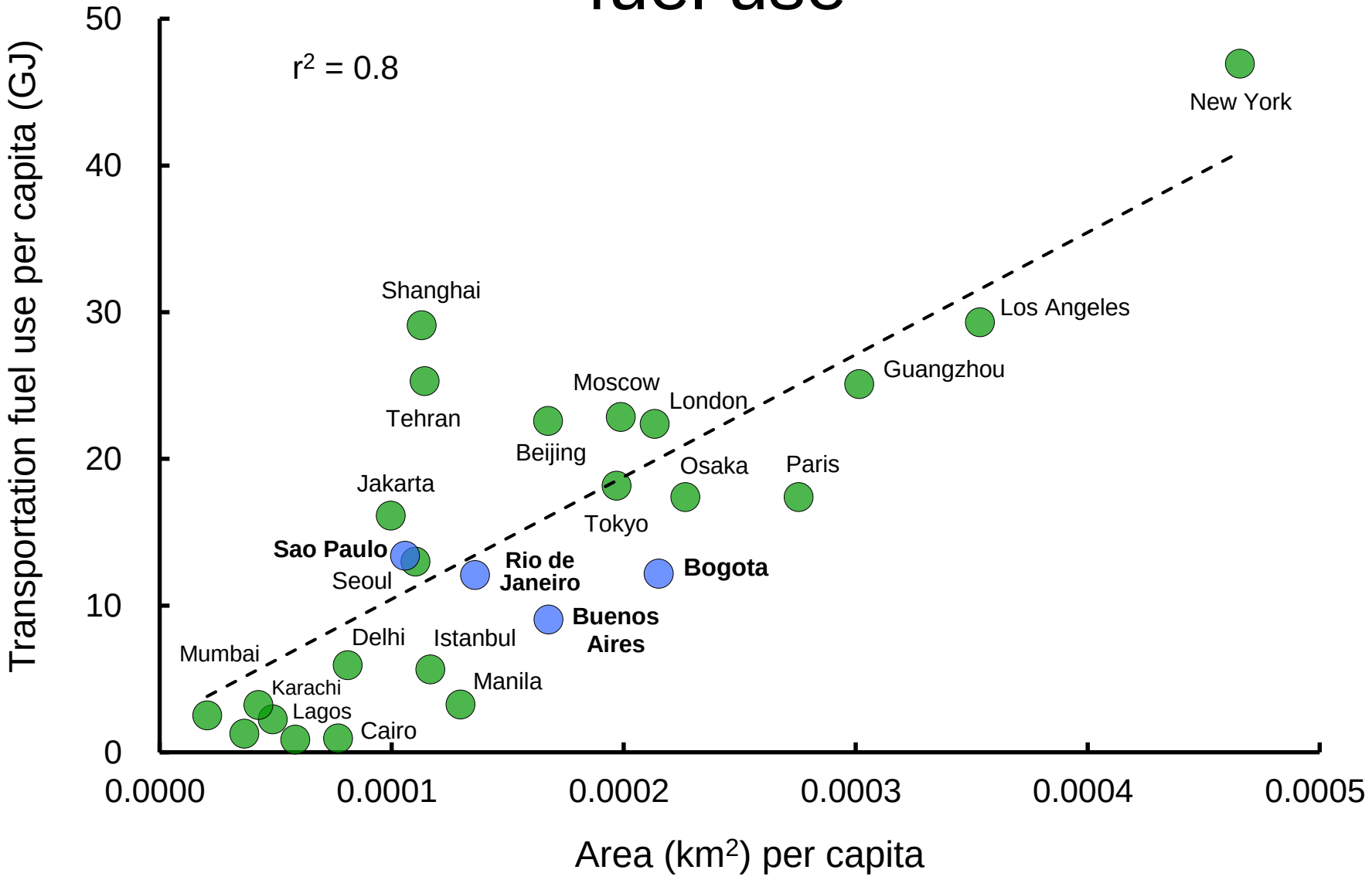
Resource consumption in megacities as a percentage of world values



