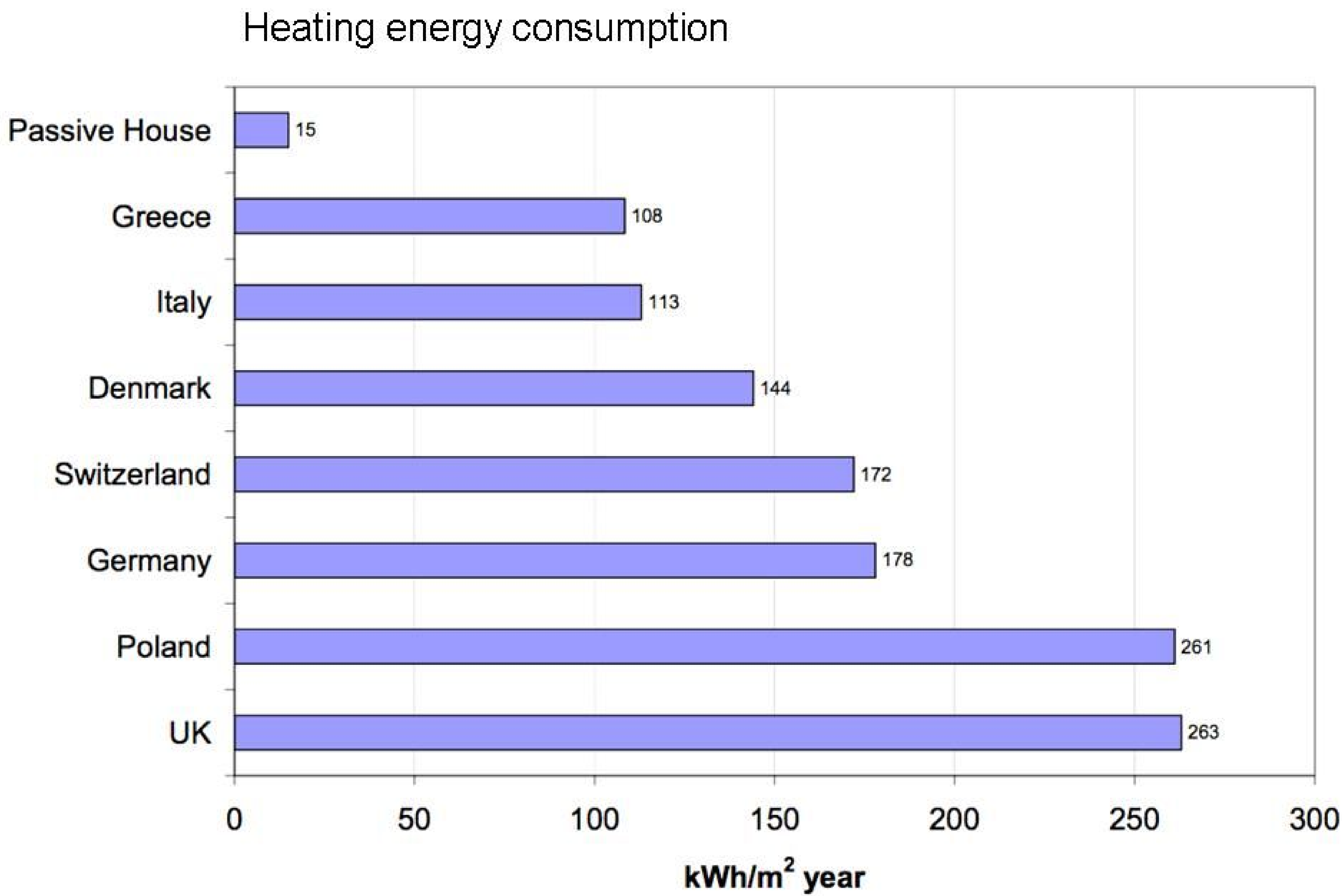
Energia, ambiente e sviluppo sostenibile: il ruolo delle città

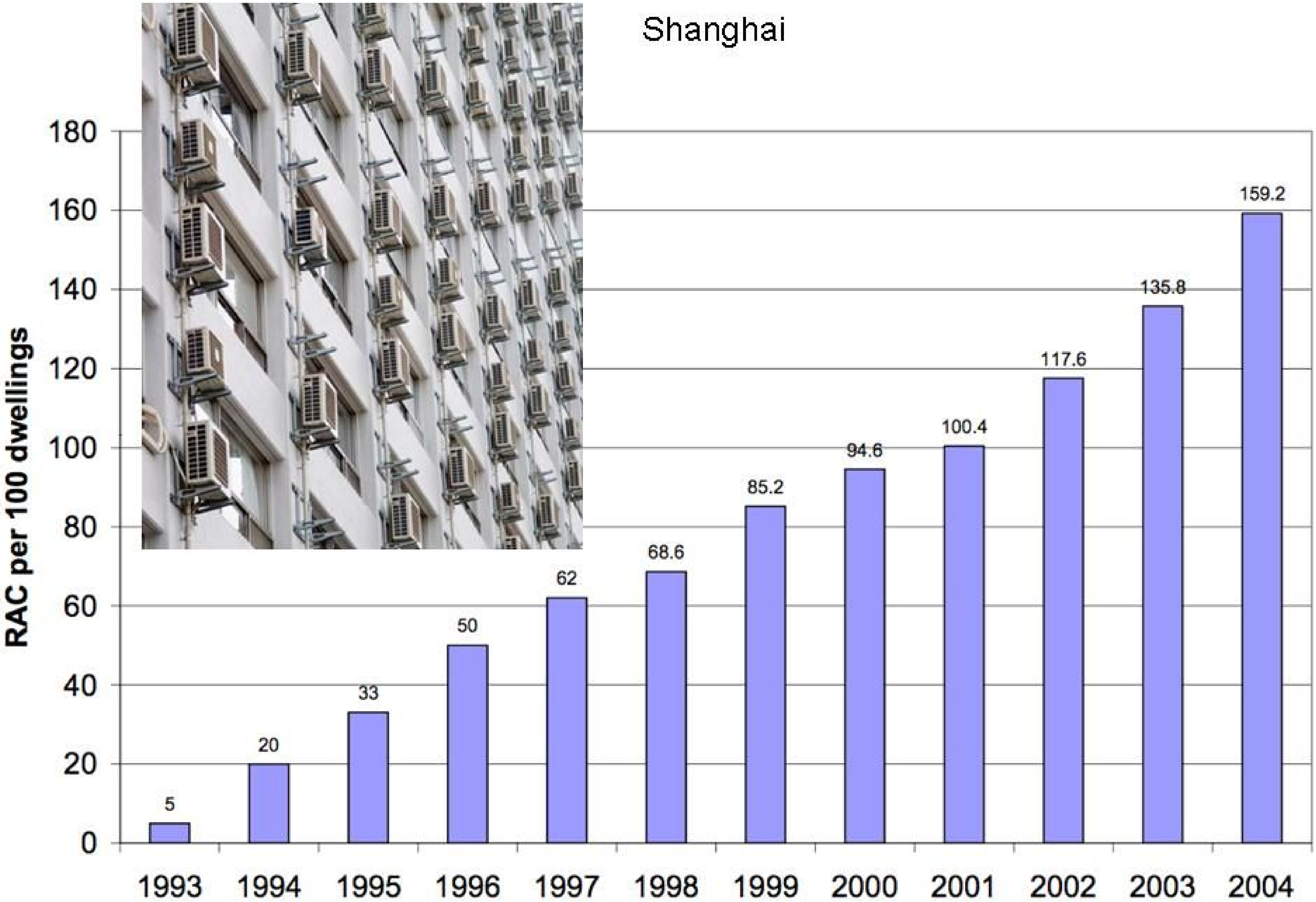
Federico M. Butera, Politecnico di Milano

Heating and cooling of of residential buildings



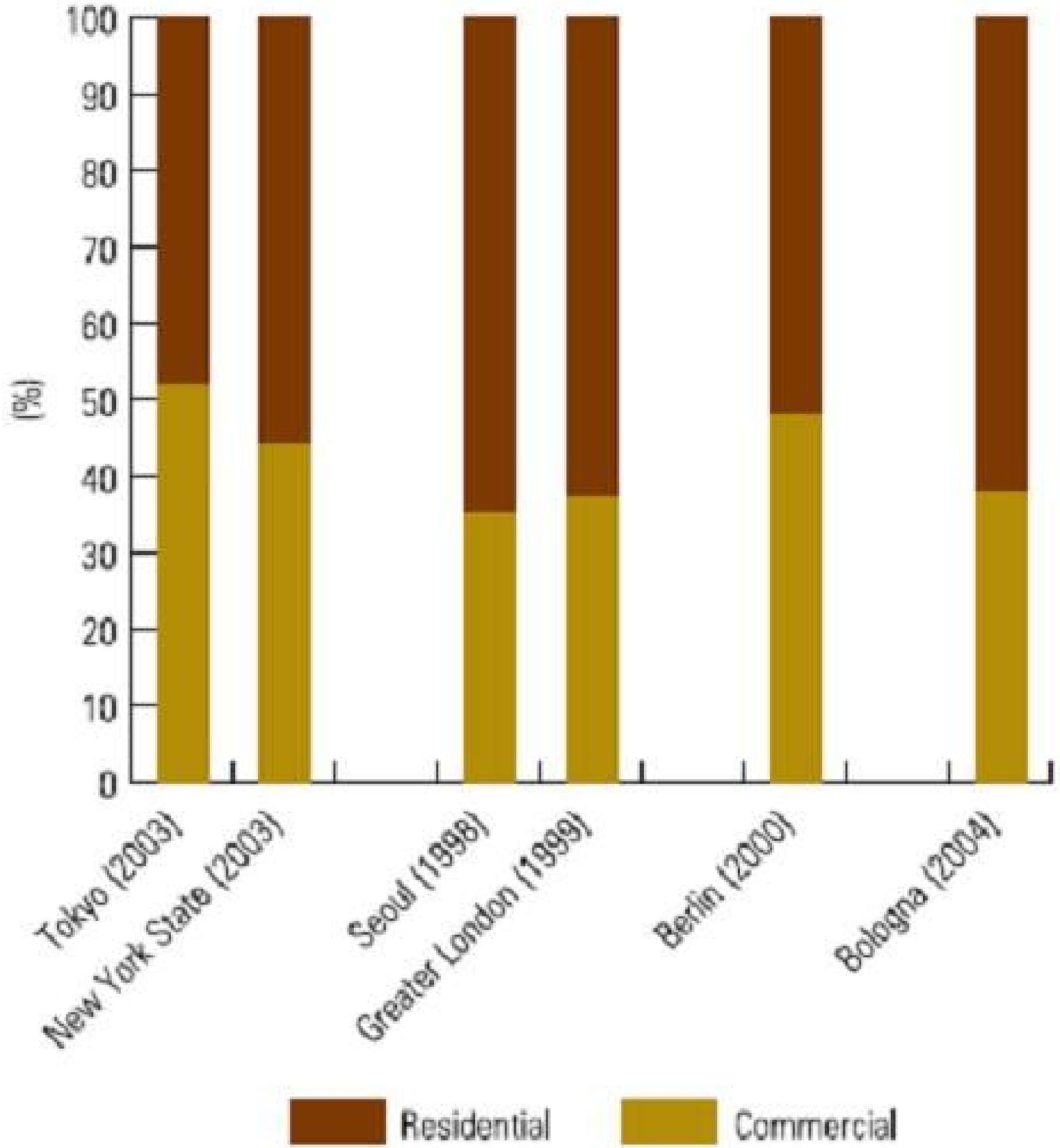
Heating energy consumption
Passive House
Greece
Italy
Denmark
Switzerland
Germany
Poland
UK
15
108
113
144
172
178
261
263
0
50
100
150
200
250
300
kWh/m2 year

According to UN- Habitat, more than 80% of total CO_2 emissions is produced in the cities


Shanghai
RAC per 100 dwellings
0
20
40
60
80
100
120
140
160
180
5
20
33
50
62
68.6
85.2
94.6
100.4
117.6
135.8
159.2
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004

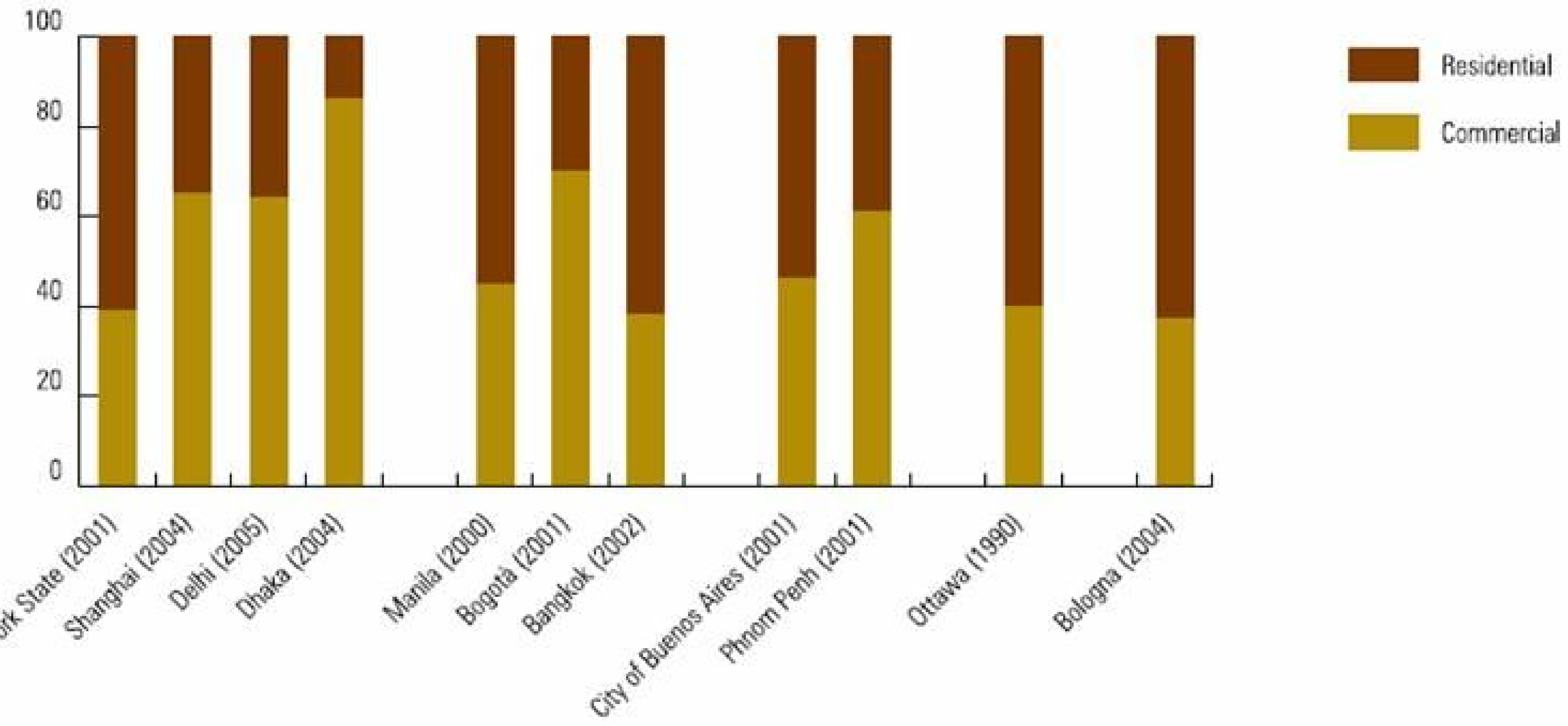
Commercial buildings energy consumption

SHARE OF ENERGY CONSUMPTION IN RESIDENTIAL AND COMMERCIAL SECTORS IN SELECTED CITIES IN HIGH-INCOME COUNTRIES



Source: UN-HABITAT, 2008
Note : Data derived from various sources, 1998-2004

SHARE OF COMMERCIAL AND RESIDENTIAL ELECTRICITY CONSUMPTION IN SELECTED CITIES

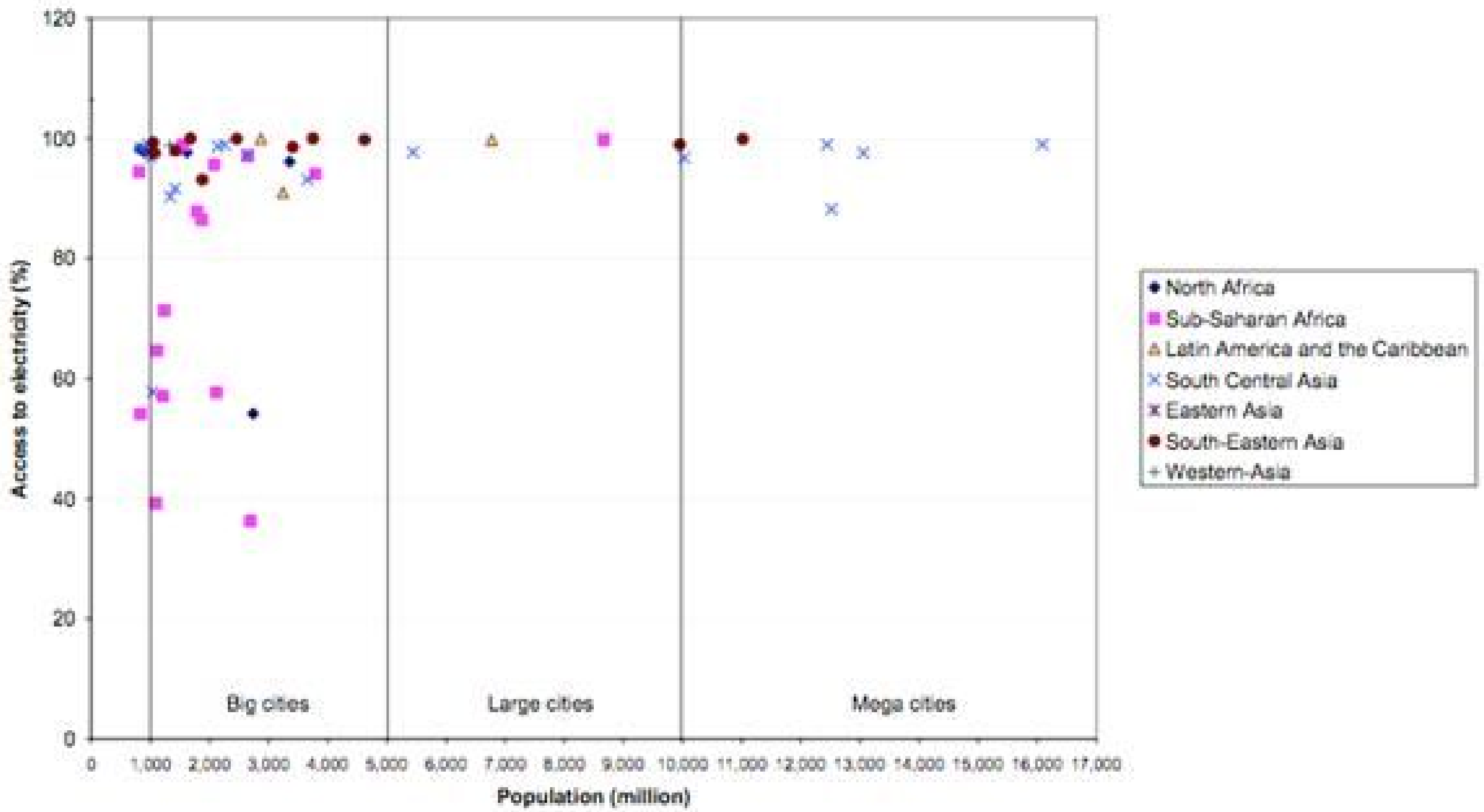


Source: UN-HABITAT Global Urban Observatory 2008 (why is New York state used, not city ? delete Ottawa, too old)
Note: Data from various sources, 2001-2004

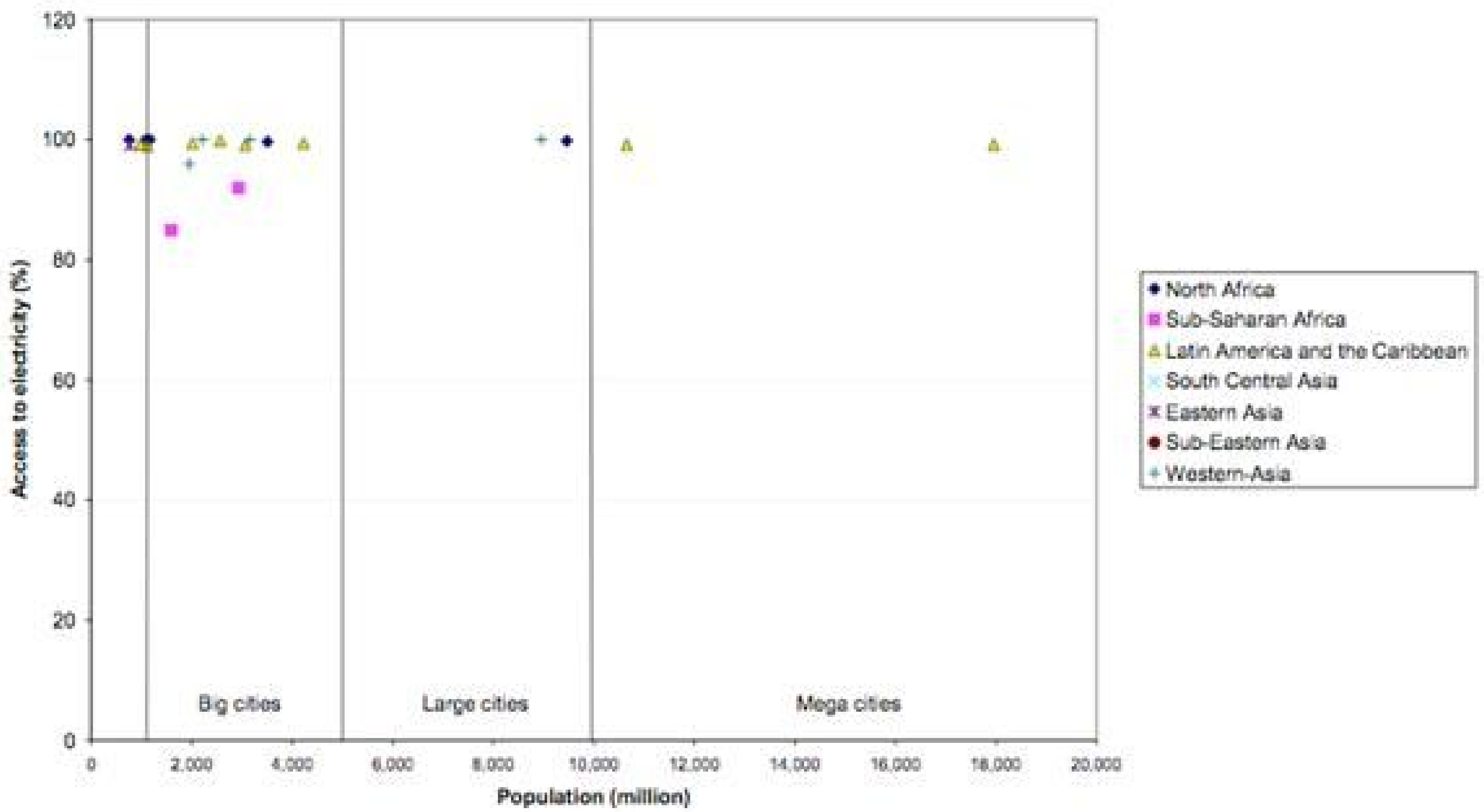
Denver Beijing Berlin Shanghai Perth Abu Dhabi