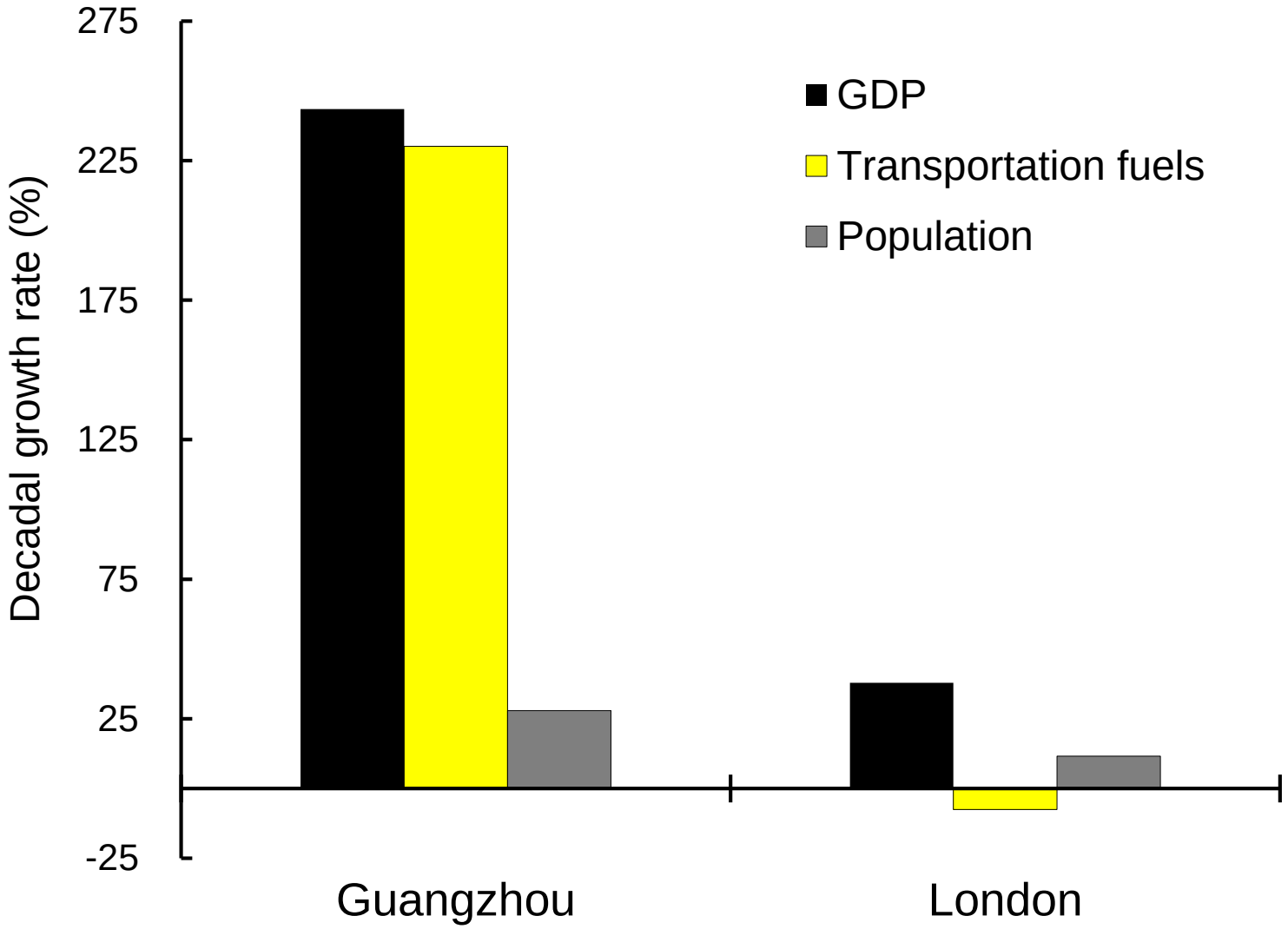
Total annual energy use



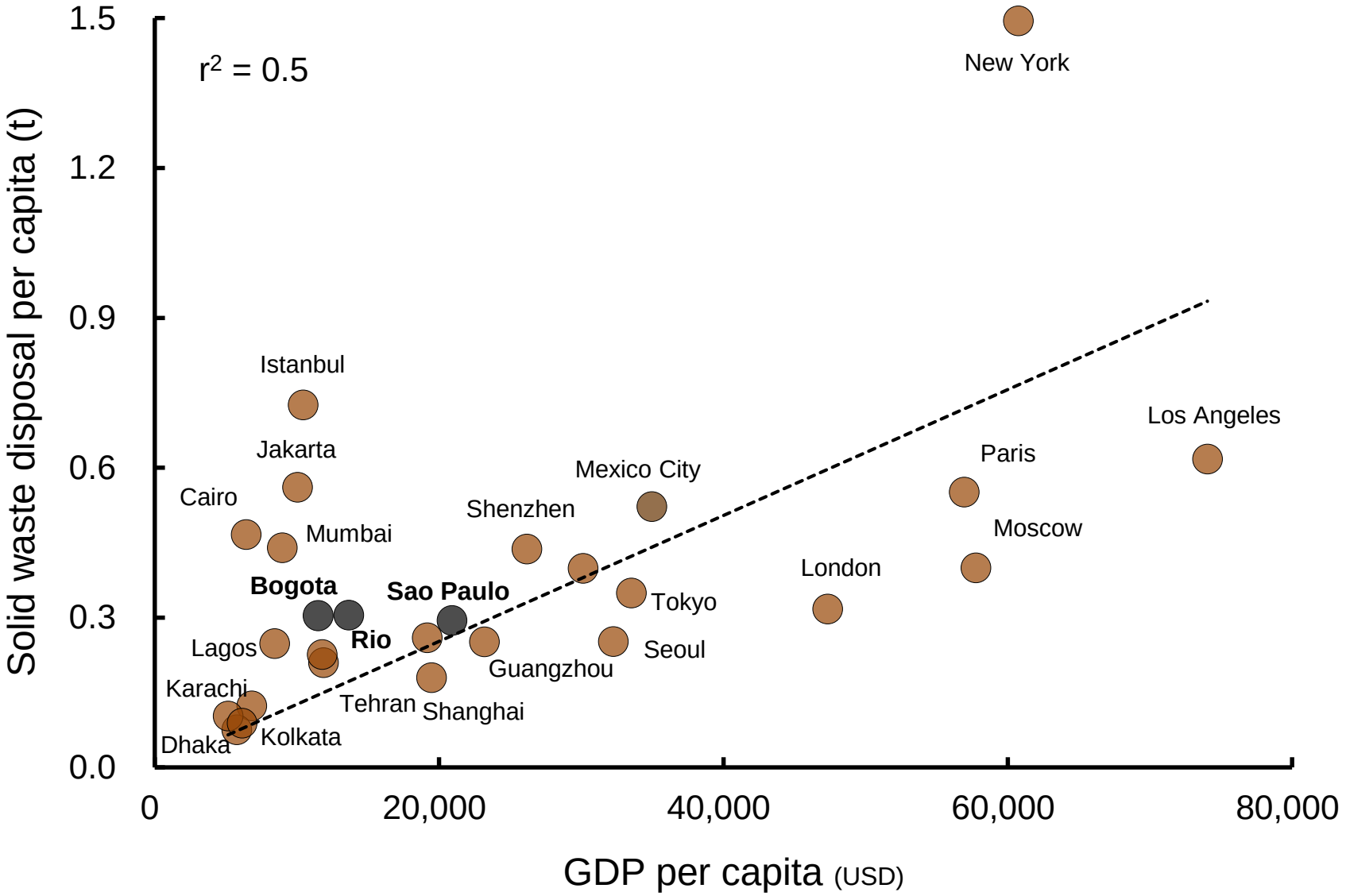
Urban form influences transportation fuel use