Household electricity consumption

Early/incipient urban transition

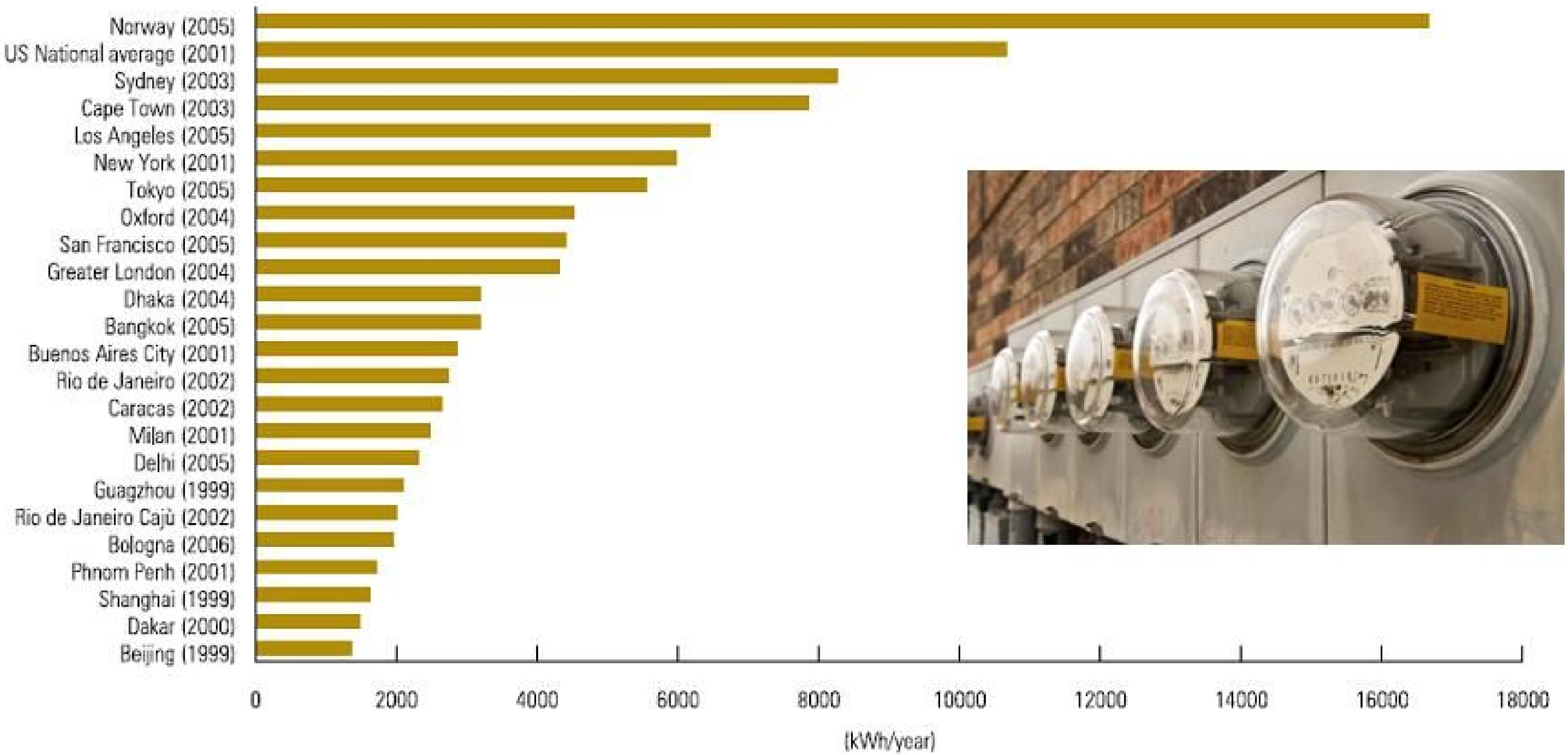


Midway Urban transition

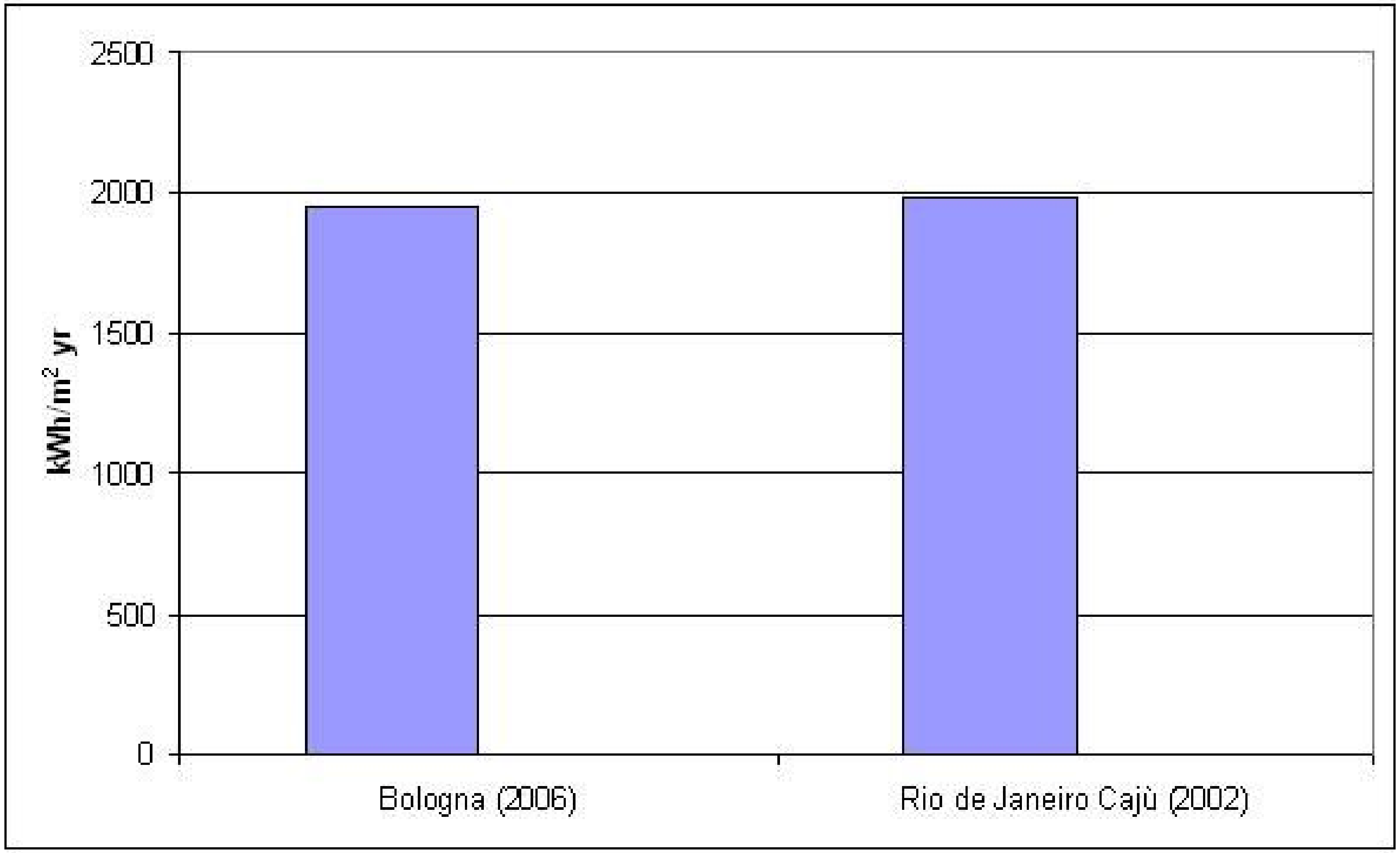


Residential buildings energy consumption

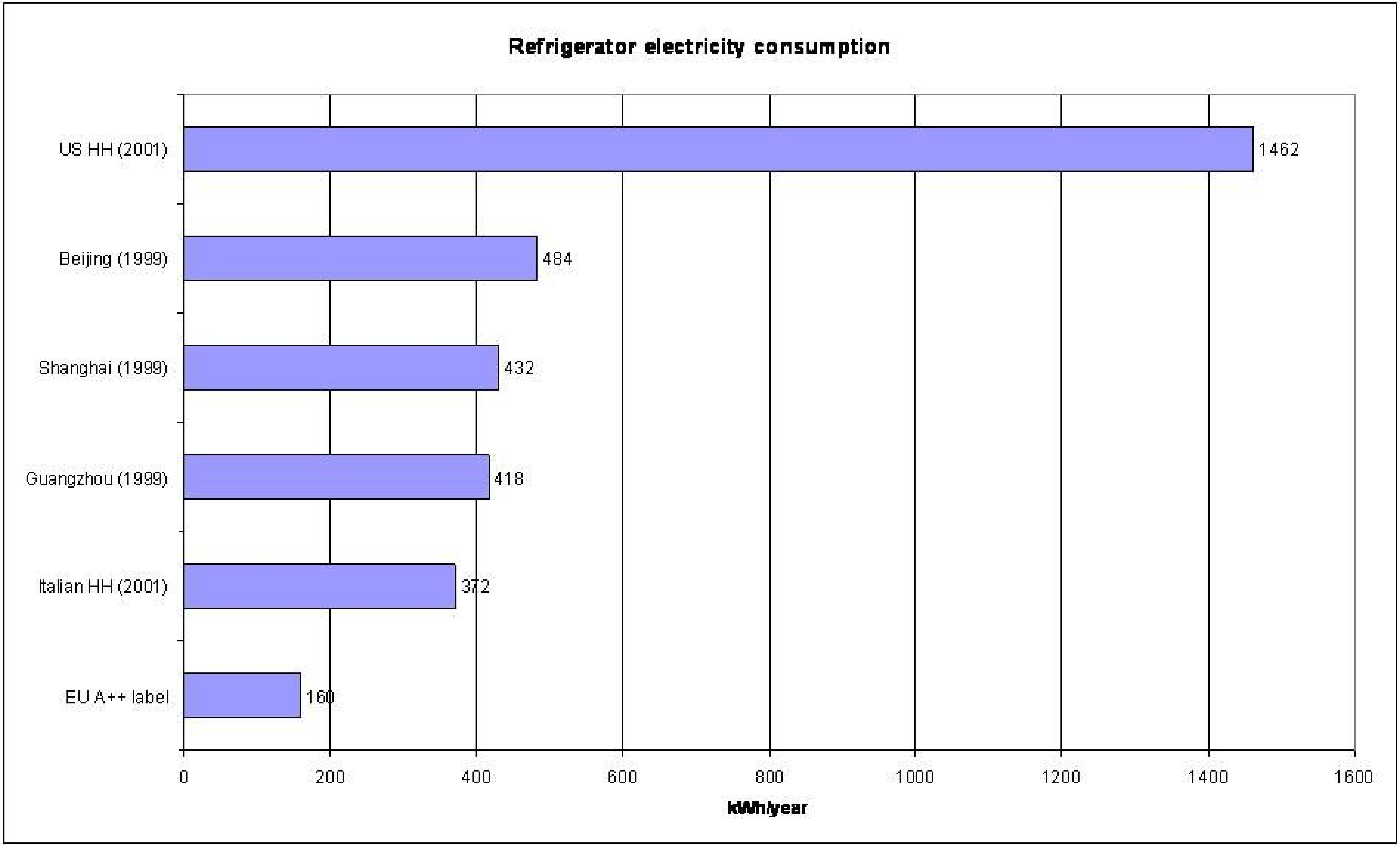
ELECTRICITY CONSUMPTION PER HOUSEHOLD (KWH/YEAR) IN SELECTED CITIES AND COUNTRIES



Source: UN-HABITAT Global Urban Observatory 2008
Note: Data from various sources, 1999-2006

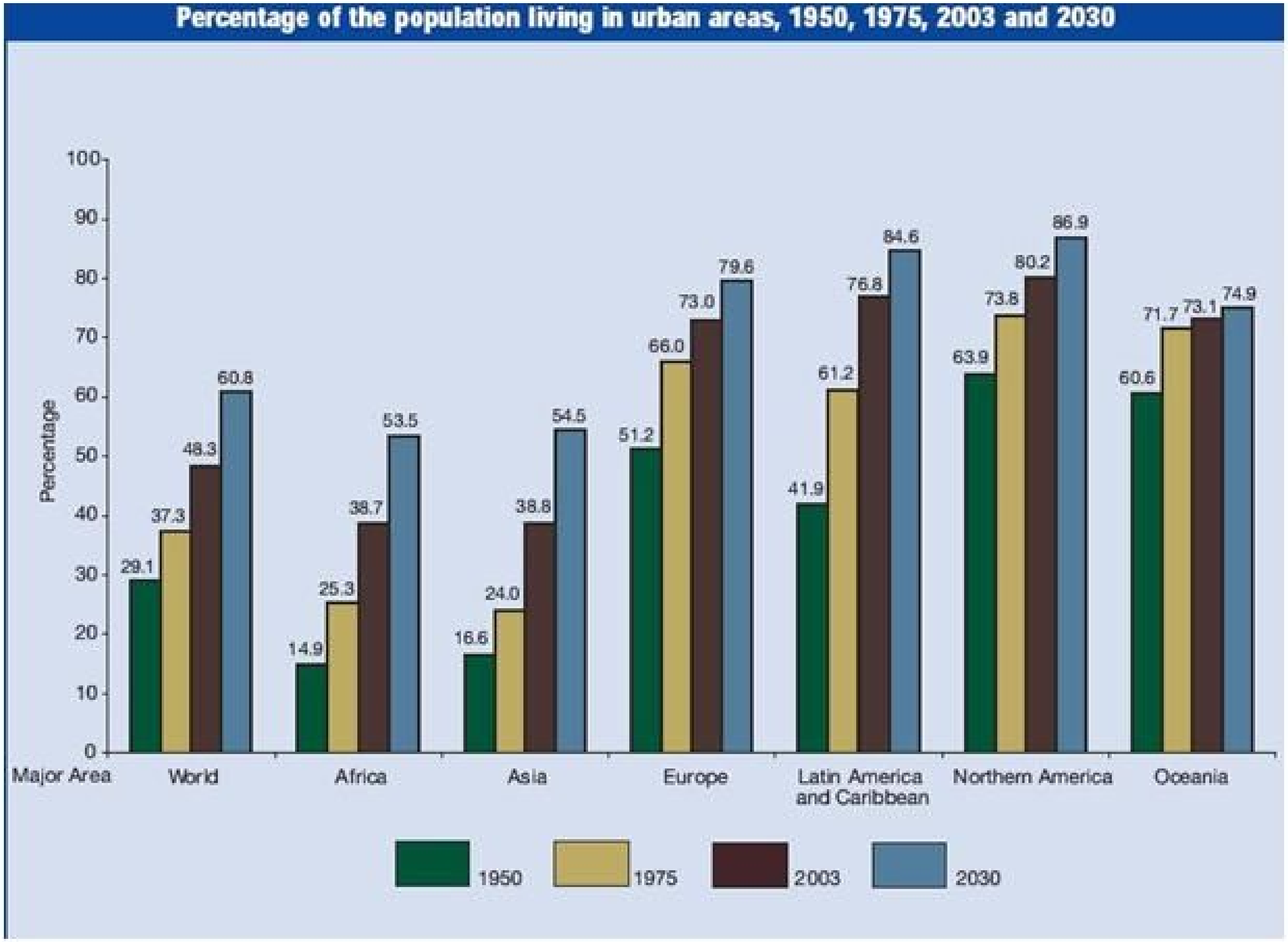


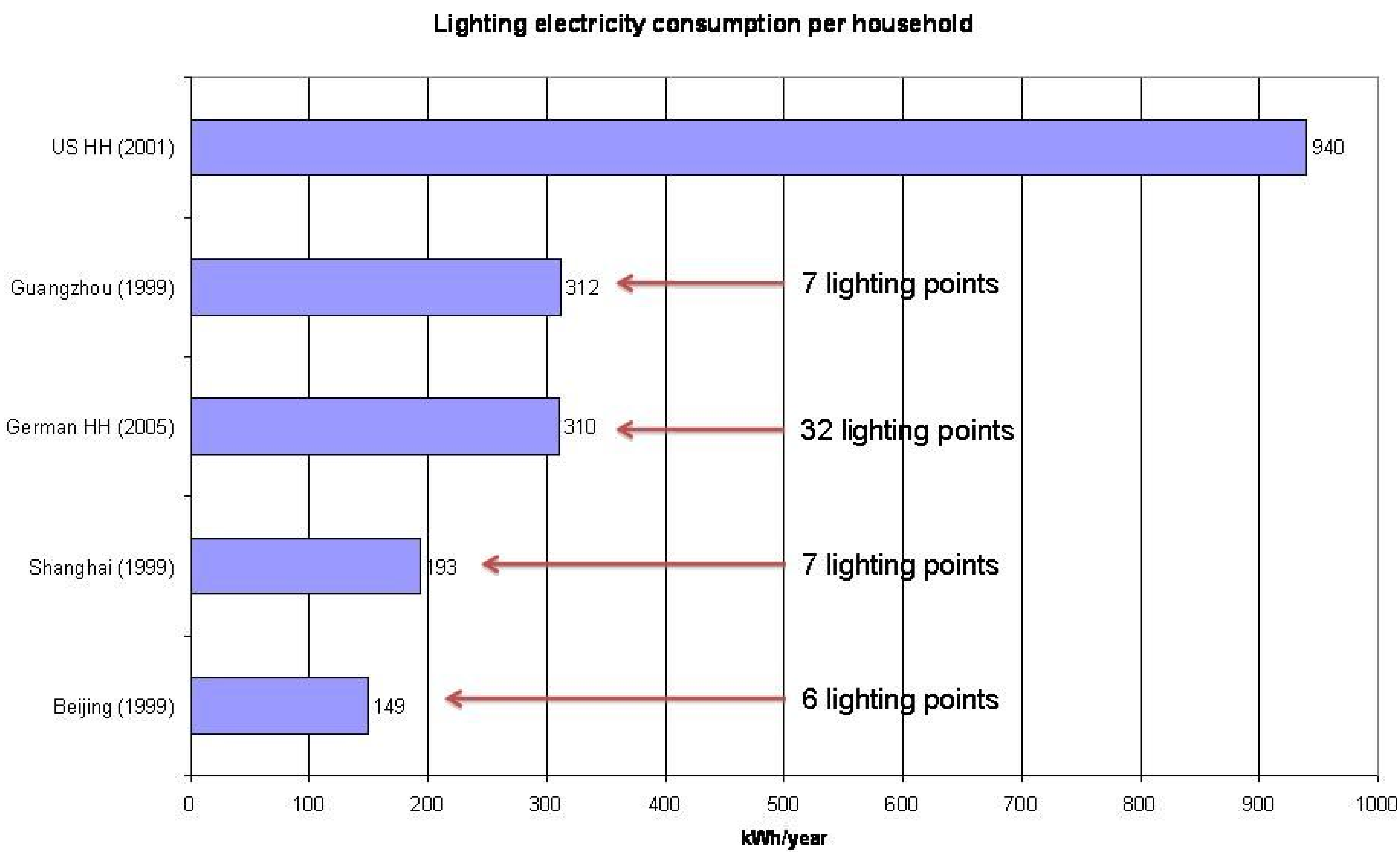
Diffusion of domestic appliances (%)		
	Cajù (2002)	Bologna (1997)
Refrigerator	83.8	98
Washing machine	40.3	89.4
Dishwasher	-	30
Television	87.4	95.2
Air conditioner	20.4	7.5
DVD	1.4	50
PC	6.8	19