“Green growth” in London, not Guangzhou



Urban wealth creates solid waste

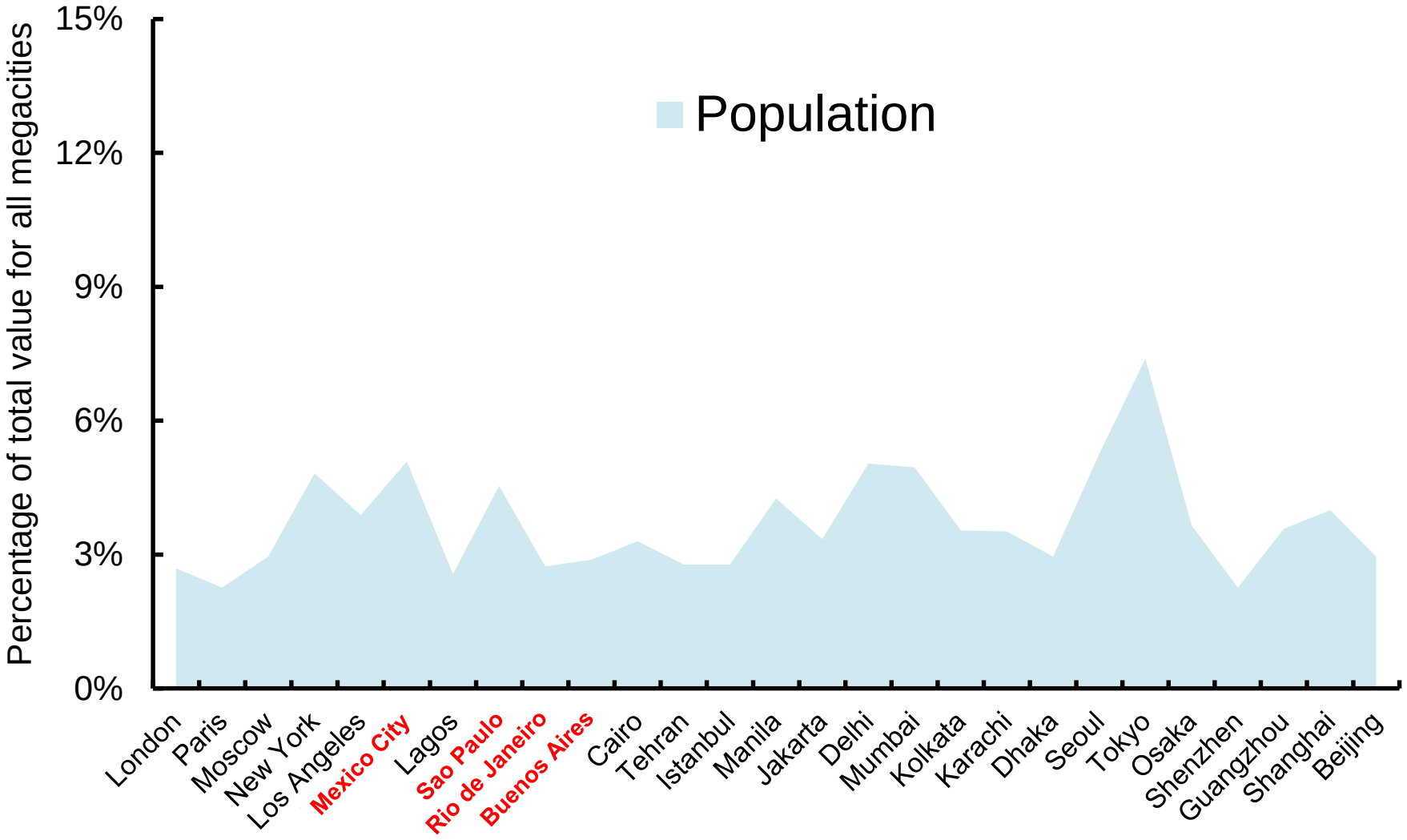


In Greater Cairo, the informal sector collects one-third of the megacity's total daily garbage and recycles 85 % of it.

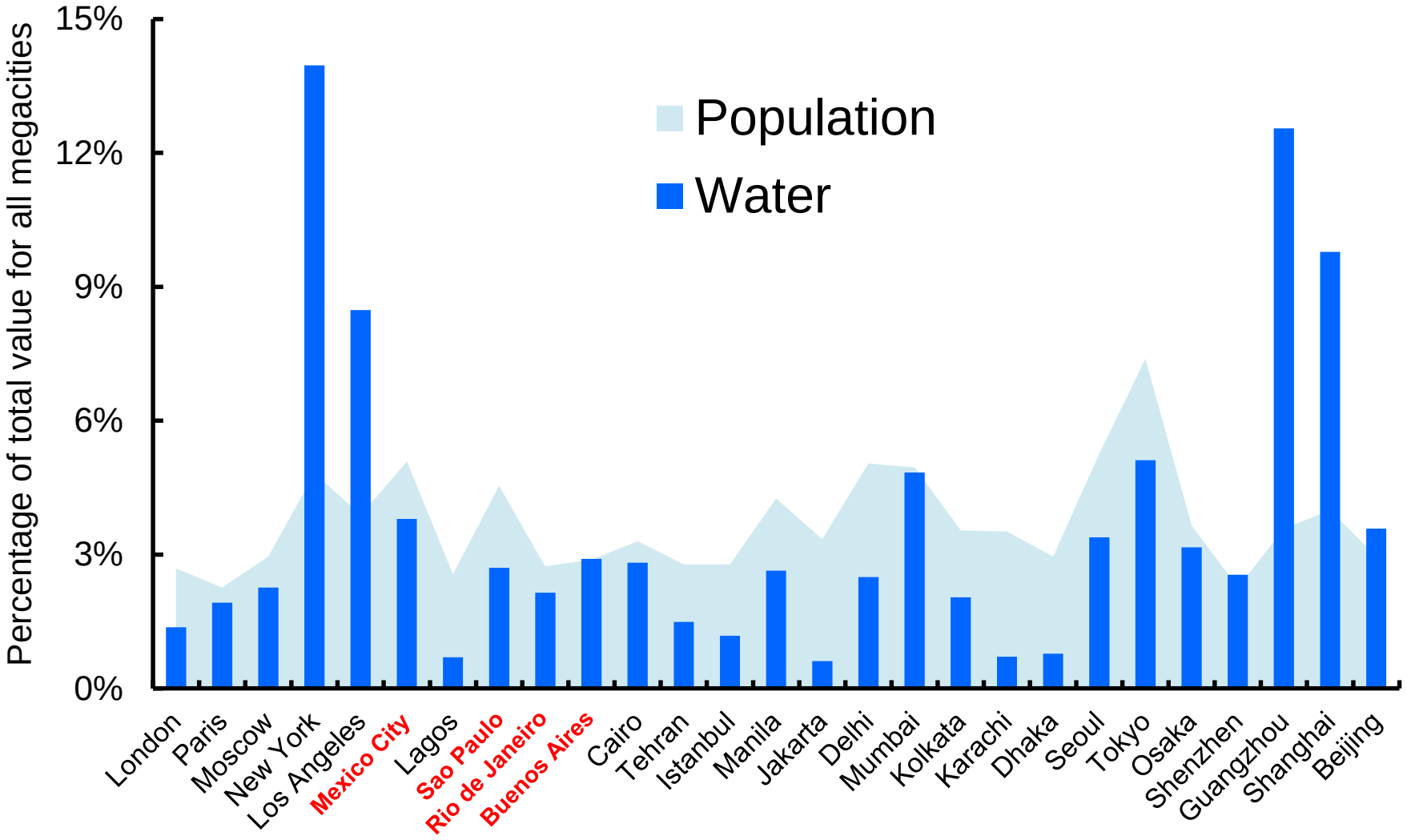
Fahmi (2005)

Photo: N. Ibrahim

Efficient (or sufficient) use of water in megacities?