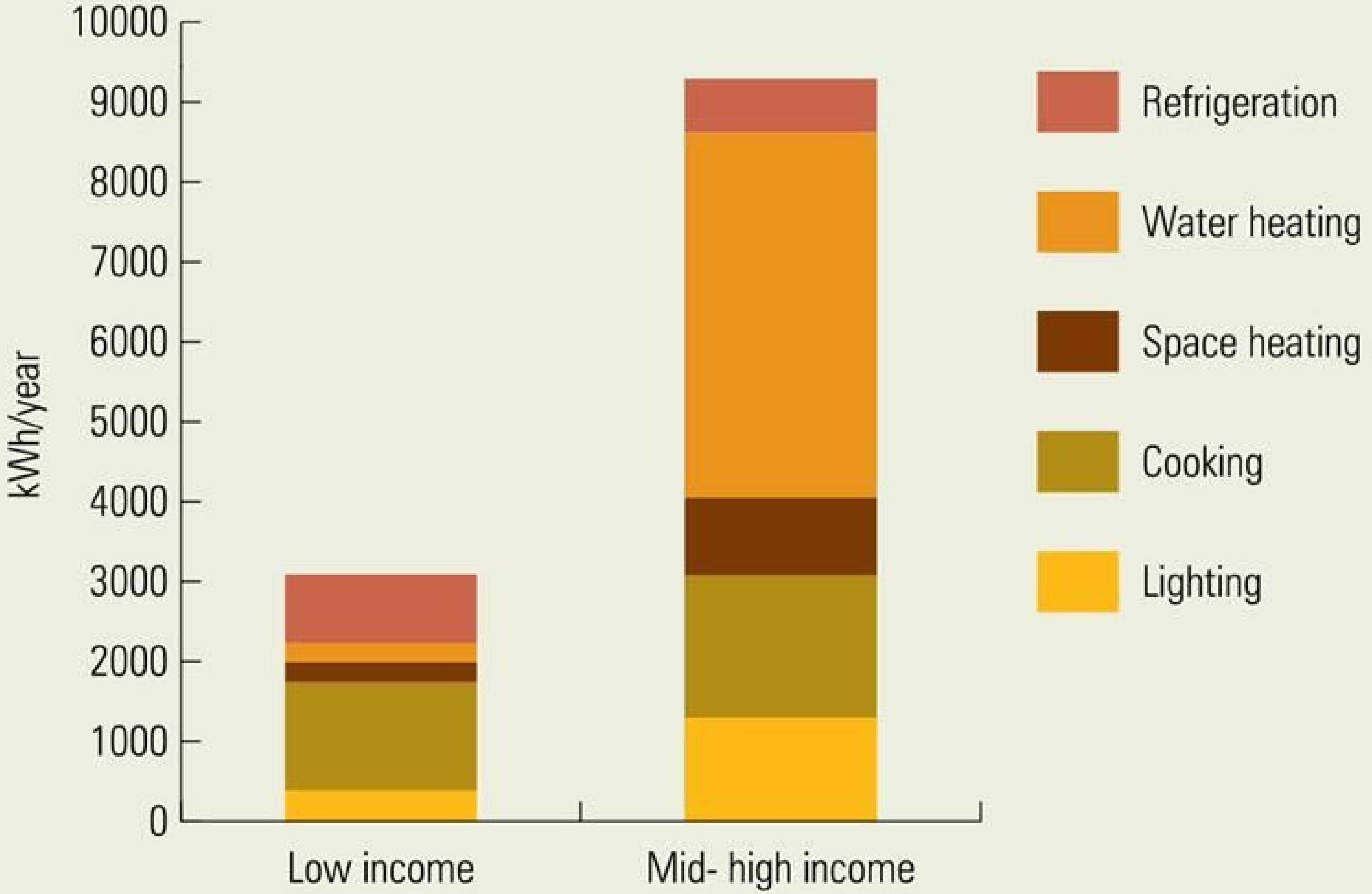
Refrigerator electricity consumption
US HH (2001)
1462
Beijing (1999)
484
Shanghai (1999)
432
Guangzhou (1999)
418
Italian HH (2001)
372
EU A++ label
160
0
200
400
600
800
1000
1200
1400
1600
kWh/year

According to UN population forecasts, in the next 45 years it will be built the equivalent of an one million inhabitants city every week, the largest part in developing countries



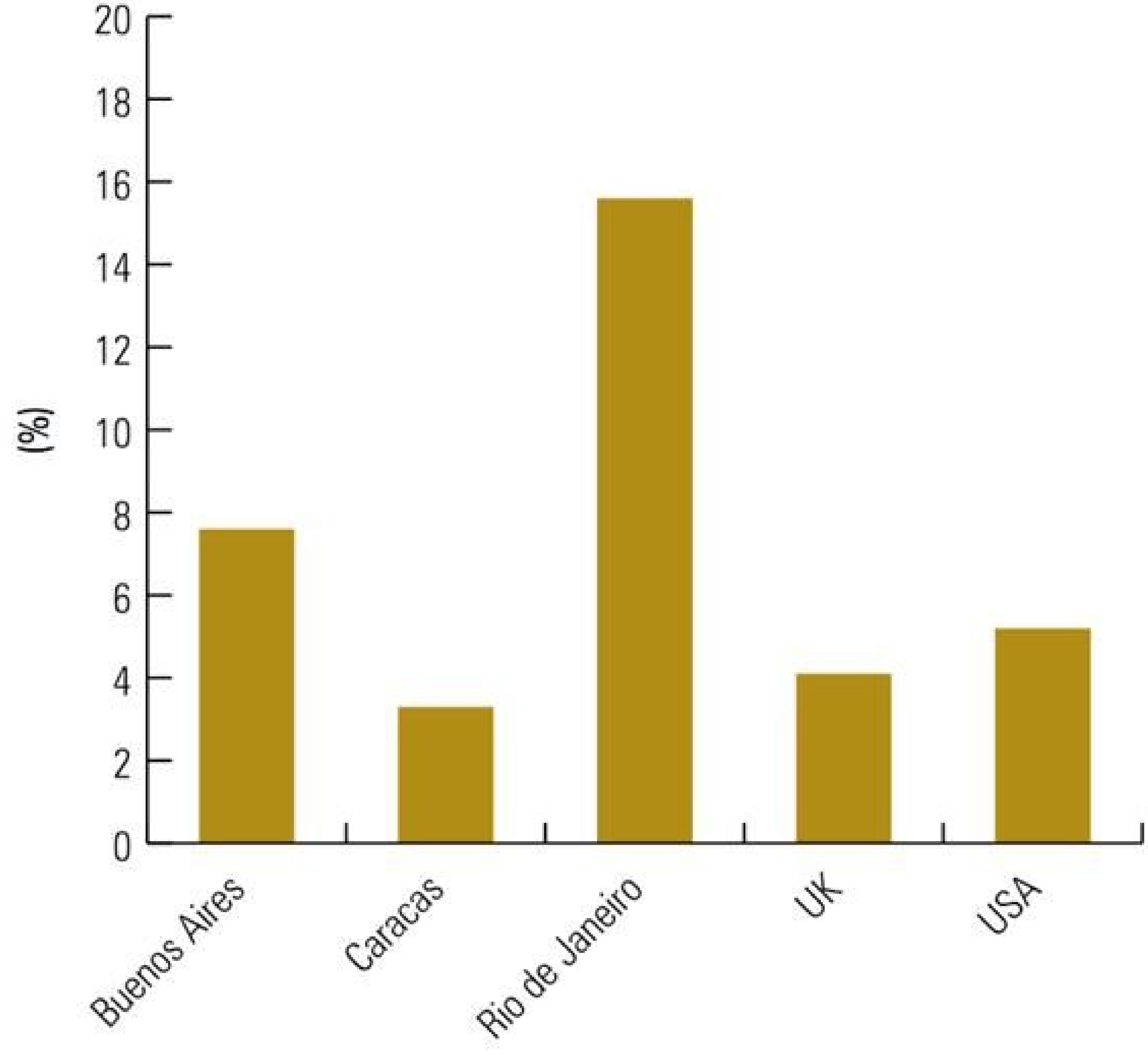

Lighting electricity consumption per household
US HH (2001)
940
Guangzhou (1999)
312
7 lighting points
German HH (2005)
310
32 lighting points
Shanghai (1999)
193
7 lighting points
Beijing (1999)
149
6 lighting points
0
100
200
300
400
500
600
700
800
900
1000
kWh/year

HOUSEHOLD ELECTRICITY CONSUMPTION DIFFERENCES IN CAPE TOWN



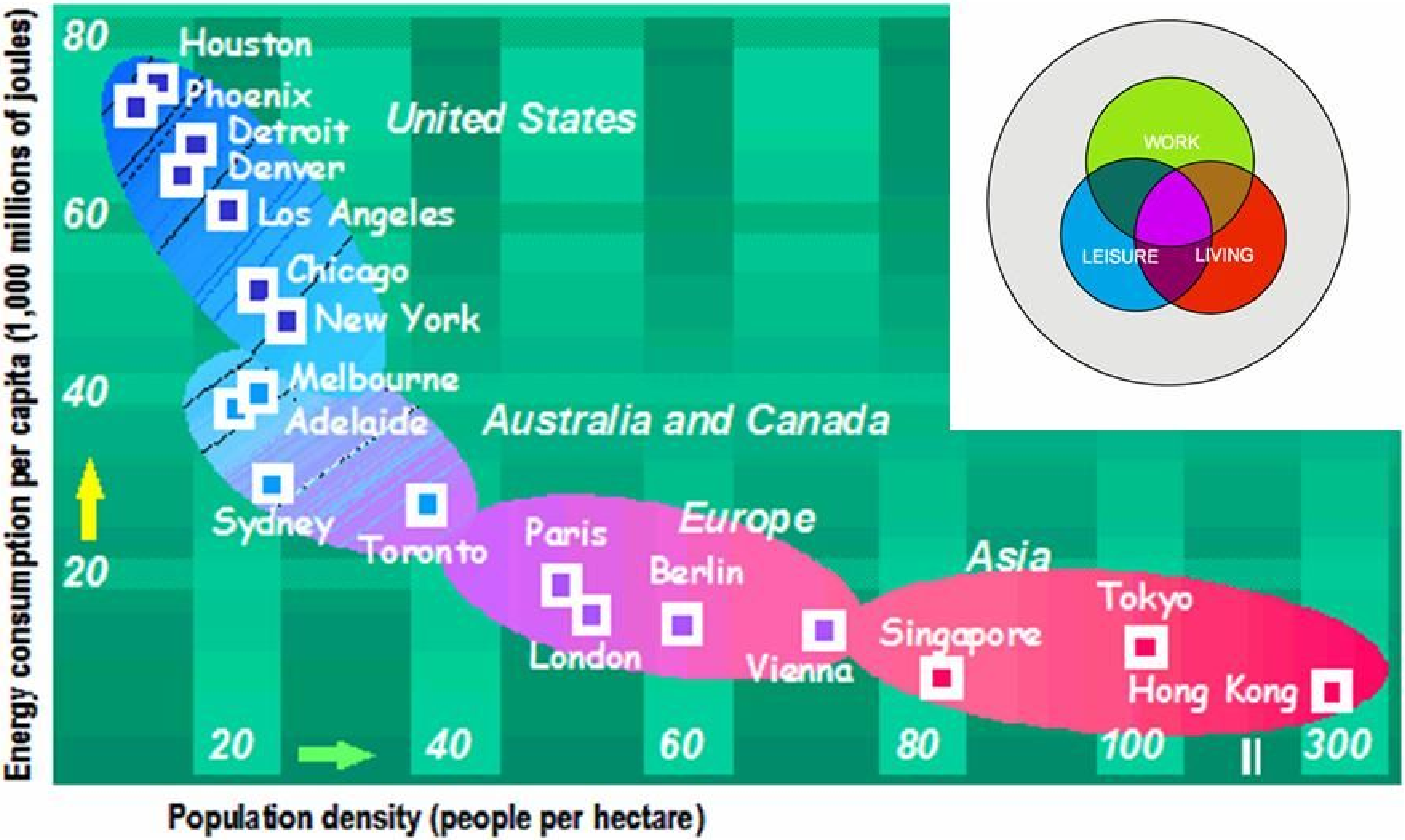
Source: Winkler, et al., 2006.

PROPORTION OF FAMILY INCOME USED FOR ENERGY IN LOW-INCOME HOUSEHOLDS IN SELECTED CITIES AND COUNTRIES



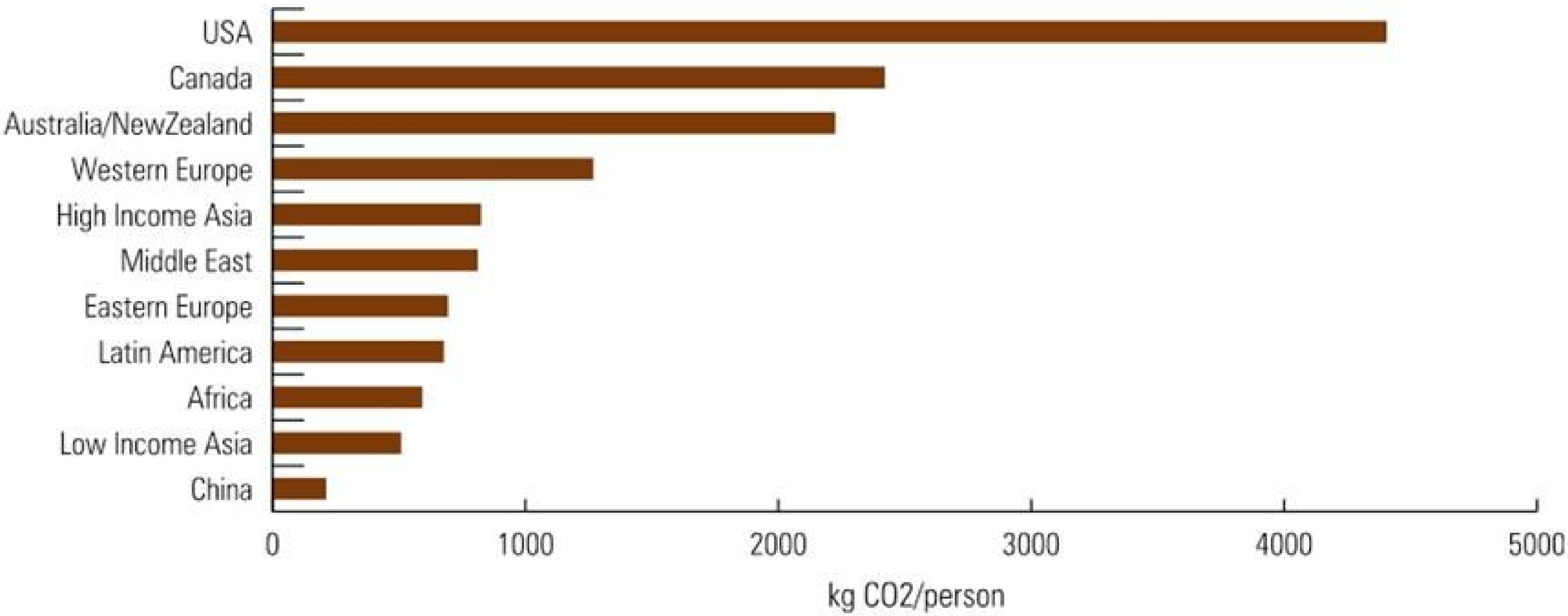
Source: World Energy Council, 2006

Transport



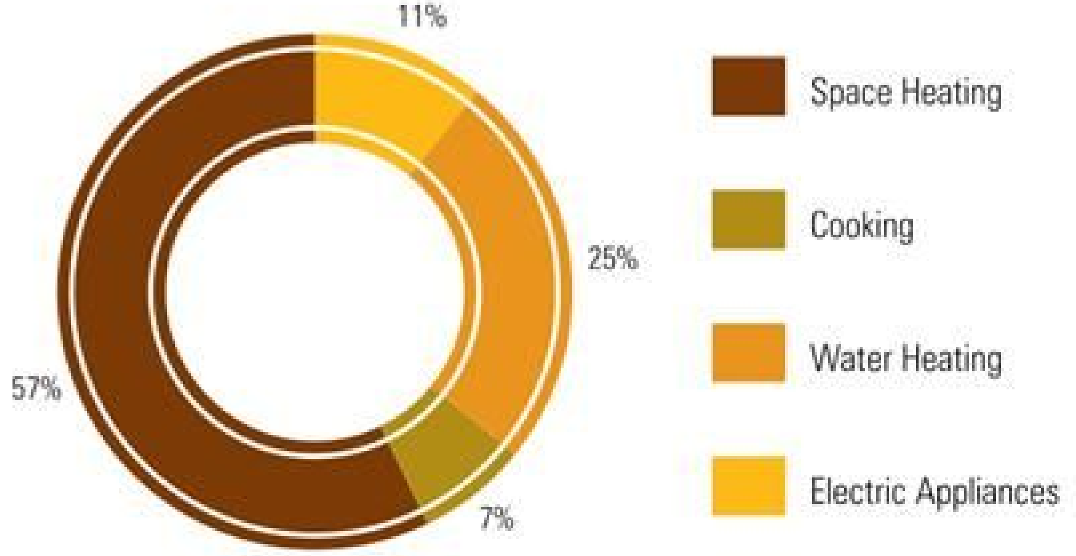
Energy consumption per capita (1,000 millions of joules)
80
60
40
20
Houston
Phoenix
Detroit
Denver
Los Angeles
Chicago
New York
United States
Melbourne
Adelaide
Australia and Canada
Sydney
Toronto
Paris
Europe
Berlin
London
Vienna
Asia
Singapore
Tokyo
Hong Kong
20
40
60
80
100
300
Population density (people per hectare)
WORK
LEISURE
LIVING

TOTAL TRANSPORT (PRIVATE AND PUBLIC) CO2 EMISSIONS IN SELECTED REGIONS AND COUNTRIES



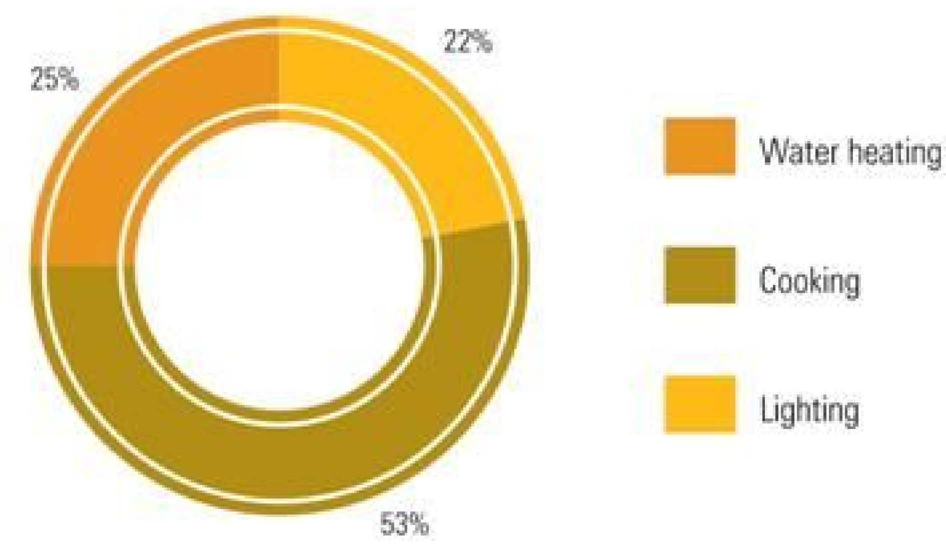
Source: Adapted from: Kenworthy, J. , 2003; http://cst.uwinnipeg.ca/documents/Transport_Greenhouse.pdf

FIGURE 3.4.2: **HOUSEHOLD ENERGY USE PATTERNS IN EU-15, 1997**



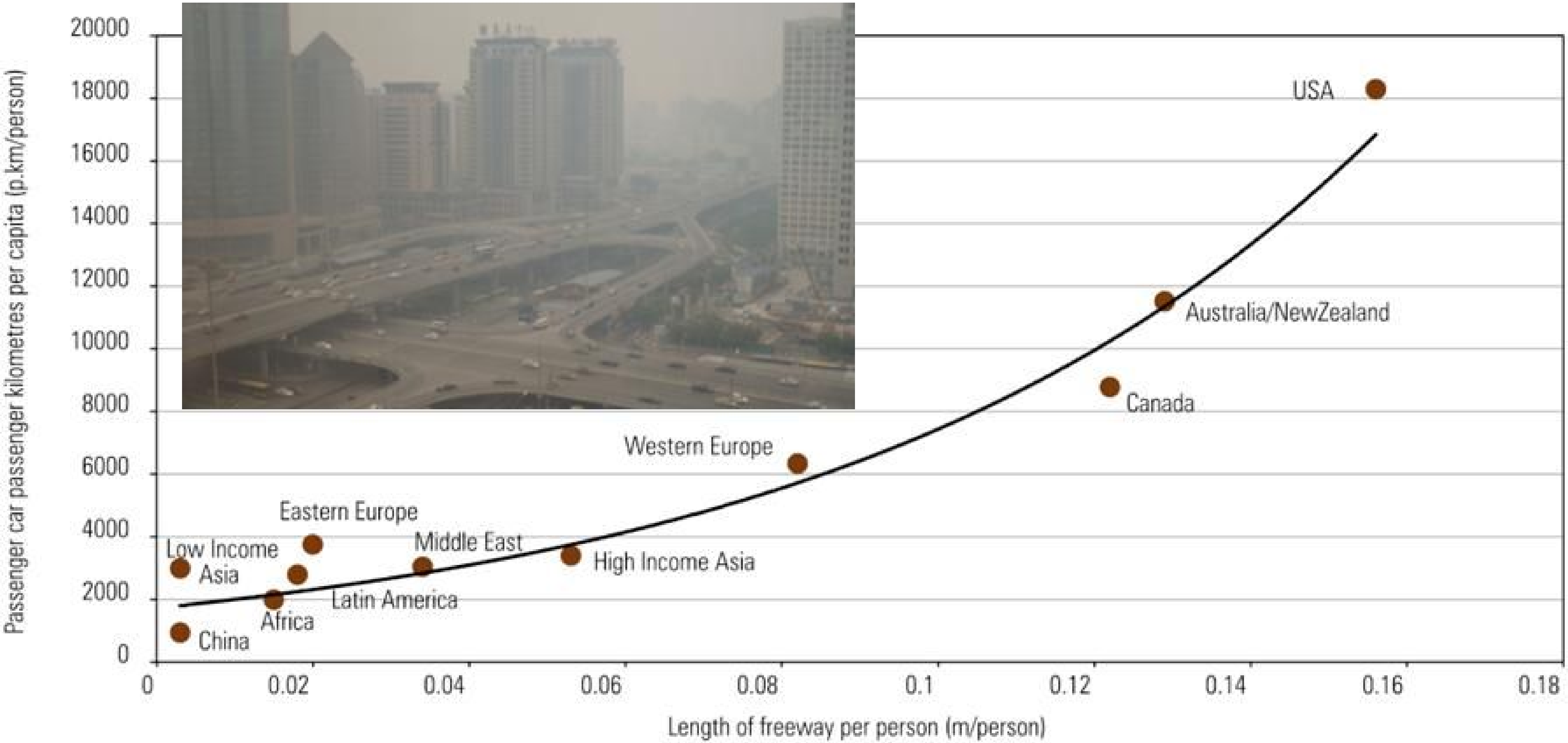
Source: Commission of the European Communities, 2001.

FIGURE 3.4.3: **LOW-INCOME HOUSEHOLD ENERGY USE PATTERNS IN CAPE TOWN, 1996**



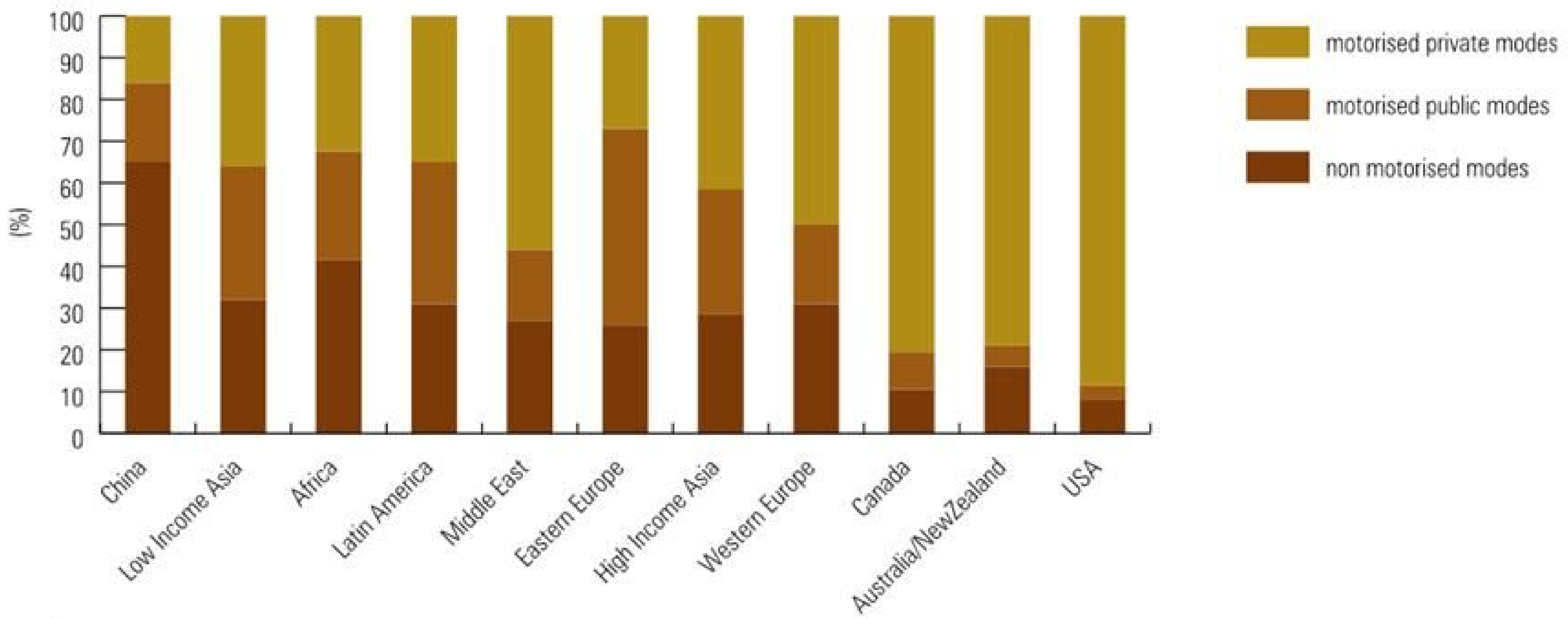
Source: Winkler, et al., 2005.

RELATIONSHIP BETWEEN LENGTH OF FREEWAY PER PERSON AND PASSENGER CAR KILOMETRES



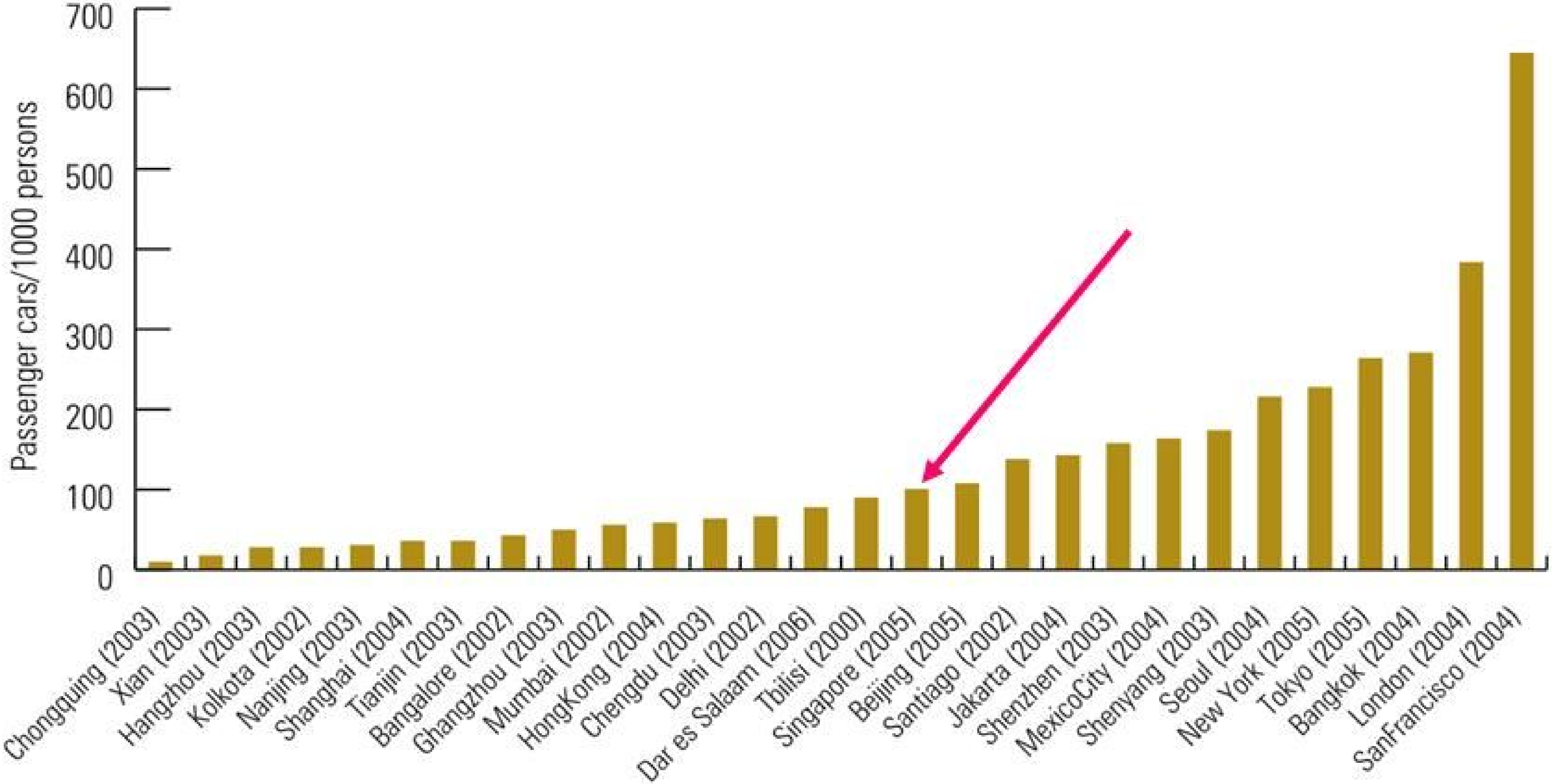
Source: Adapted from: Kenworthy 2003

SHARE OF MOTORIZED AND NON-MOTORIZED PRIVATE AND PUBLIC TRANSPORT IN SELECTED REGIONS AND COUNTRIES

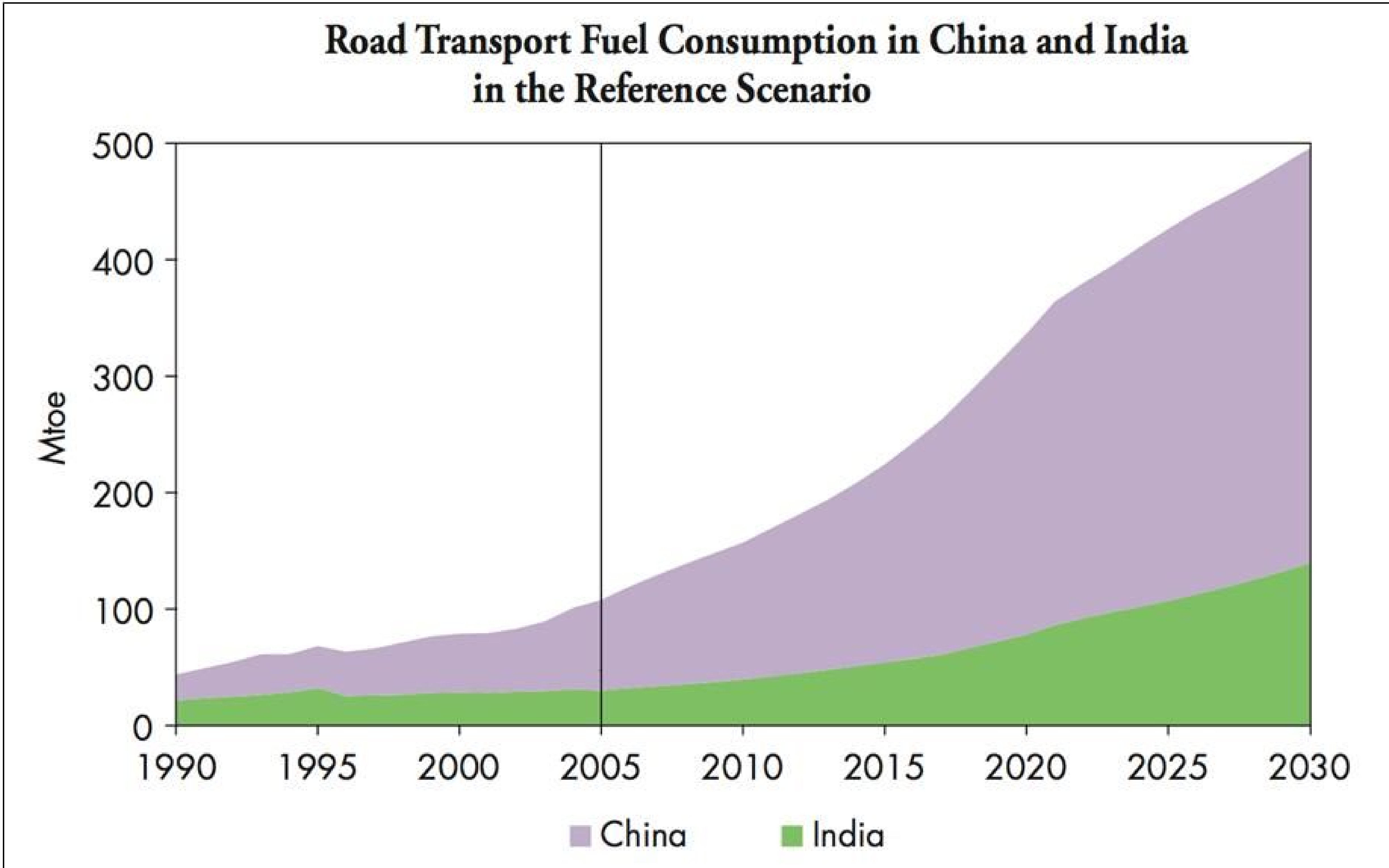


Source: Adapted from: Kenworthy, 2003

CAR OWNERSHIP IN SELECTED CITIES



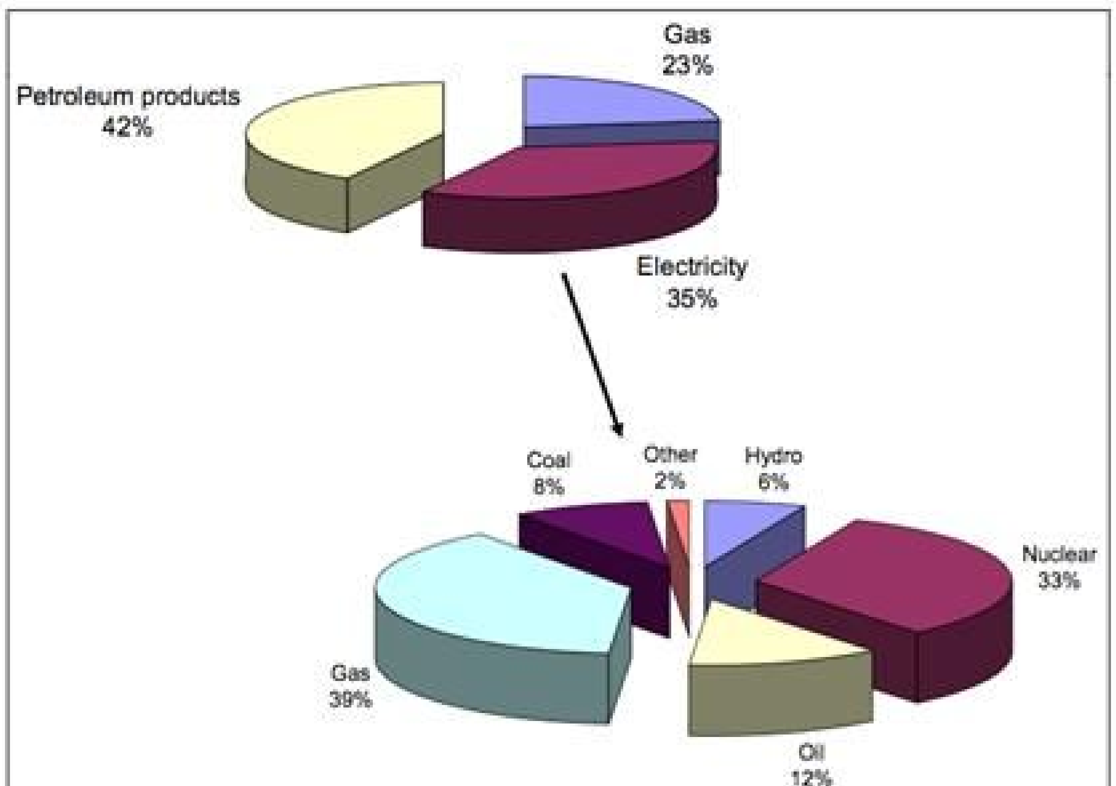
Source: UN-HABITAT Global Urban Observatory 2008
Note: Data derived from various sources, 2000-2004



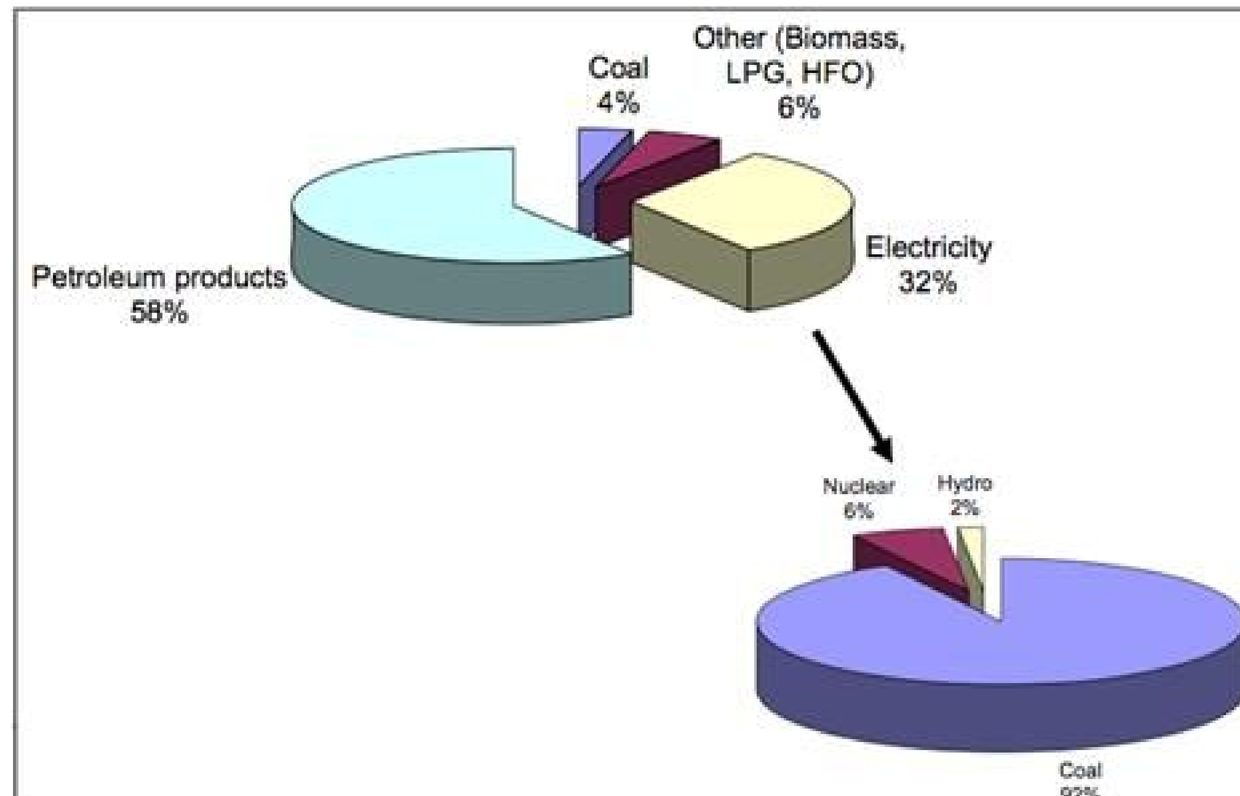
Road Transport Fuel Consumption in China and India
in the Reference Scenario
500
400
300
200
100
0
Mtoe
1990
1995
2000
2005
2010
2015
2020
2025
2030
China
India

Source:IEA

	Energy Consumption	Emissions	
	kWh per capita	ton CO_2 per capita	kg CO_2/kWh
Mexico City (2000)	9230	3.27	0.35
Cape Town (2004)	12200	6.43	0.53
Beijing (1998)	17090	6.90	0.40
Tokyo Metropolis (2003)	19170	5.94	0.31
Greater London (1999)	23610	6.96	0.29