Efficient (or sufficient) use of water in megacities?

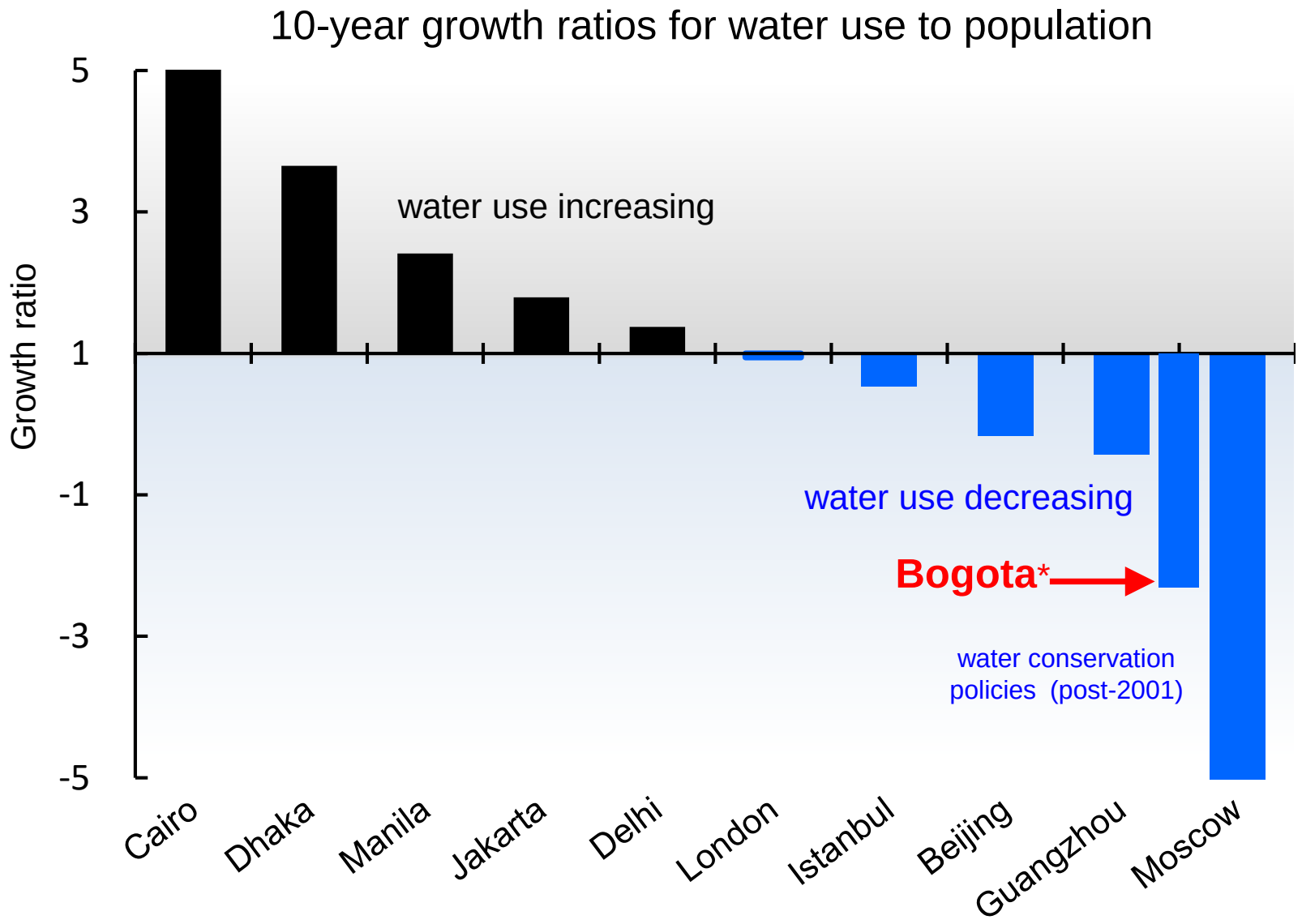


广州为何成为“大花洒”

Why Guangzhou became a giant “showerhead”

Nanfang Daily, June 2008

Policies matter: Water conservation in Moscow



* Estimate (Piña & Martinez, 2014)