Tokyo fuel mix

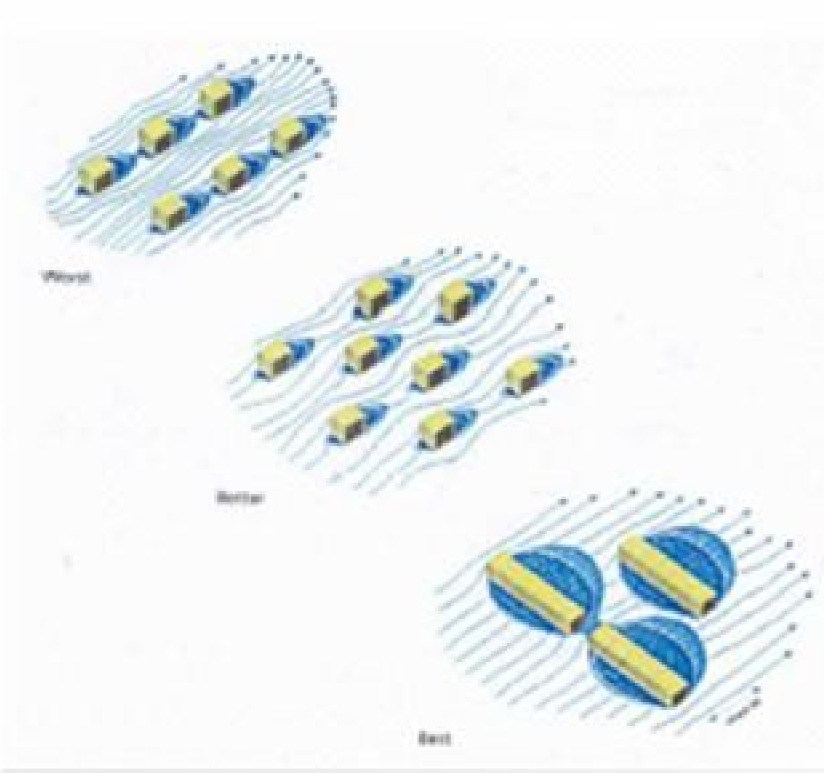


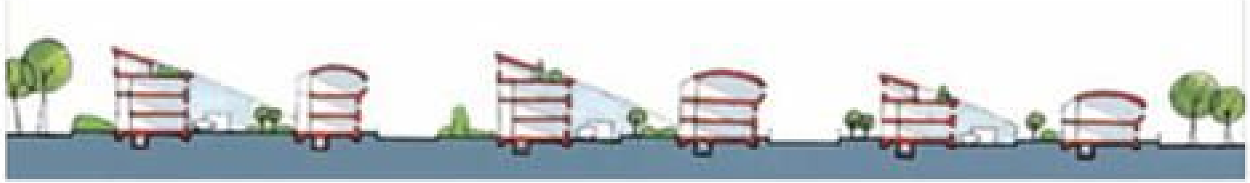
Cape Town fuel mix

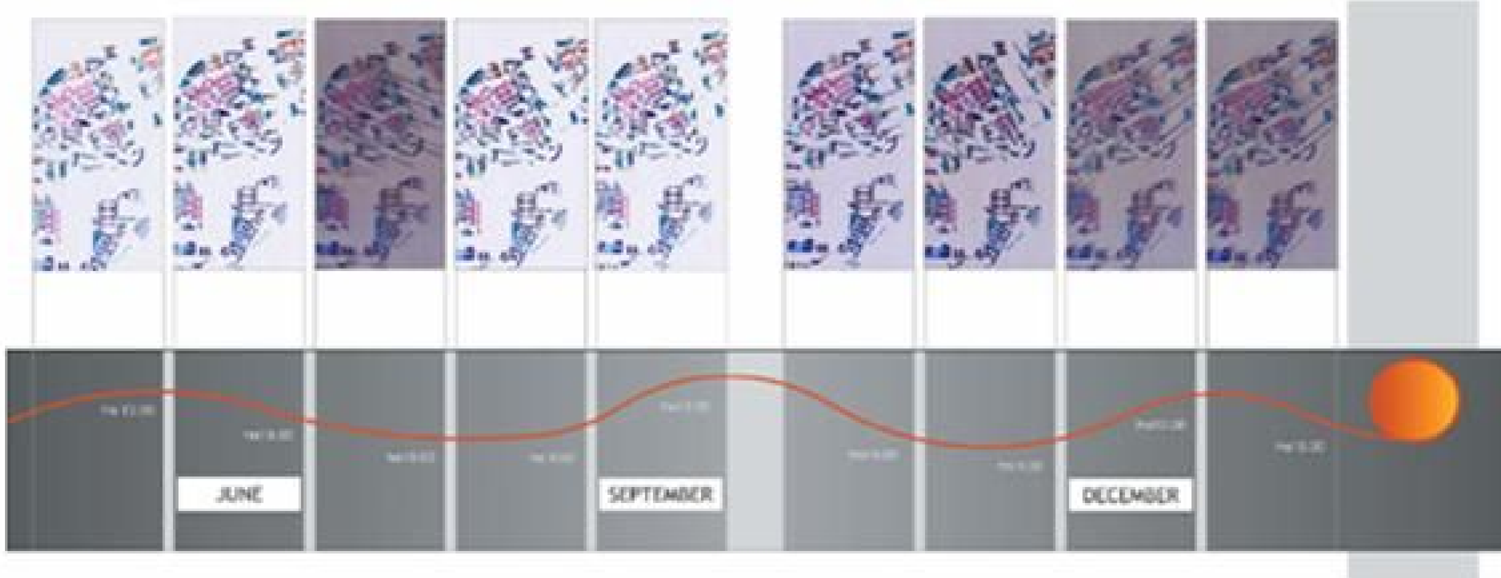
Guidelines for low energy – low emission urban design

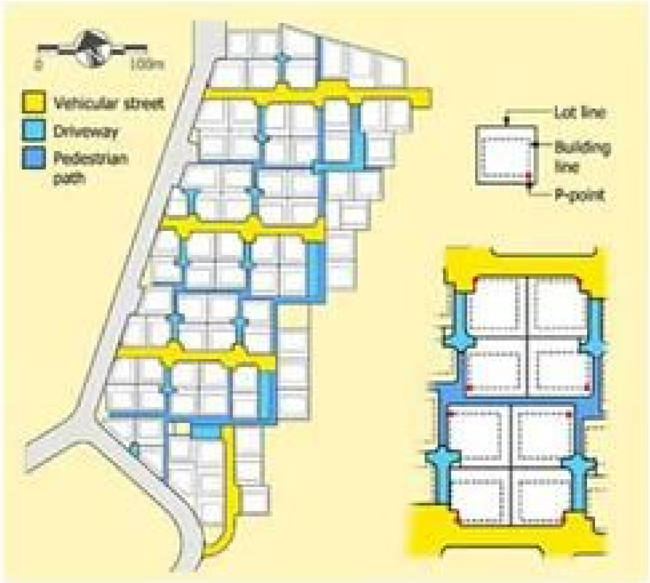
1. minimise energy demand
2. minimise energy consumption
3. recycle energy and materials
4. substitute fossil fuels with renewable energy

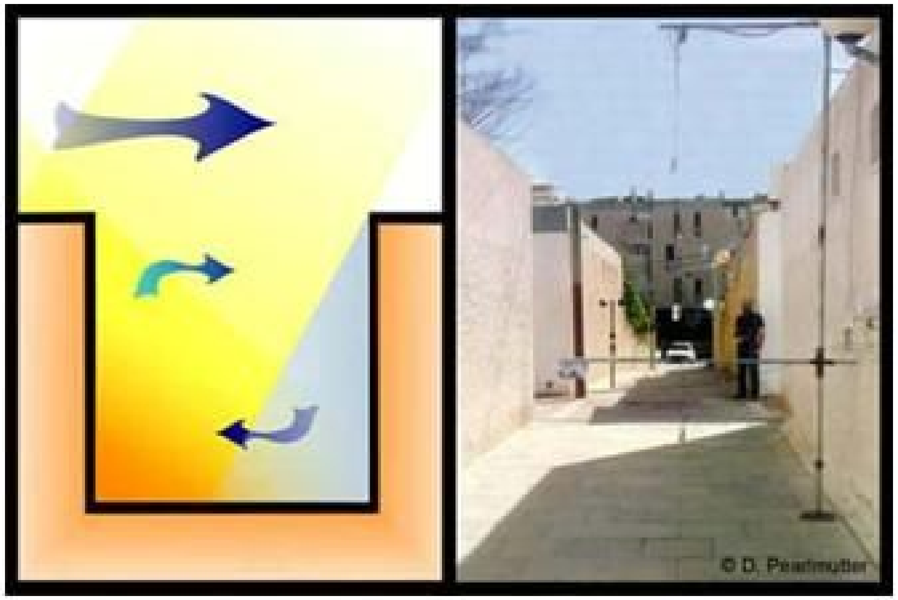
1. Minimise energy demand

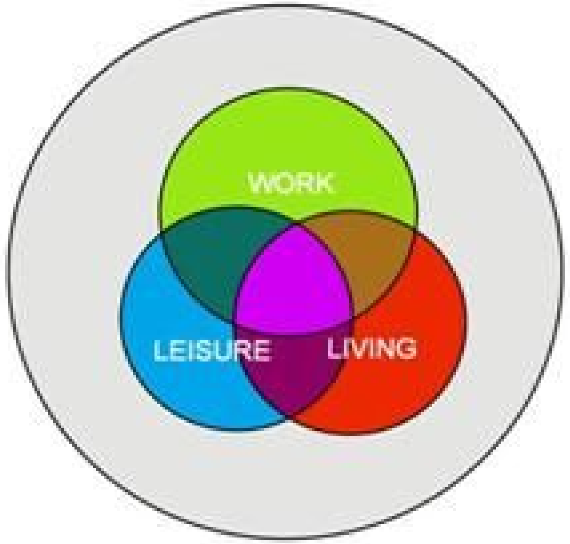




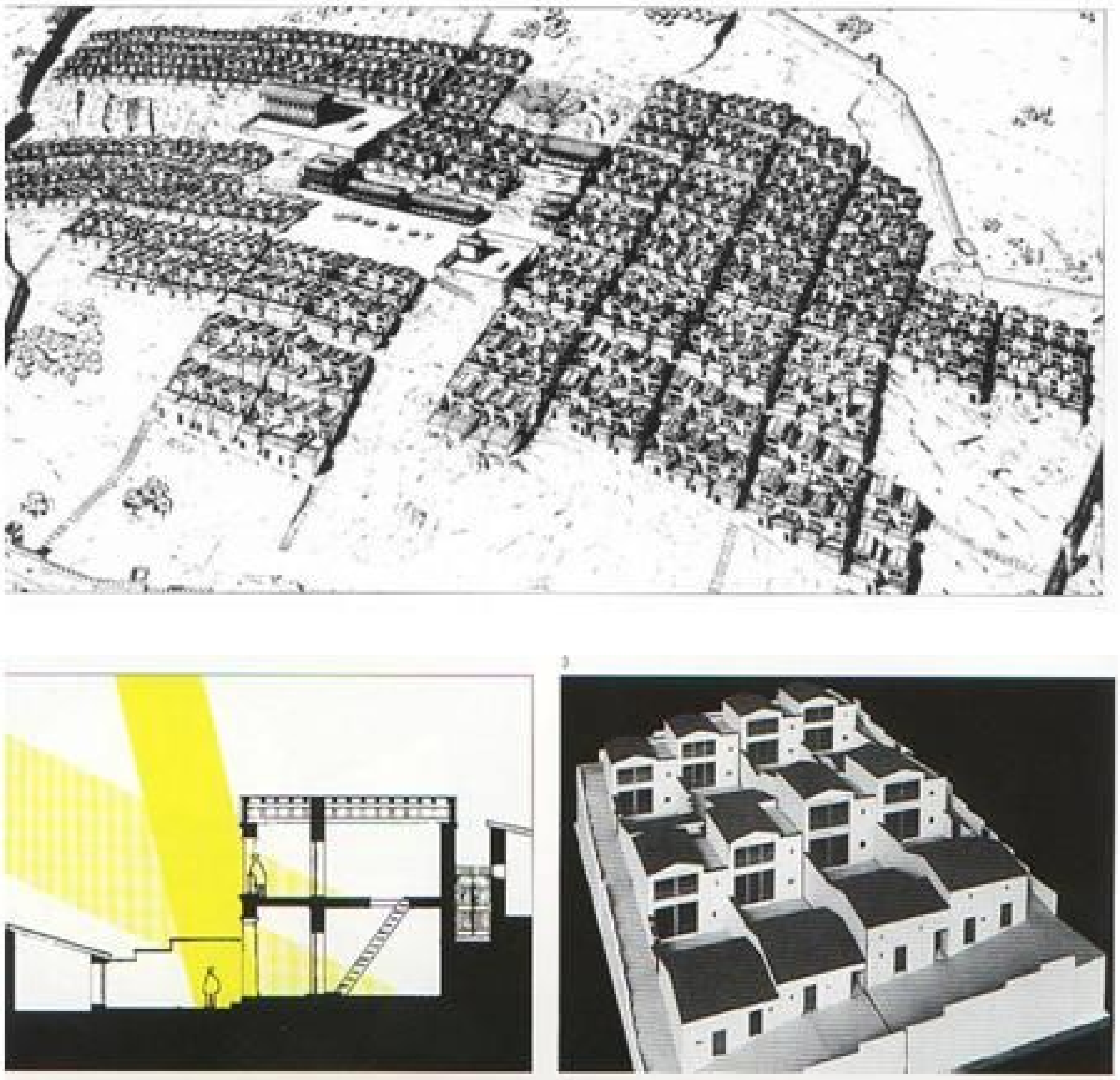




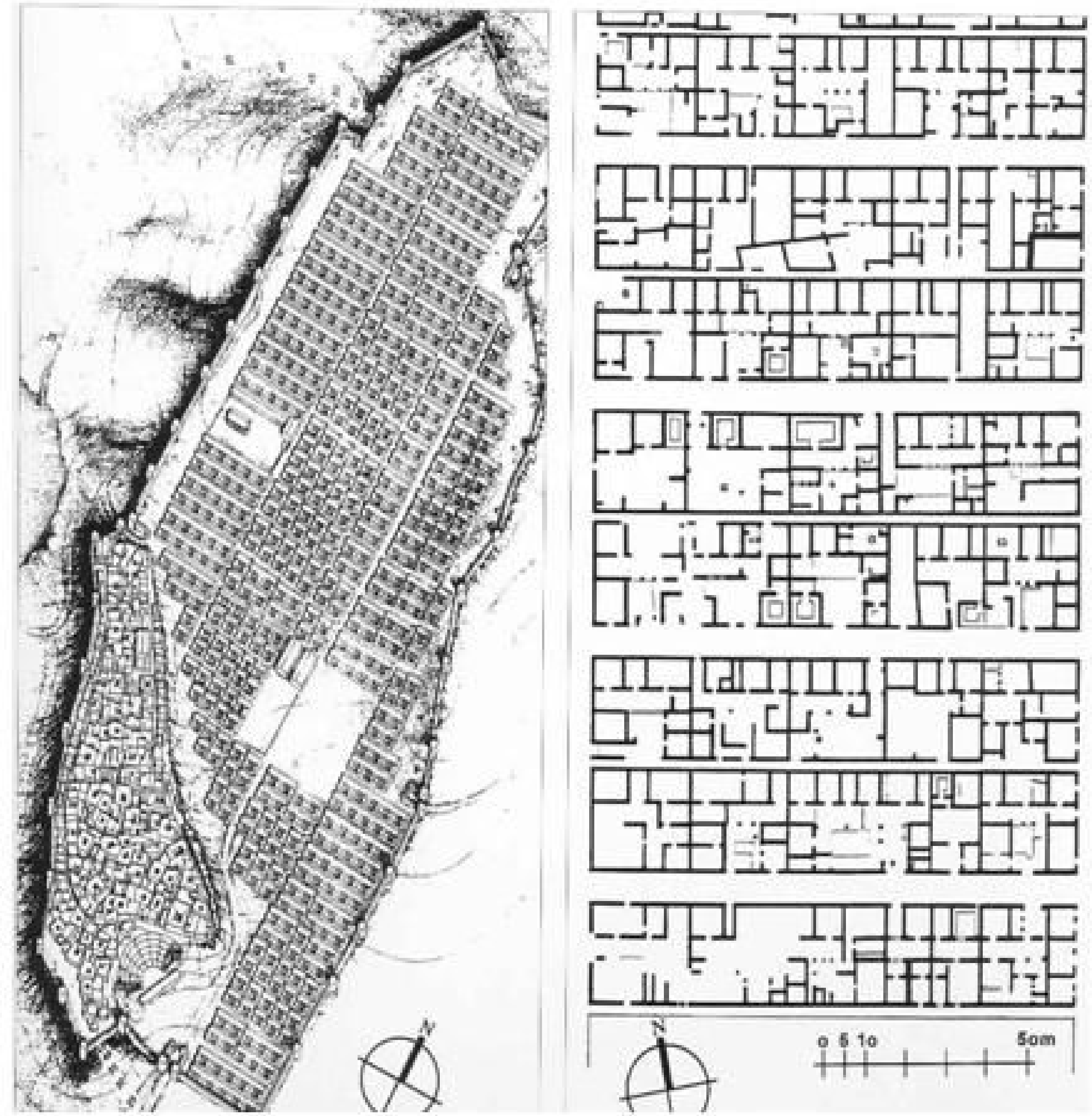




1. Minimise energy demand



Priene (Asia Minor)



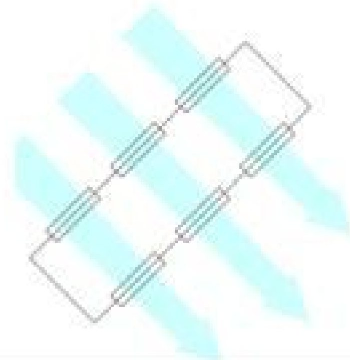
Olintus (Ancient Greece)

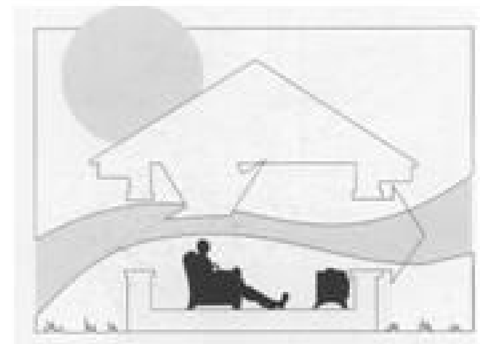
1. Minimise energy demand

BUILDING SCALE

Some basic rules must be followed, aiming to meet the best thermal and visual comfort condition with low energy demand, thermal and electrical.

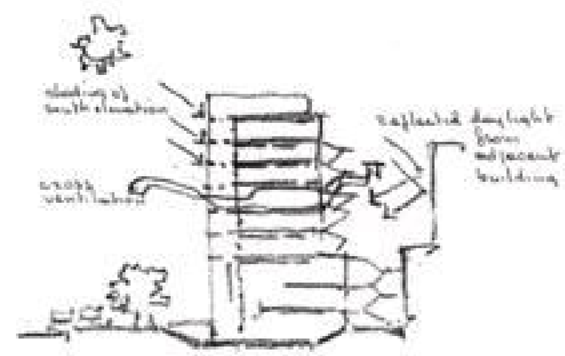
Improve building insulation

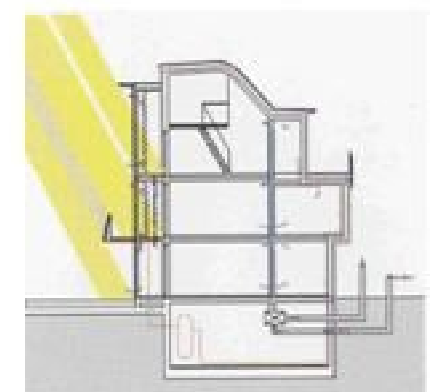


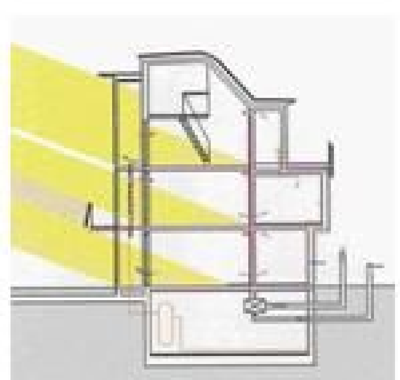


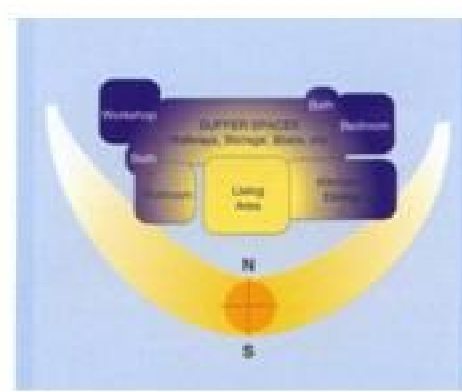
Take profit of ventilation in summer

Protect from solar radiation in summer



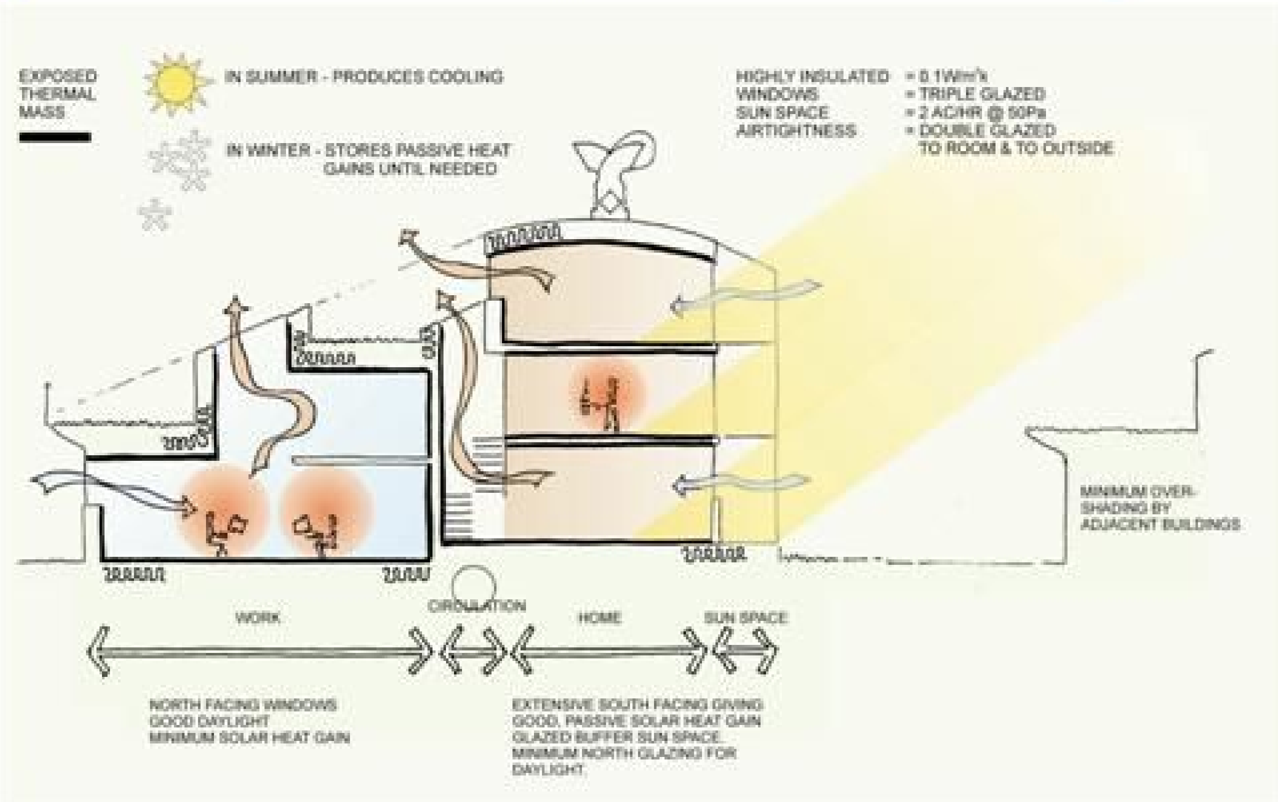


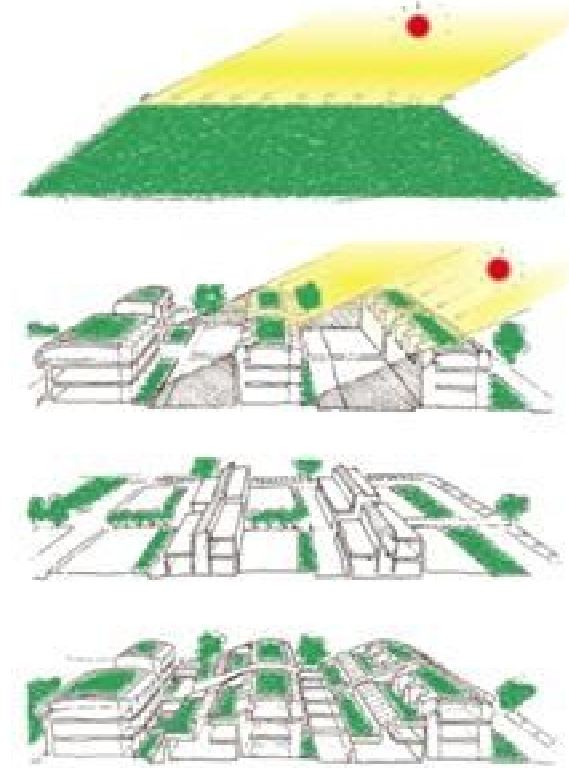




Enhance solar radiation benefits in winter

1. Minimise energy demand



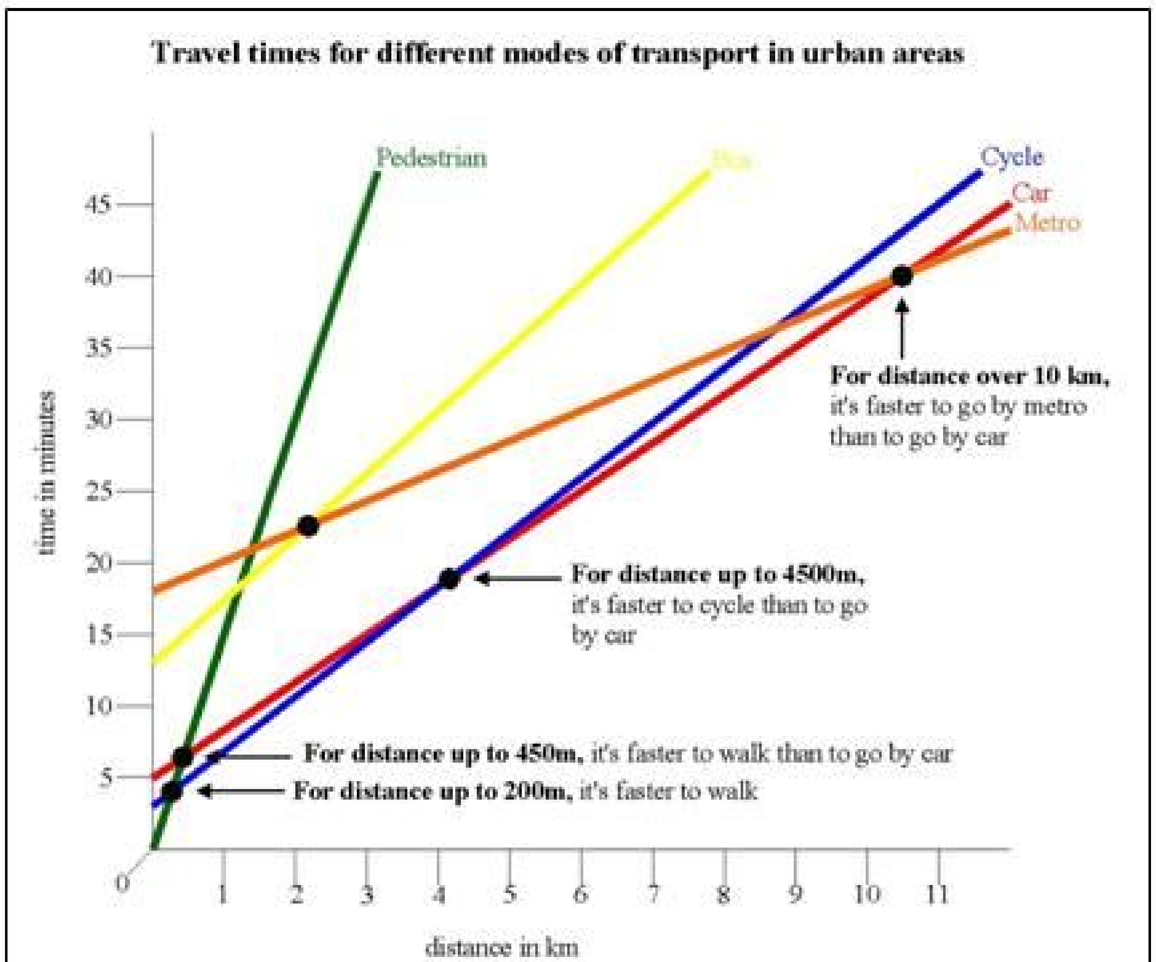


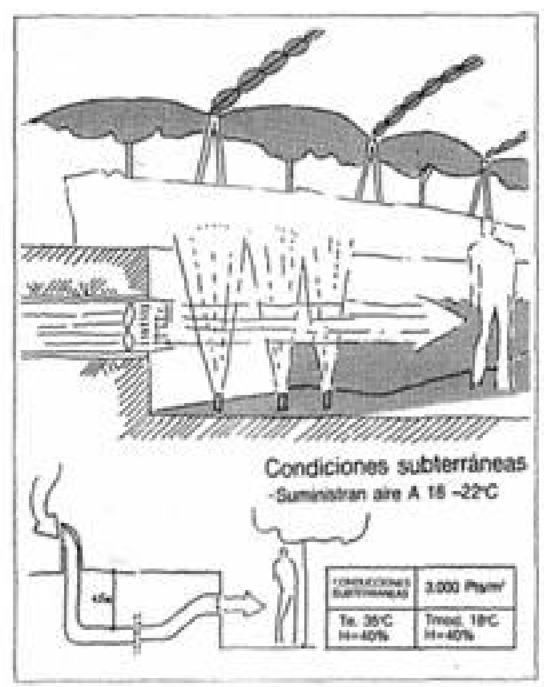
BedZed

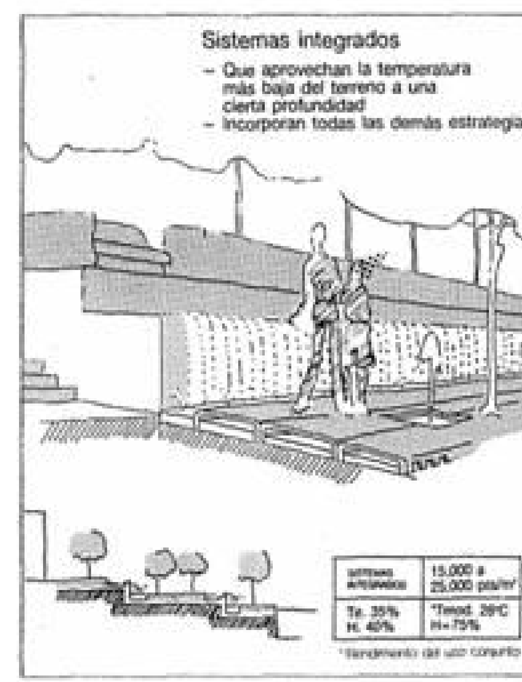
Cooking

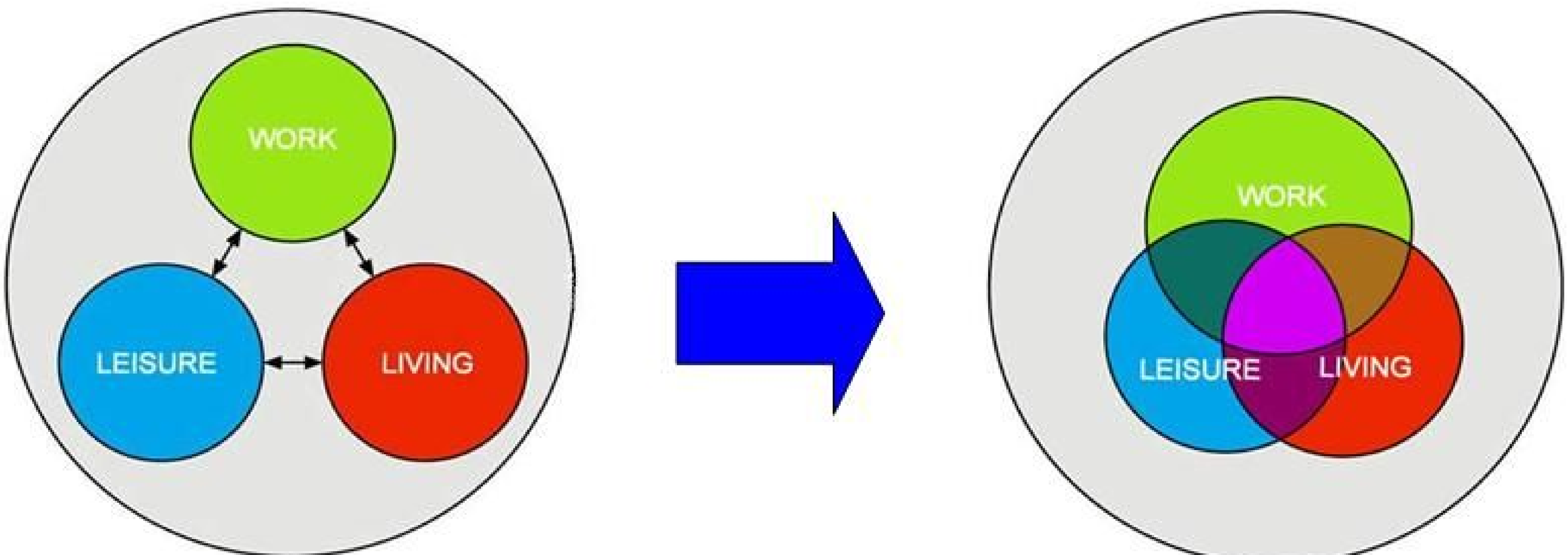
1. Minimise energy demand

Favour walking and cycling, also with mitigated environment urban paths.