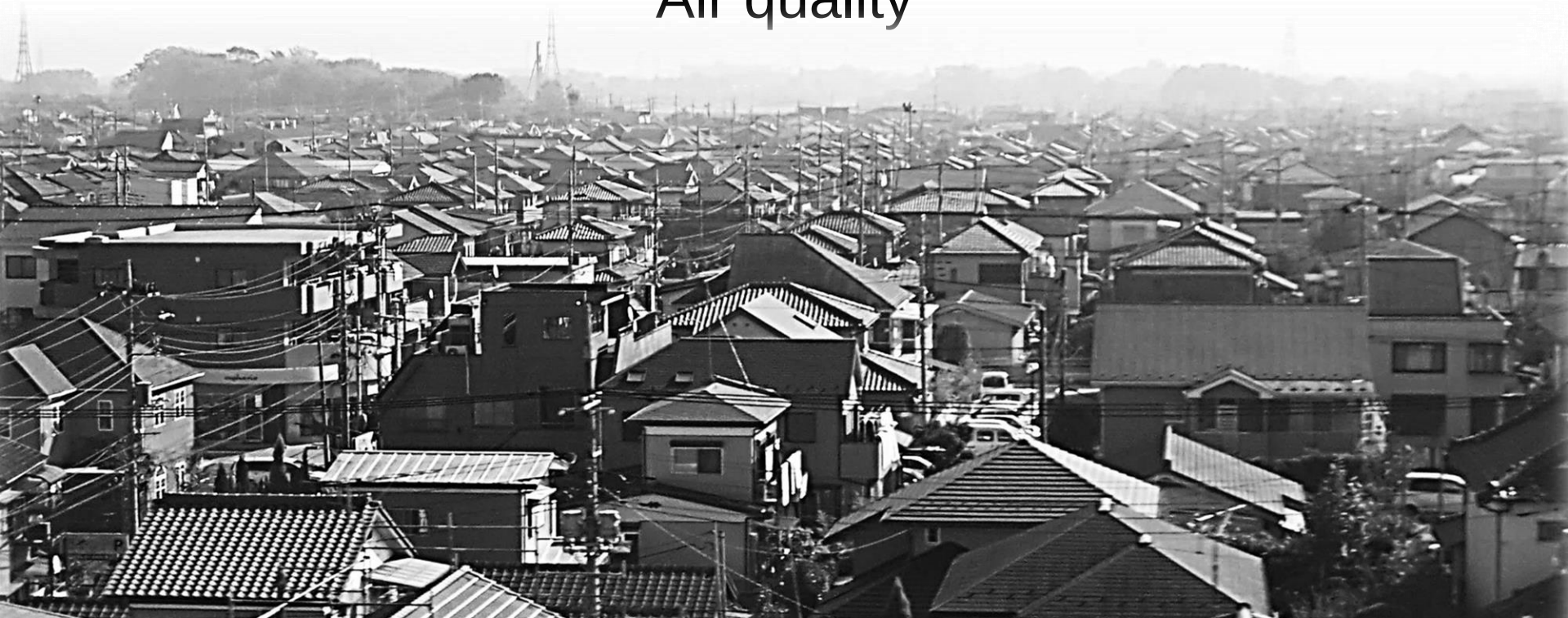
Roadmap to the future

‘The electric megacity’

Economy

City services

Air quality

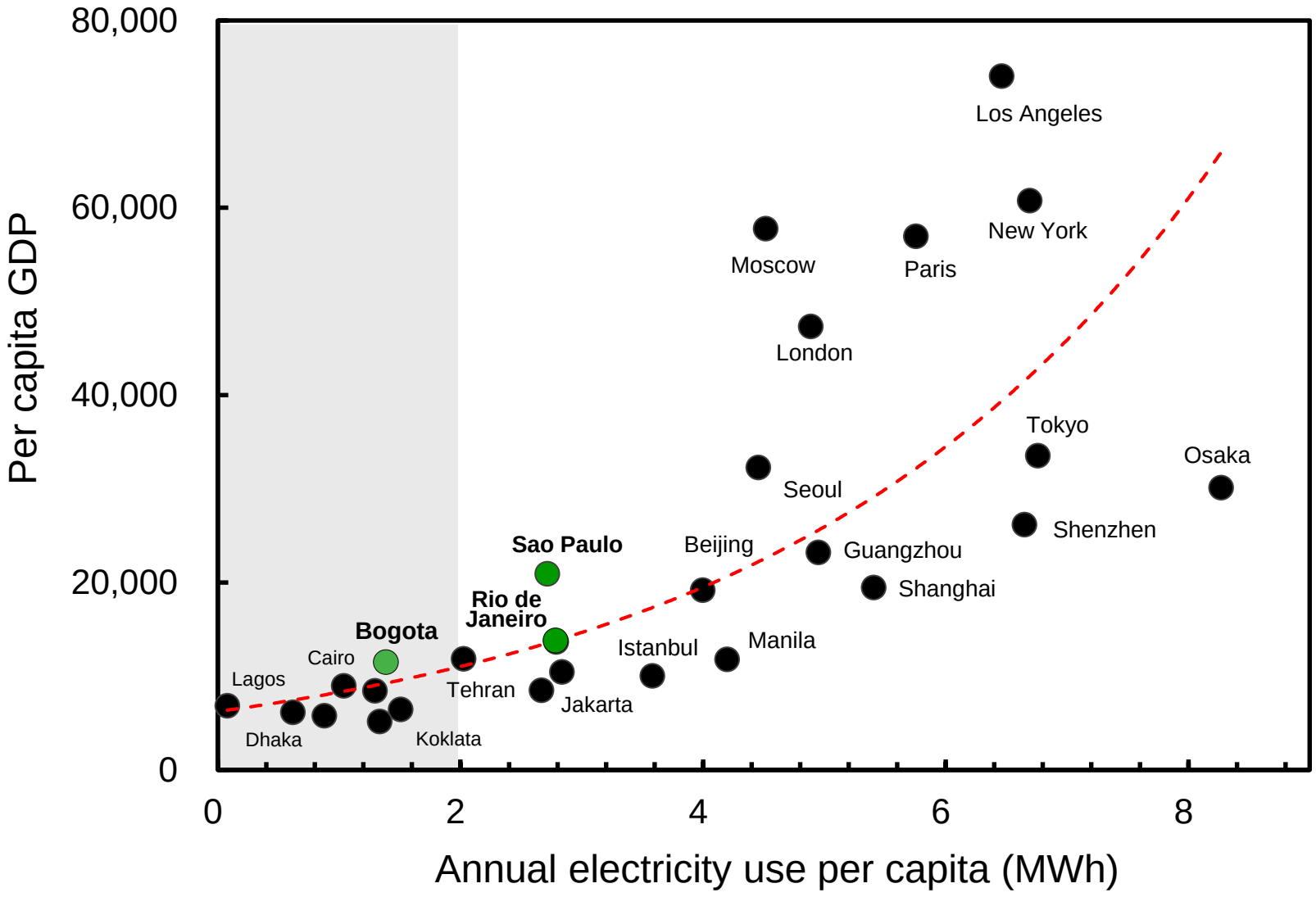


Electric mobility in megacities (2011)

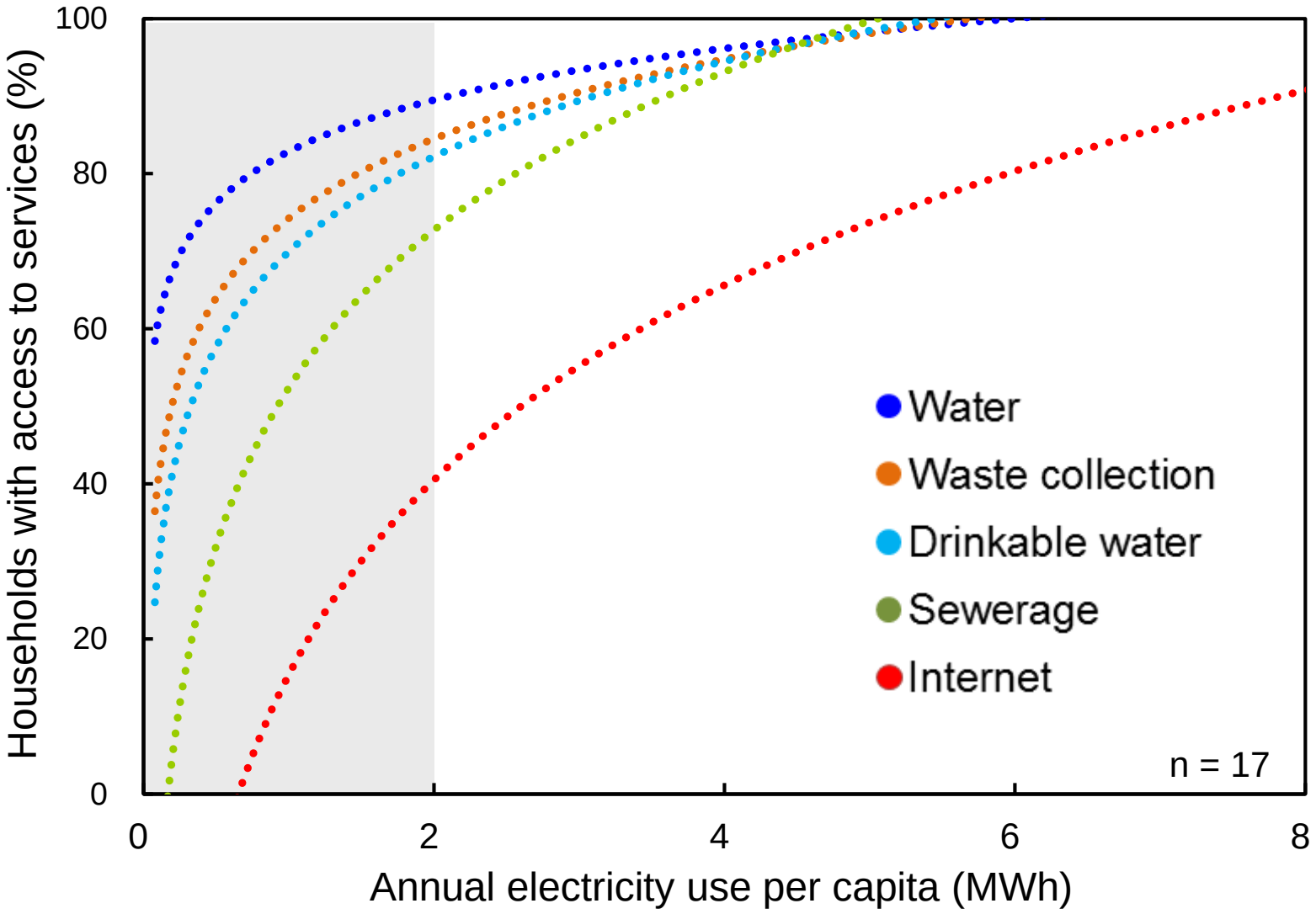
Megacity	No. of electric vehicles	No. of electric vehicle charging points
Los Angeles	32,874[a]	235
Beijing	21,628[b]	1,274
Paris	10,578	4,800
Shenzhen	6,630[b]	12,750
London	2,114	1,315
Guangzhou	800	1,049
Istanbul	500	80
Shanghai	40	93
Seoul	33	384

[a] scaled by population from state to megacity level
[b] includes electric buses

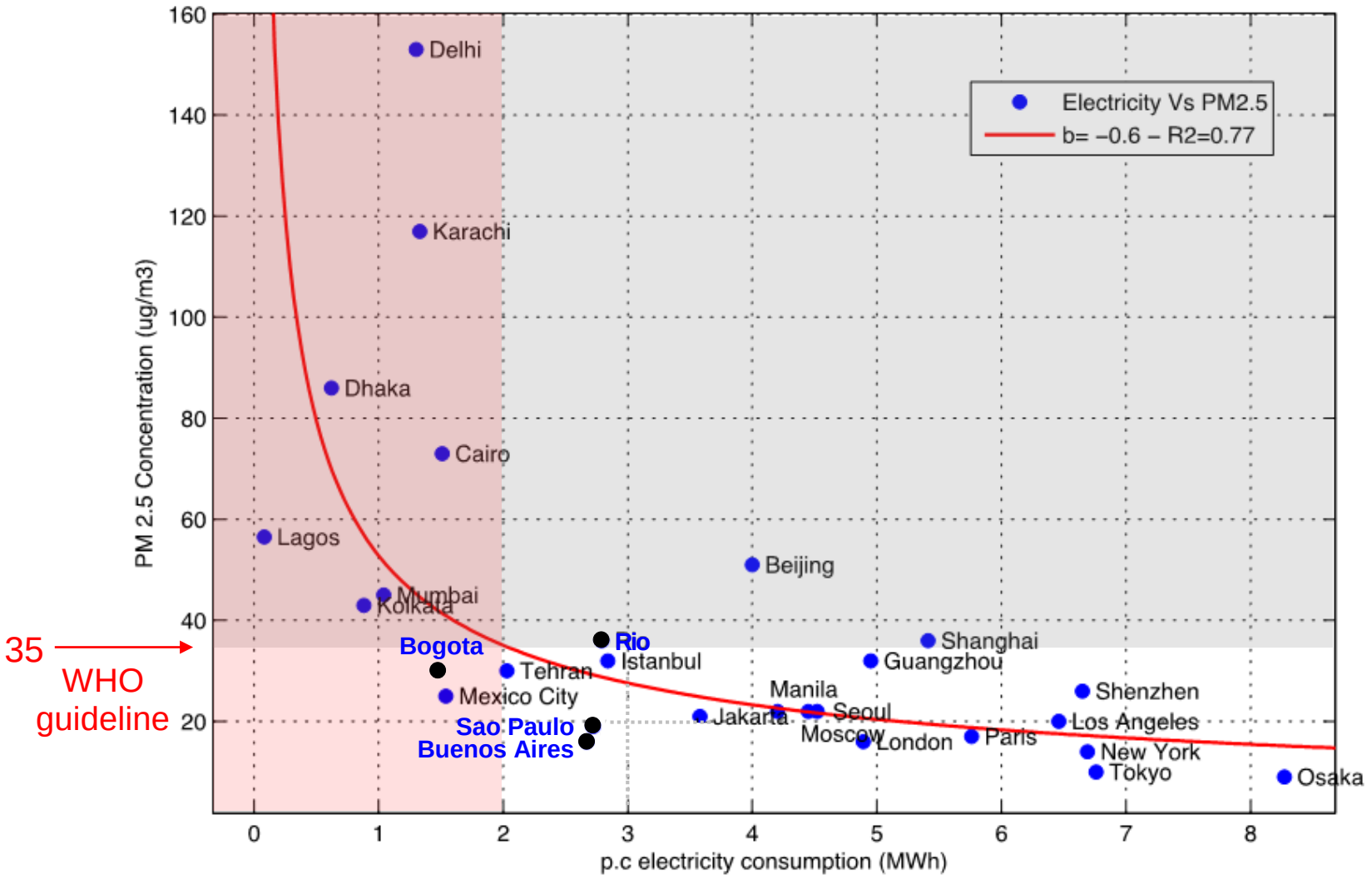
Electricity supply brings economic prosperity