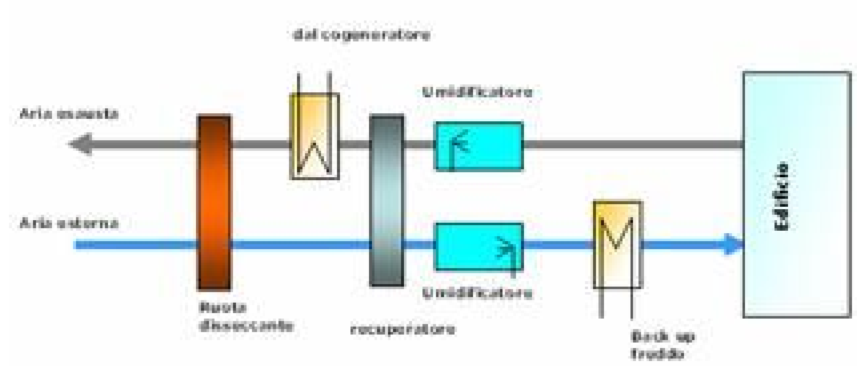

WORK
LEISURE
LIVING
WORK
LEISURE
LIVING

2. Minimise energy consumption

CHP

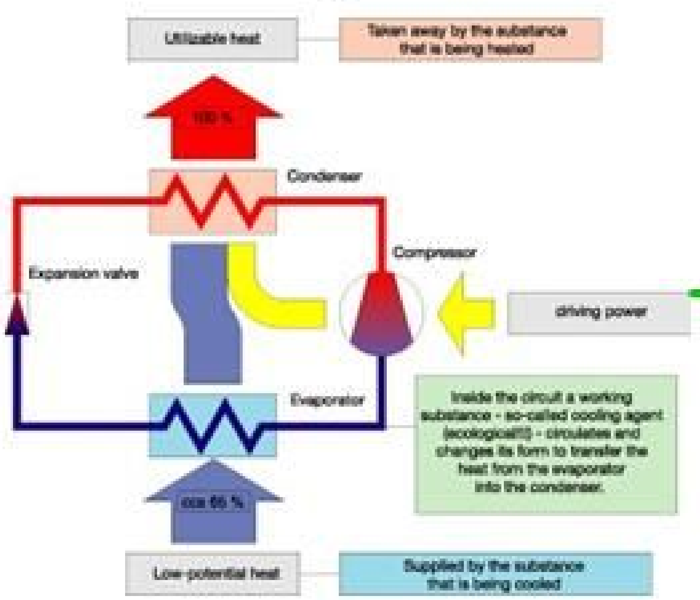
Heat

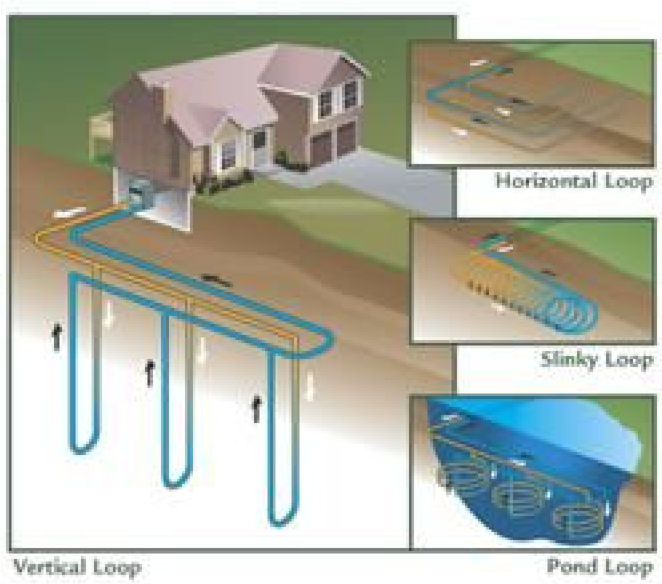
Absorbtion chiller

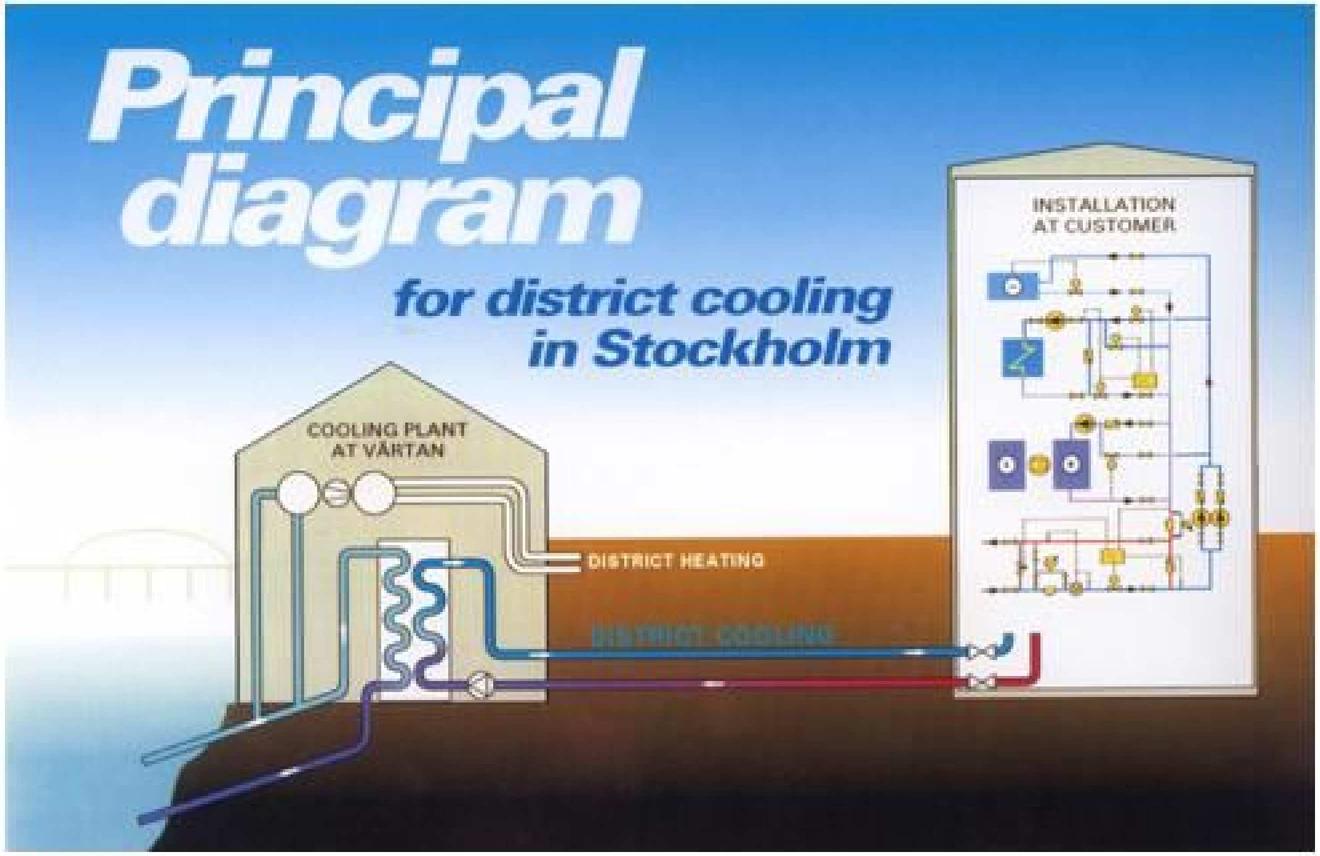


Desiccant cooling

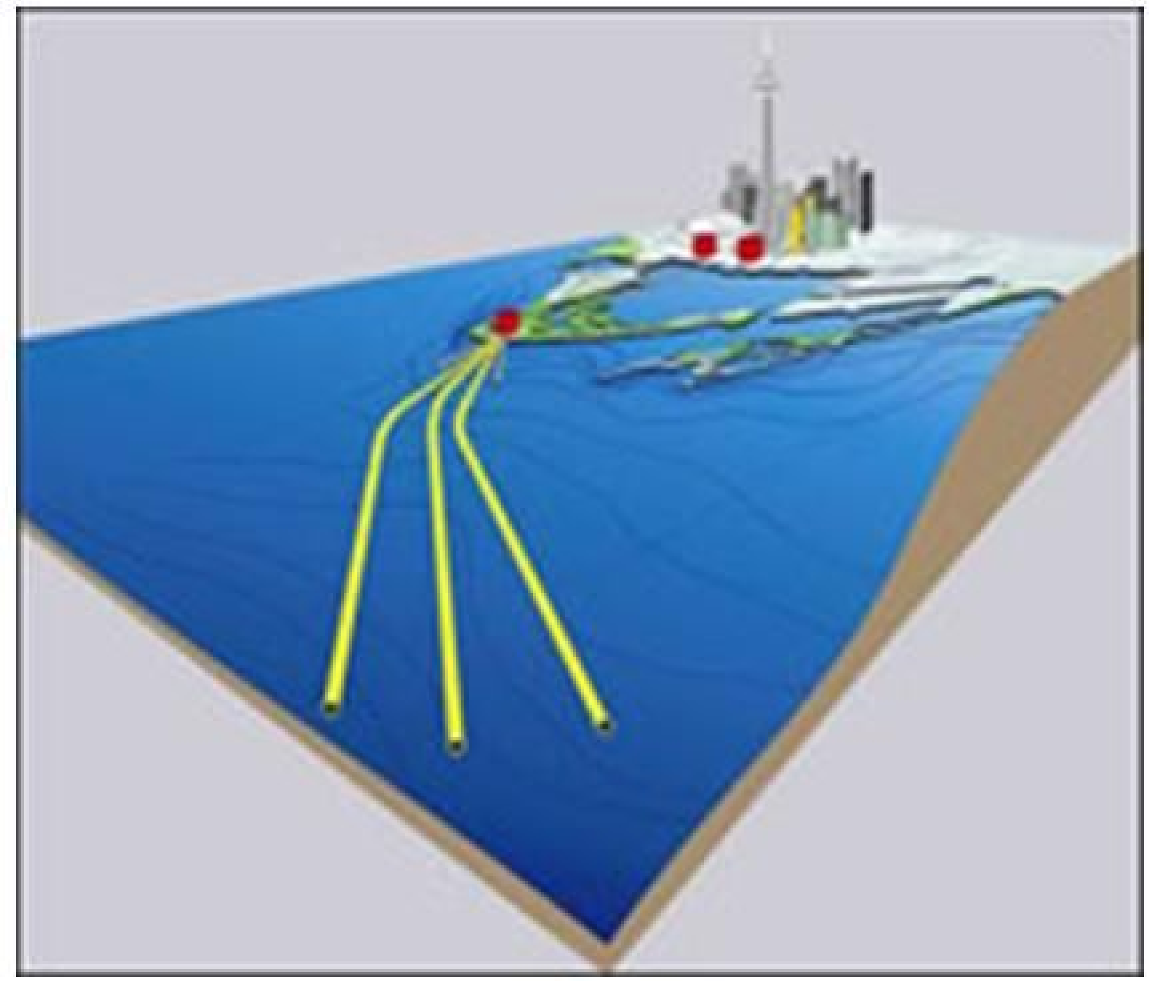
Heat Pump



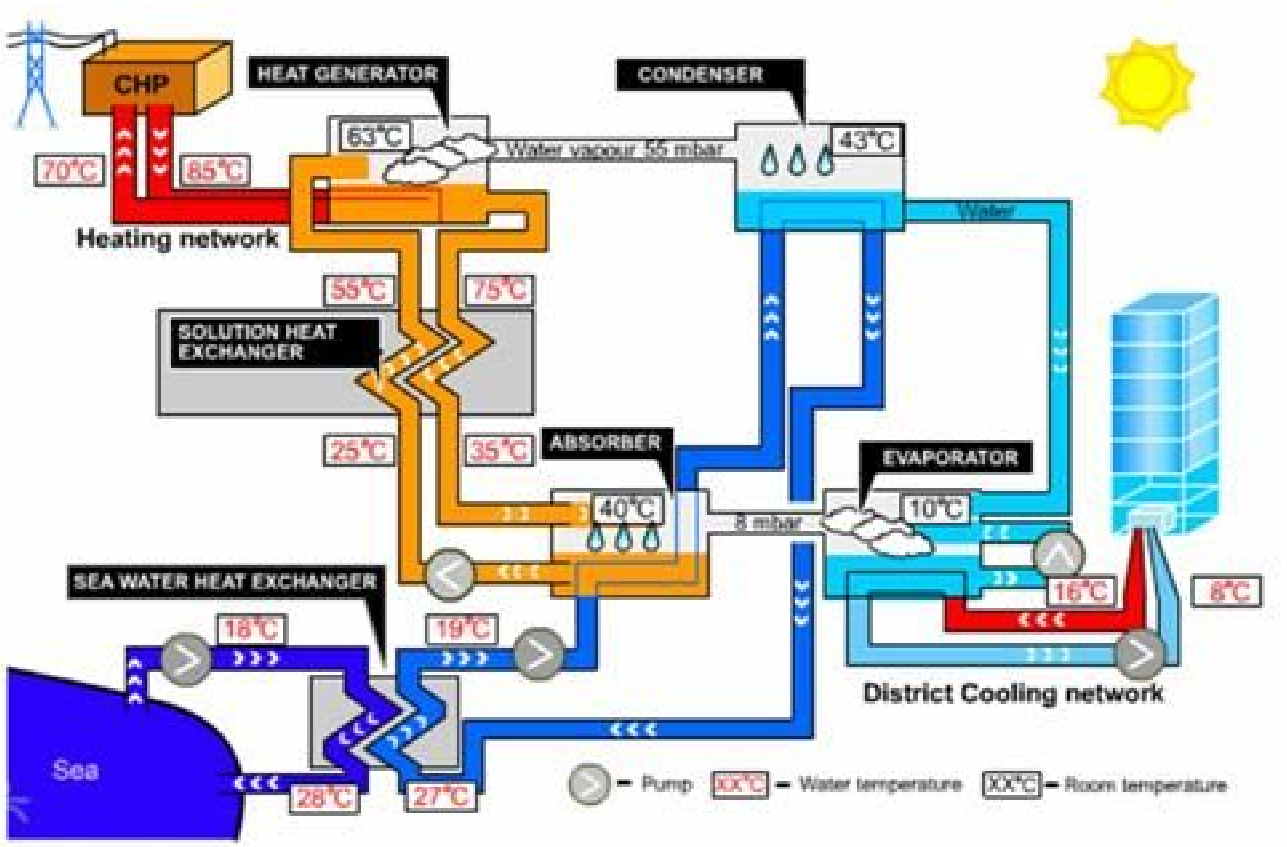




Stokholm



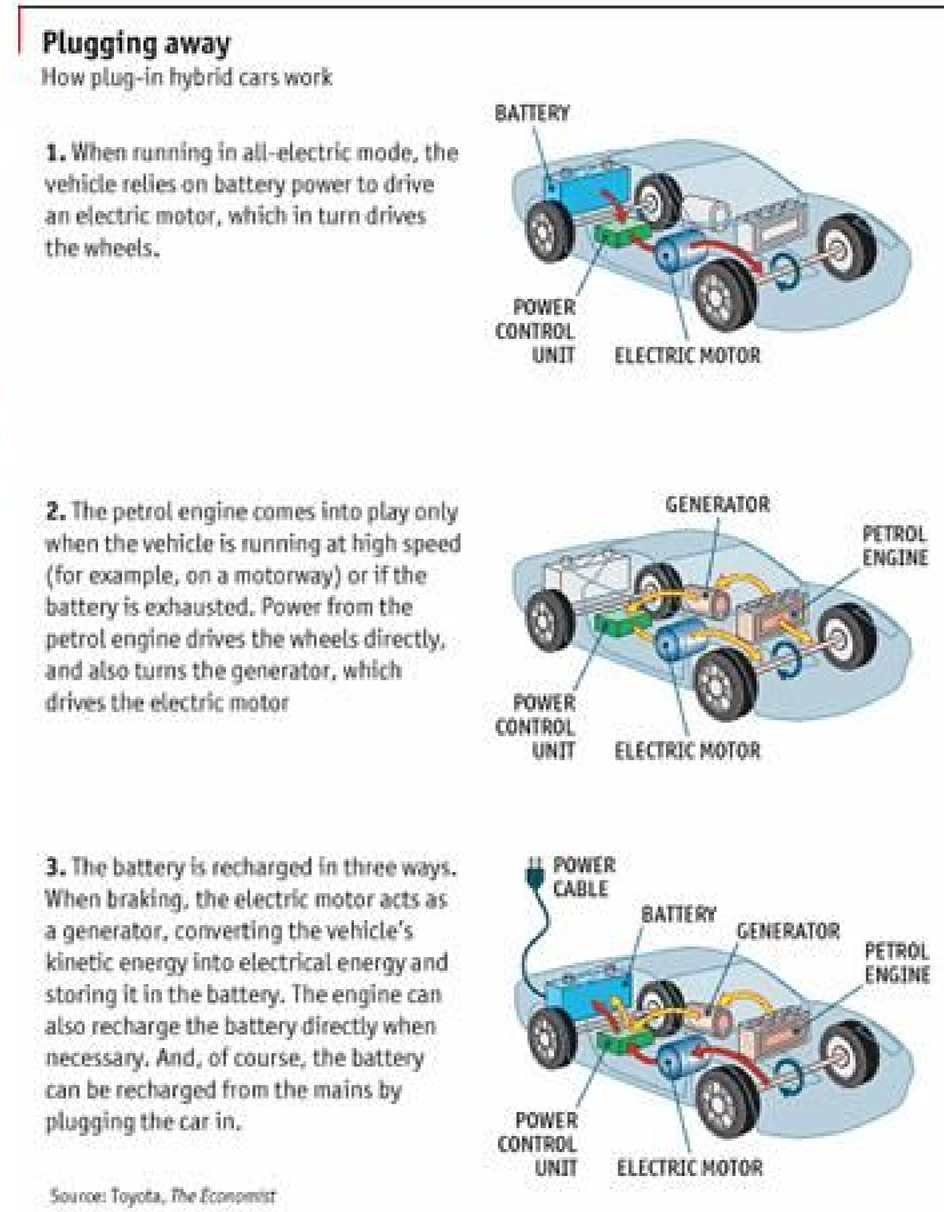
Toronto



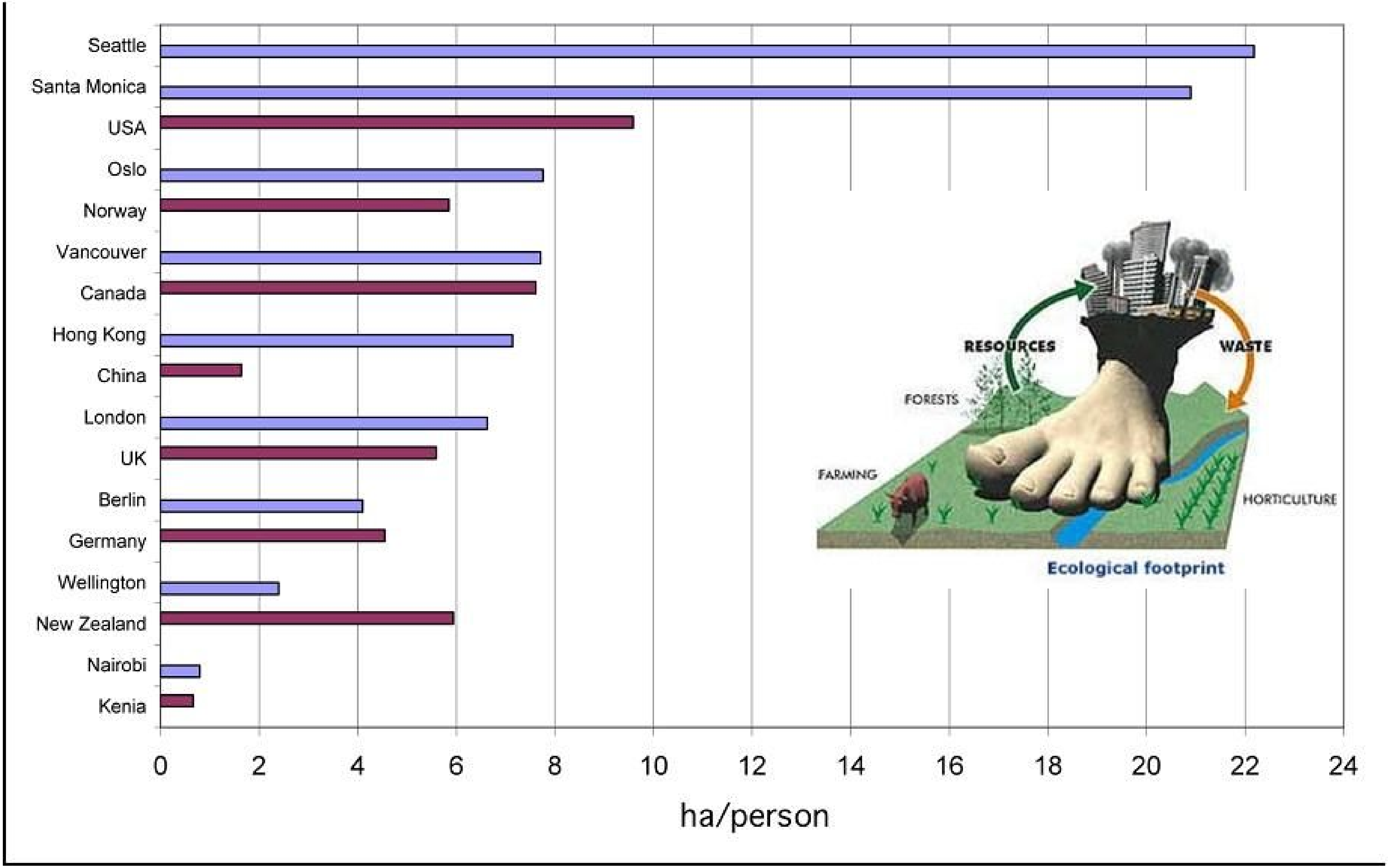
Helsinki

2. Minimise energy consumption

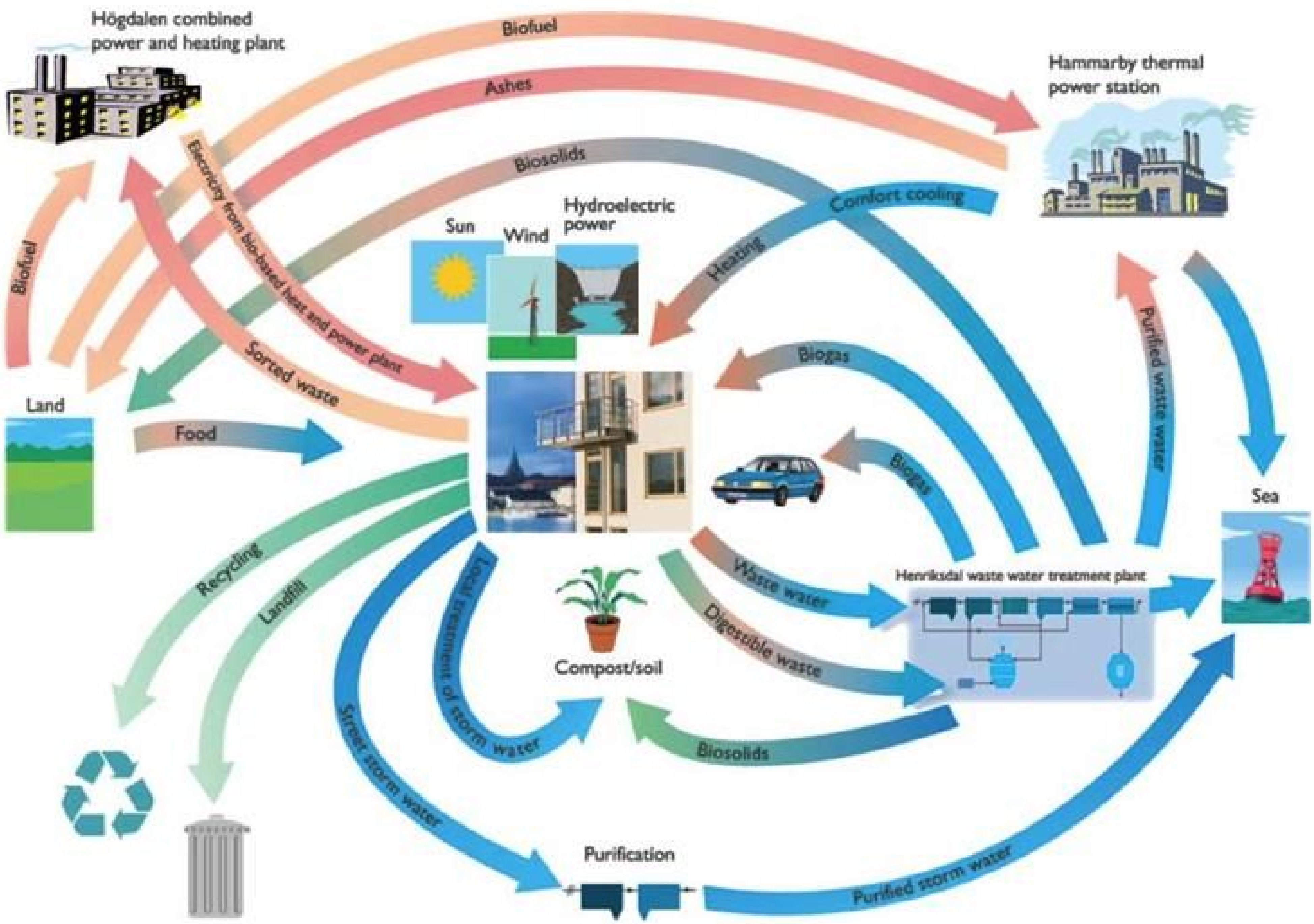
Modern and efficient public rail transportation, hybrid electric urban cars



Ecological footprint

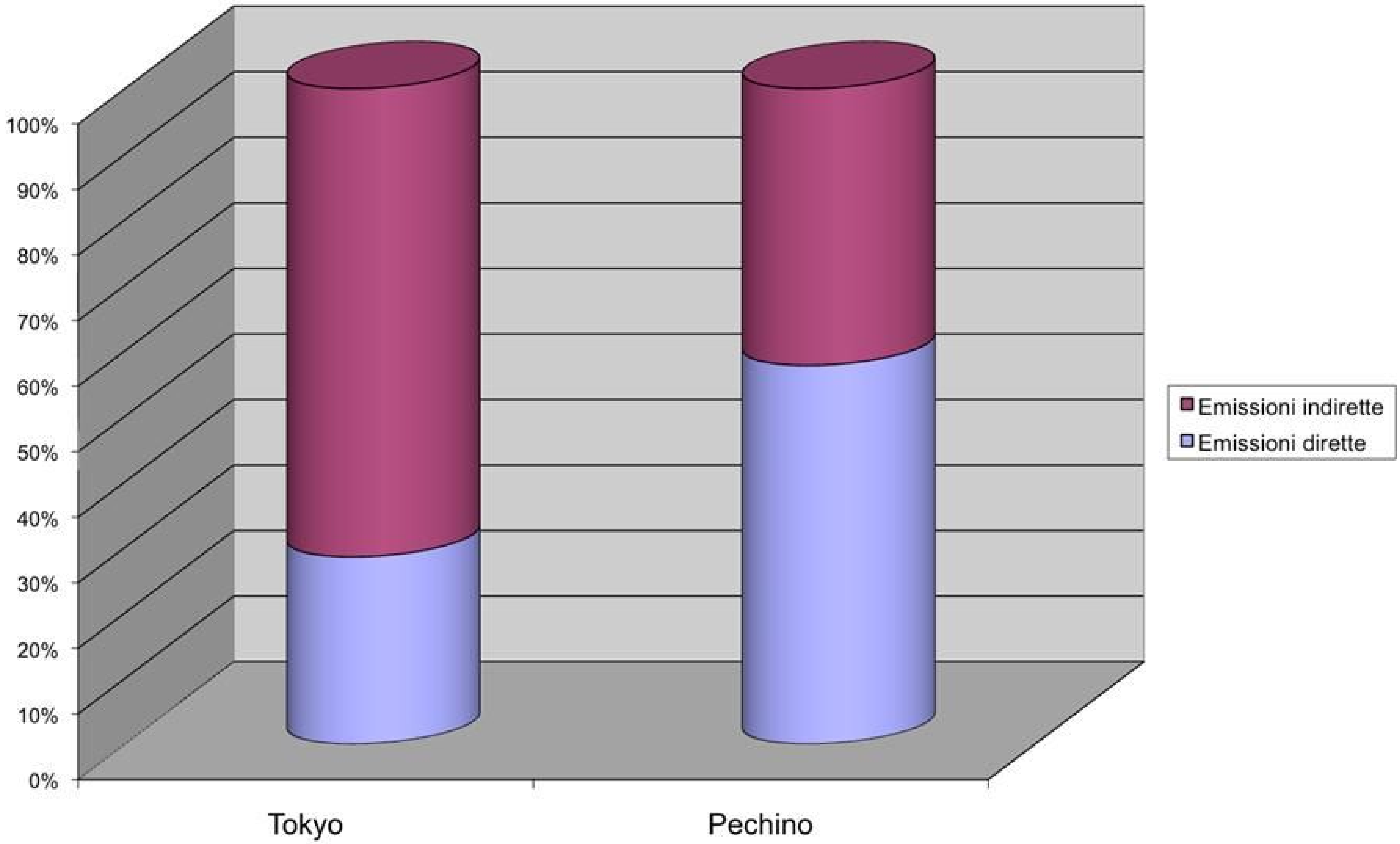


3. Ricycle and reuse



Hammarby, Sweden

3. Ricycle and reuse



4. Substitute fossil fuels with renewable energy

Zero carbon buildings

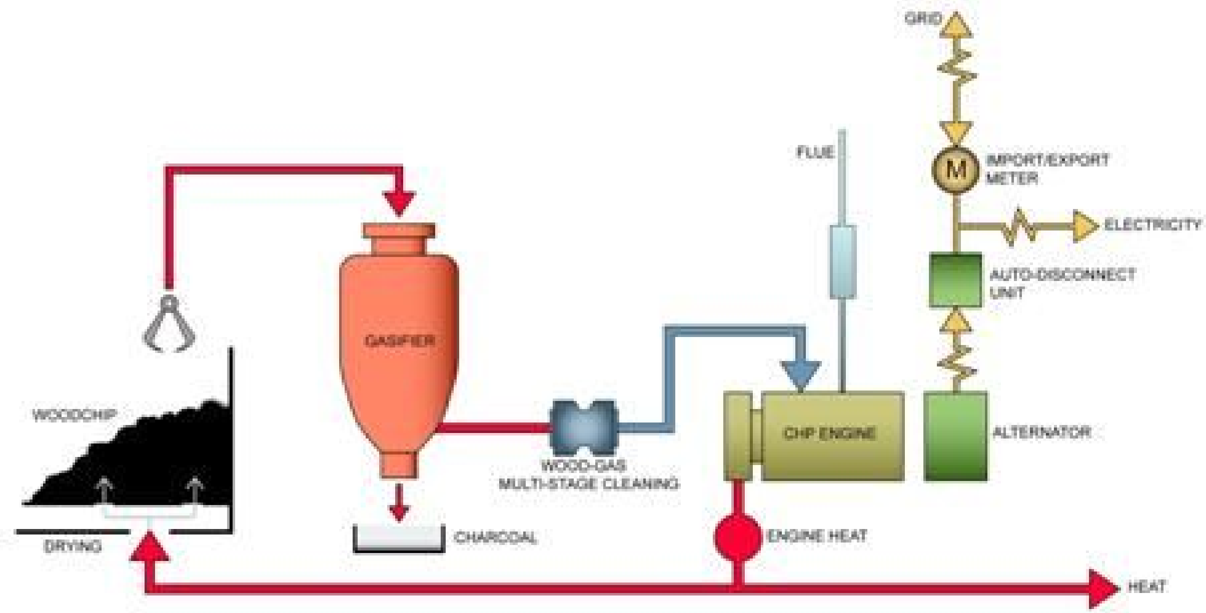
UK

Italy

Hungary

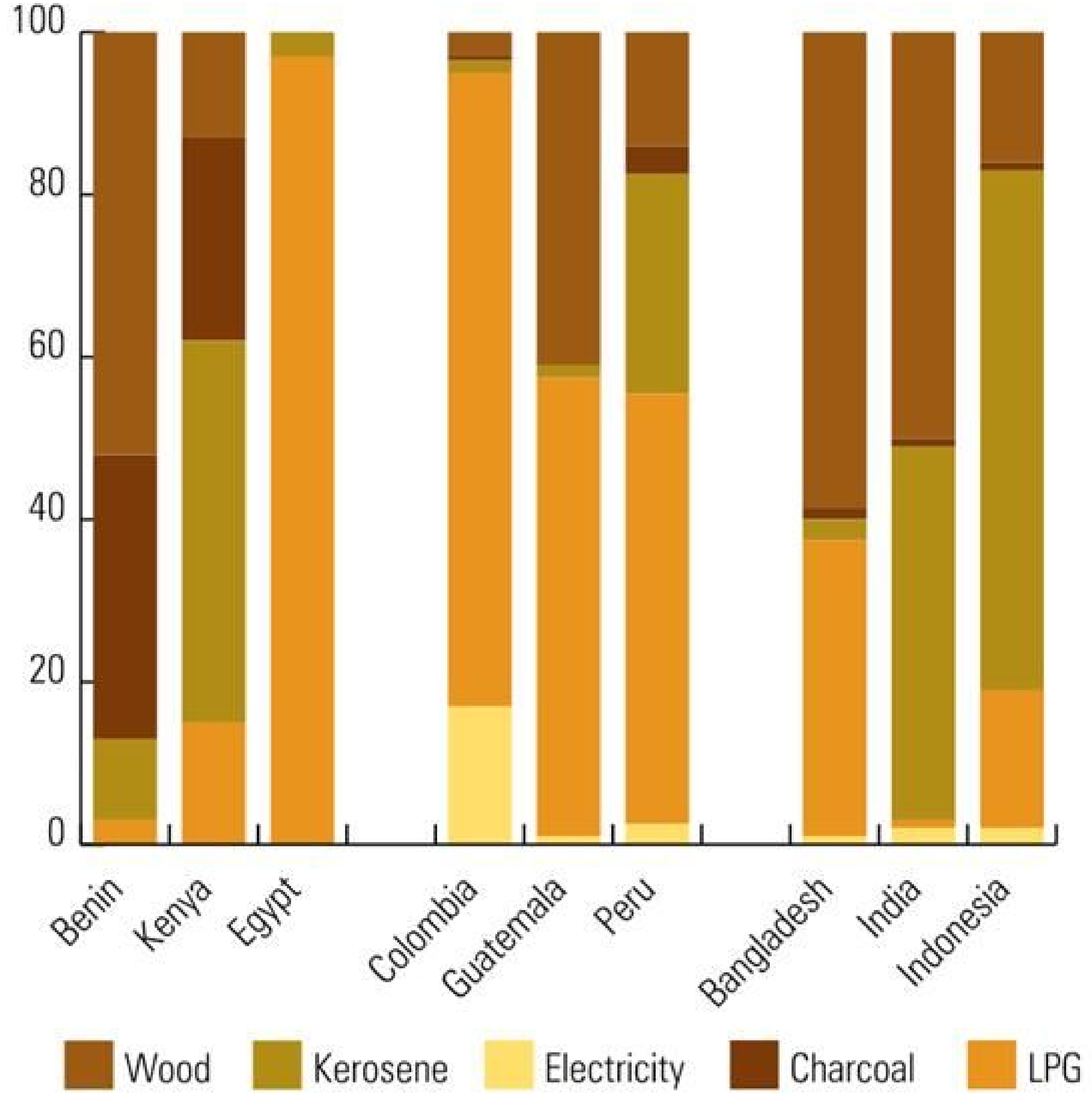
4. Substitute fossil fuels with renewable energy

Gas from biomass, either by gasification or anaerobic digestion of agricultural residuals can substitute natural gas for many uses, including cooking and mini CHP units.