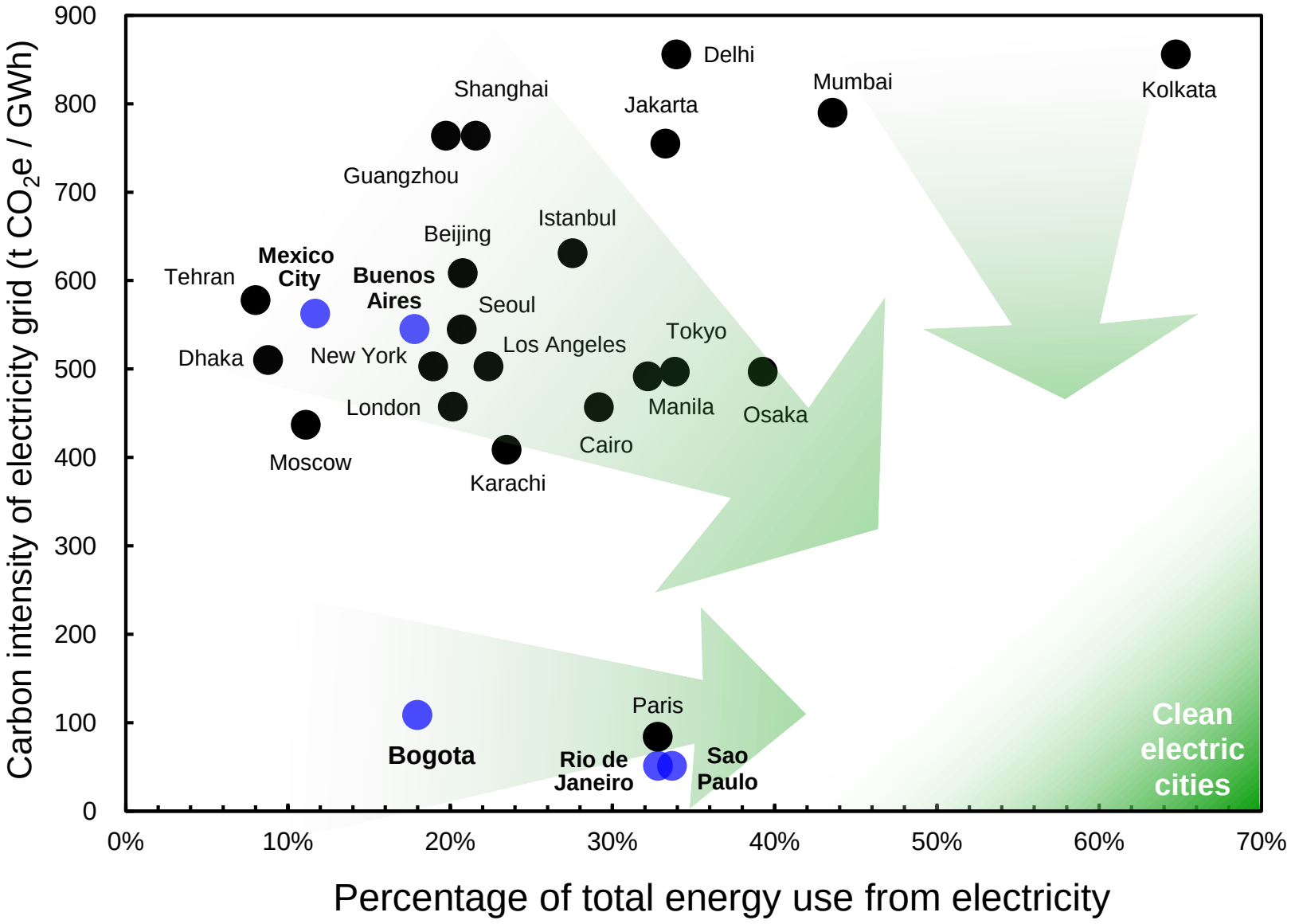
Electricity supply enables basic service delivery



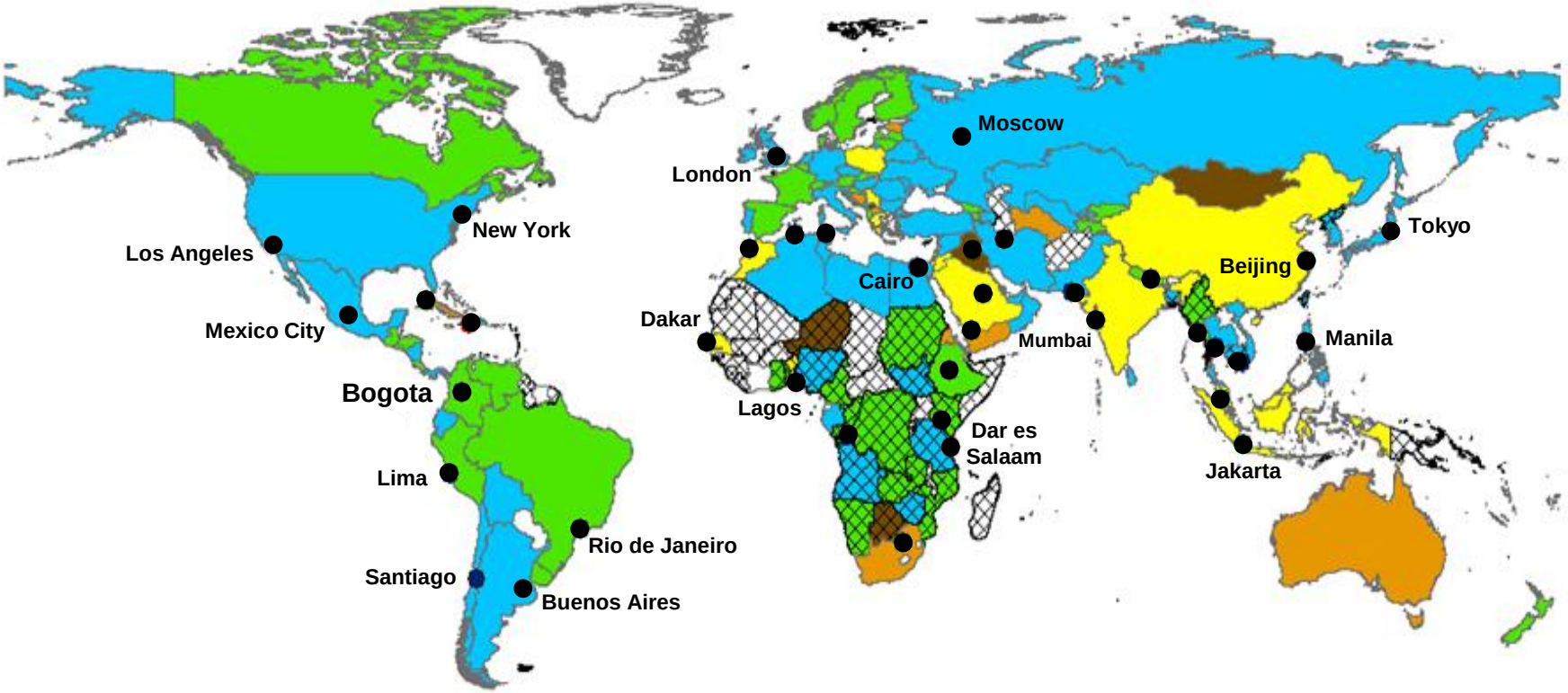
(Clean) electricity supply improves air quality



Transforming to low-carbon electric megacities



In which cities is electrification a good strategy to pursue?



> 10 % of urban population without access to electricity

0
1 - 300
301 - 600
601 - 800
801 - 1000
1001 - 1448

Carbon intensity of the electricity grid
(tCO_2e/GWh)

Michael Westphal
World Resources Institute

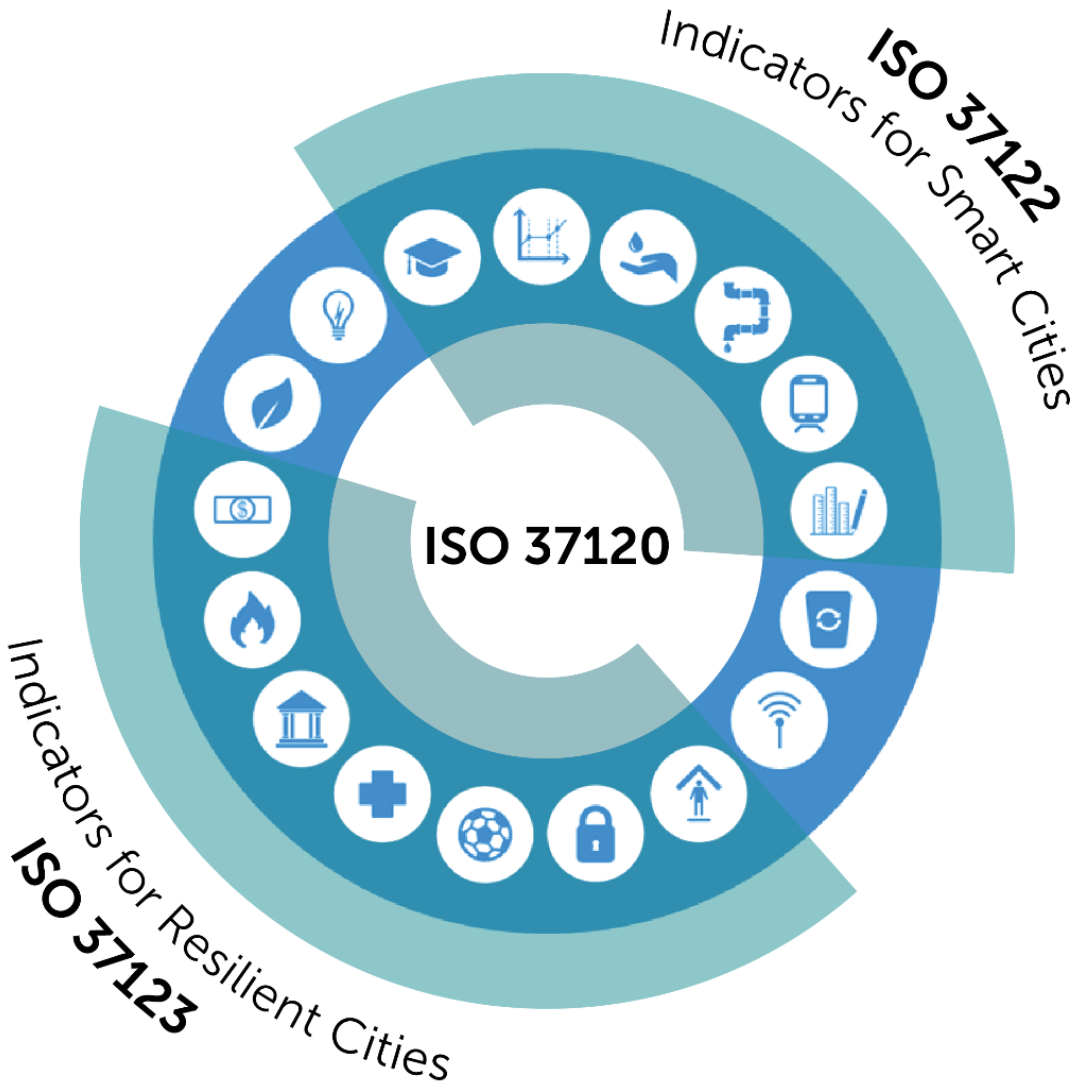
Data for 27 megacities

Kennedy C, Stewart I, et al., 2015. Energy & material flows of megacities. *Proceedings of the National Academy of Sciences (USA):* 112, 5985–5990.

Data for ISO 37120 certified cities

World Council on City Data
www.dataforcities.org

Creating a Family of Standards for City Data



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