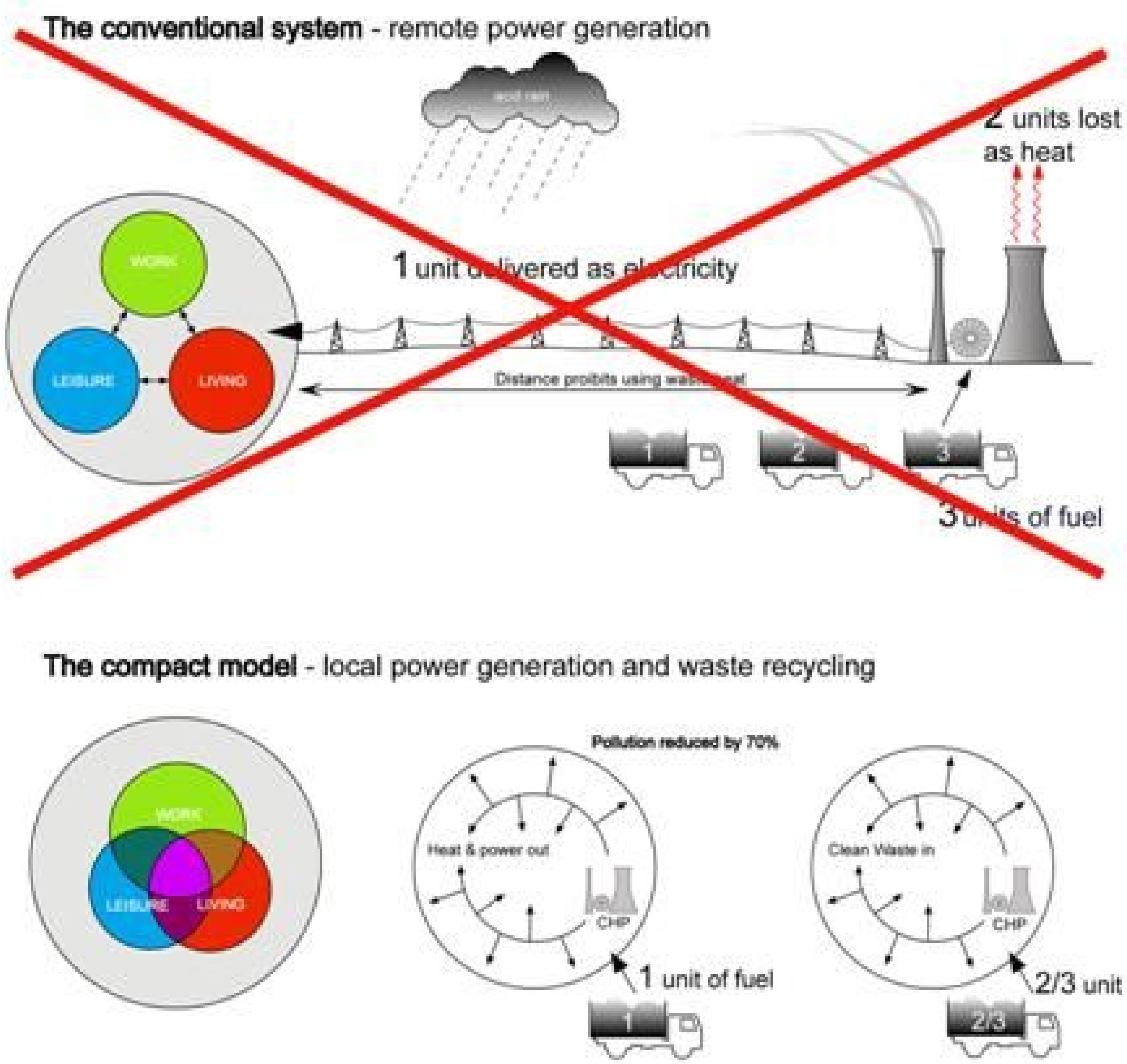
BedZed

DISTRIBUTION OF URBAN HOUSEHOLDS BY TYPE OF FUEL FOR COOKING IN SELECTED COUNTRIES



Source: UN-HABITAT, Global Urban Observatory, 2008

A new energy system must be implemented

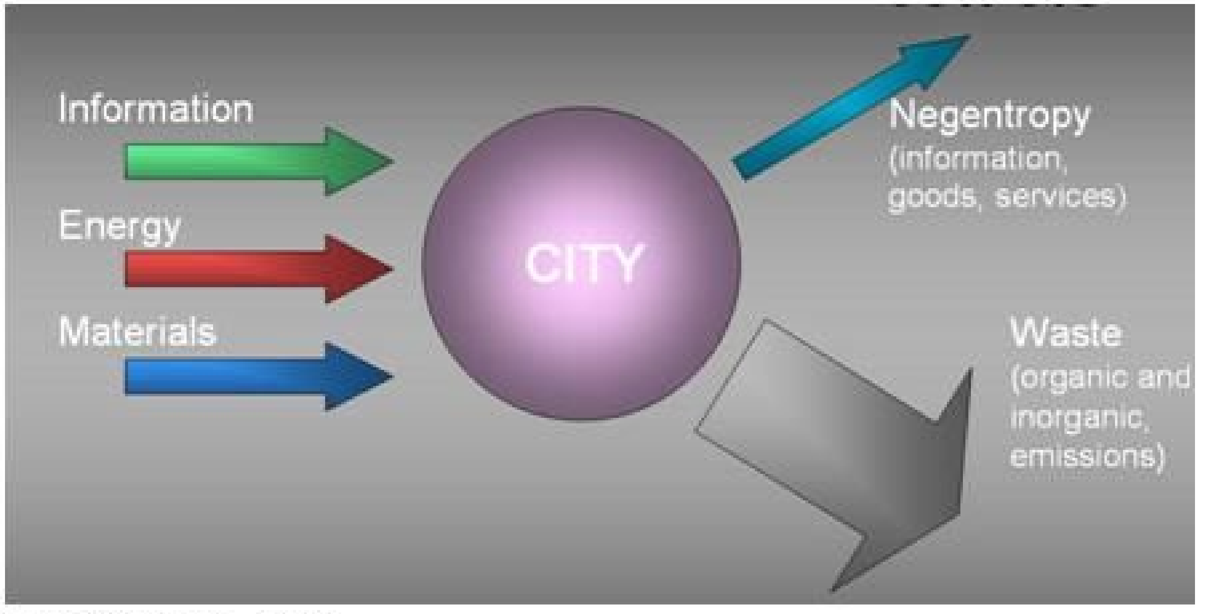


"It is impossible to solve a problem with the same means that caused this problem".
A. Einstein

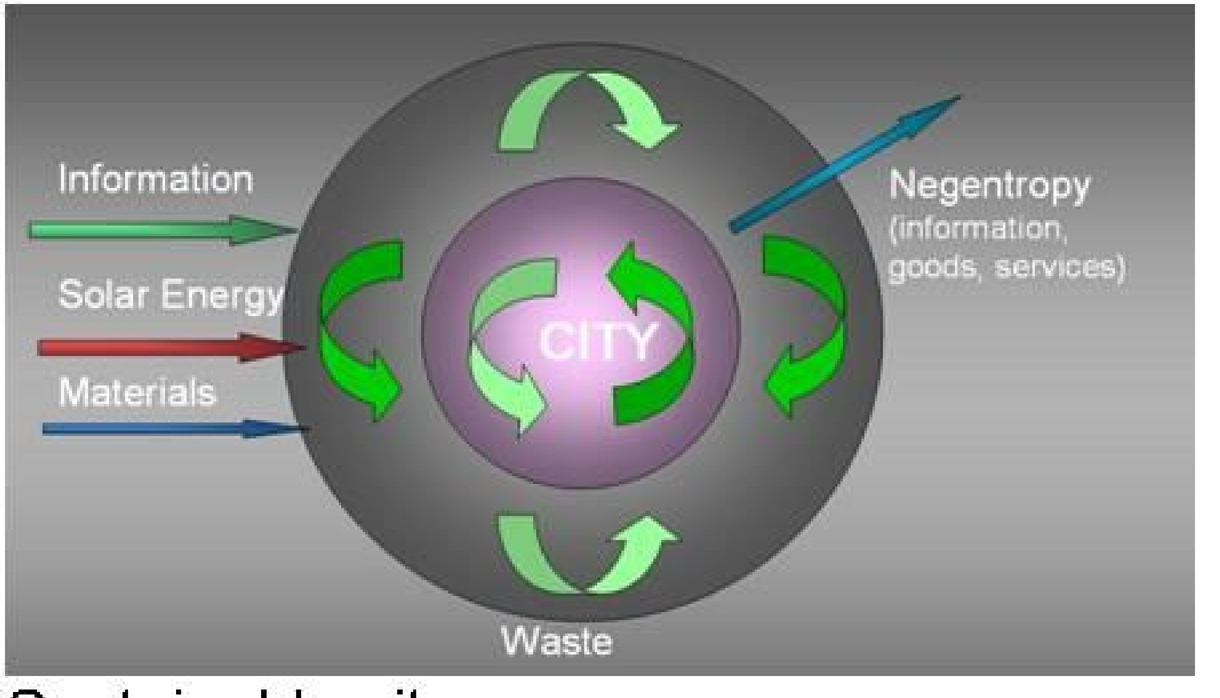
A new energy paradigm for a sustainable built environment: Distributed Generation

From linear to circular metabolism

Cities should mimic ecosystems, and a "new alliance" between man and nature must be set up. New settlements in developing countries have, in principle, the chance to do so.

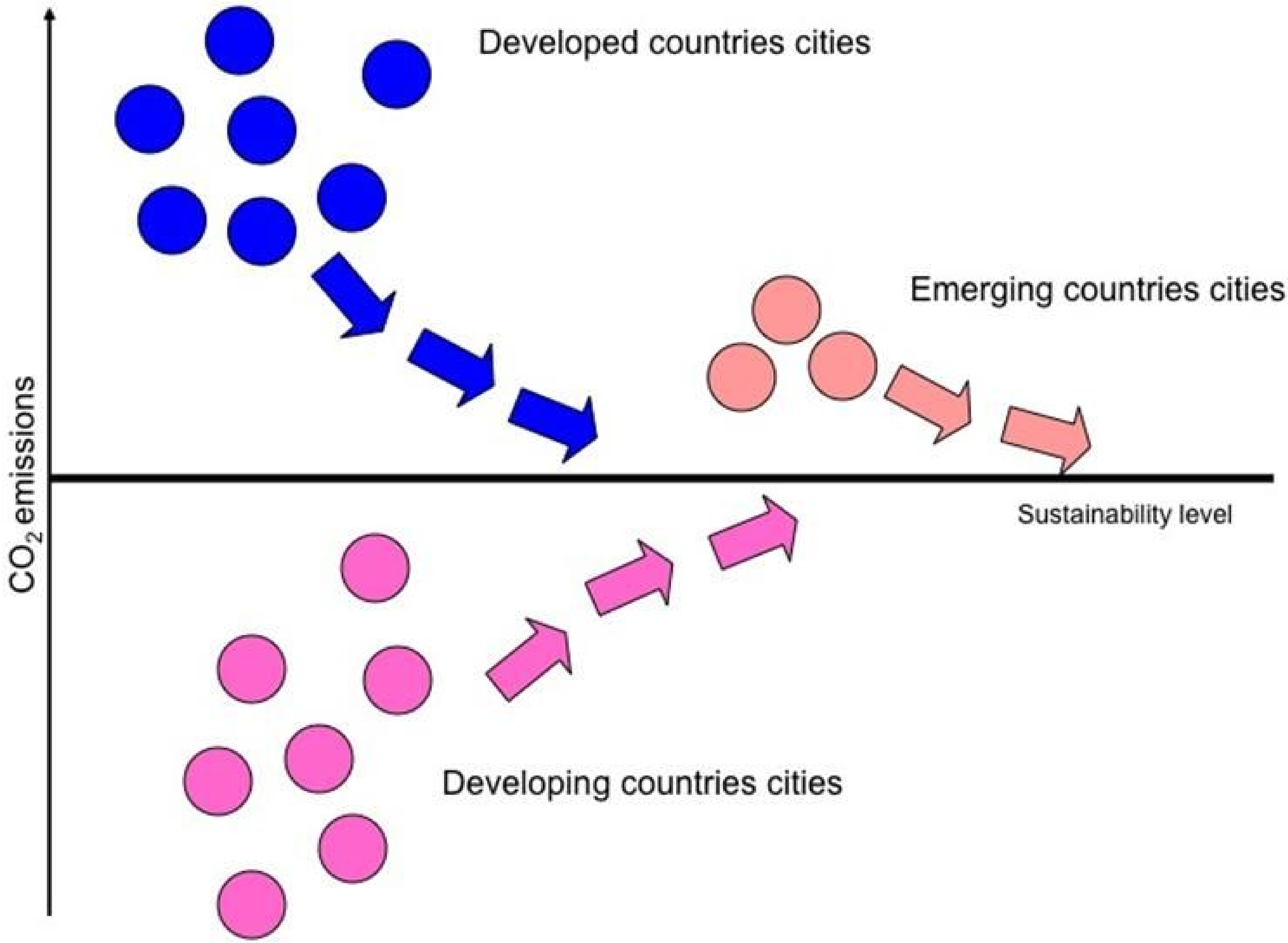


Today's city

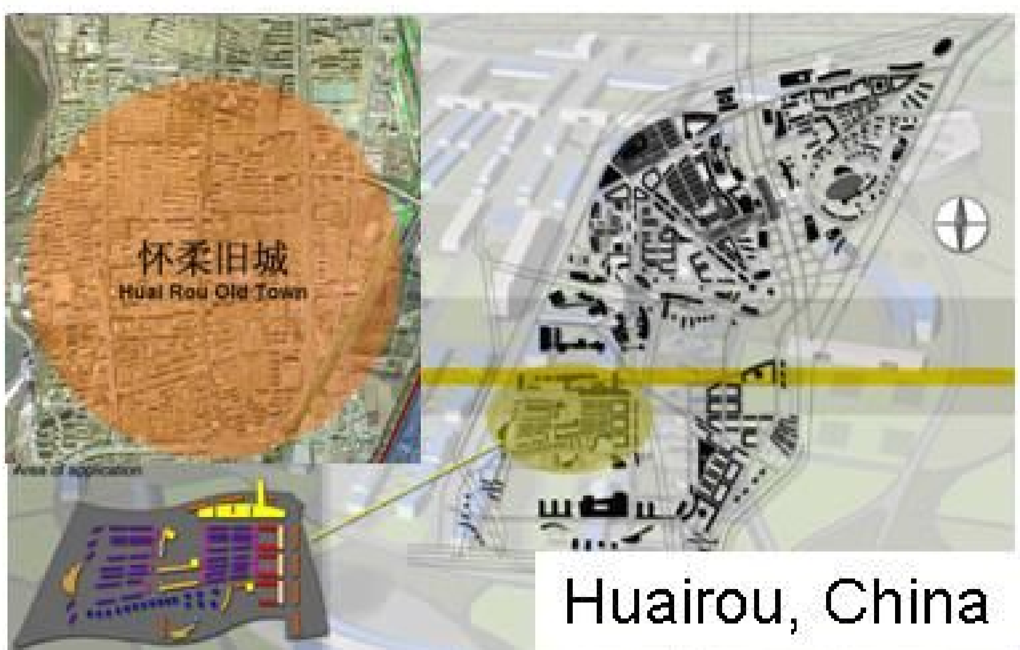


Sustainable city

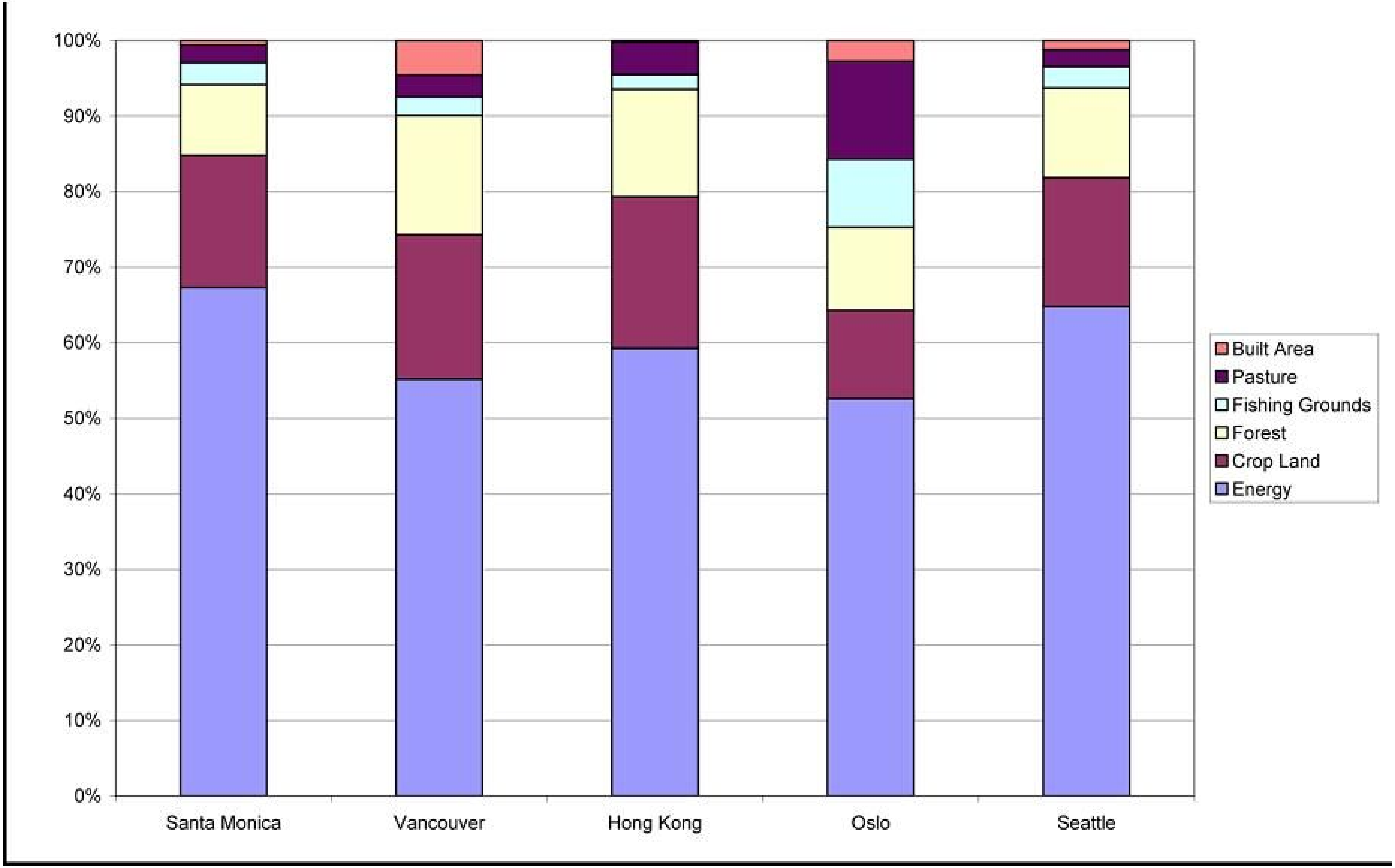
A joint effort



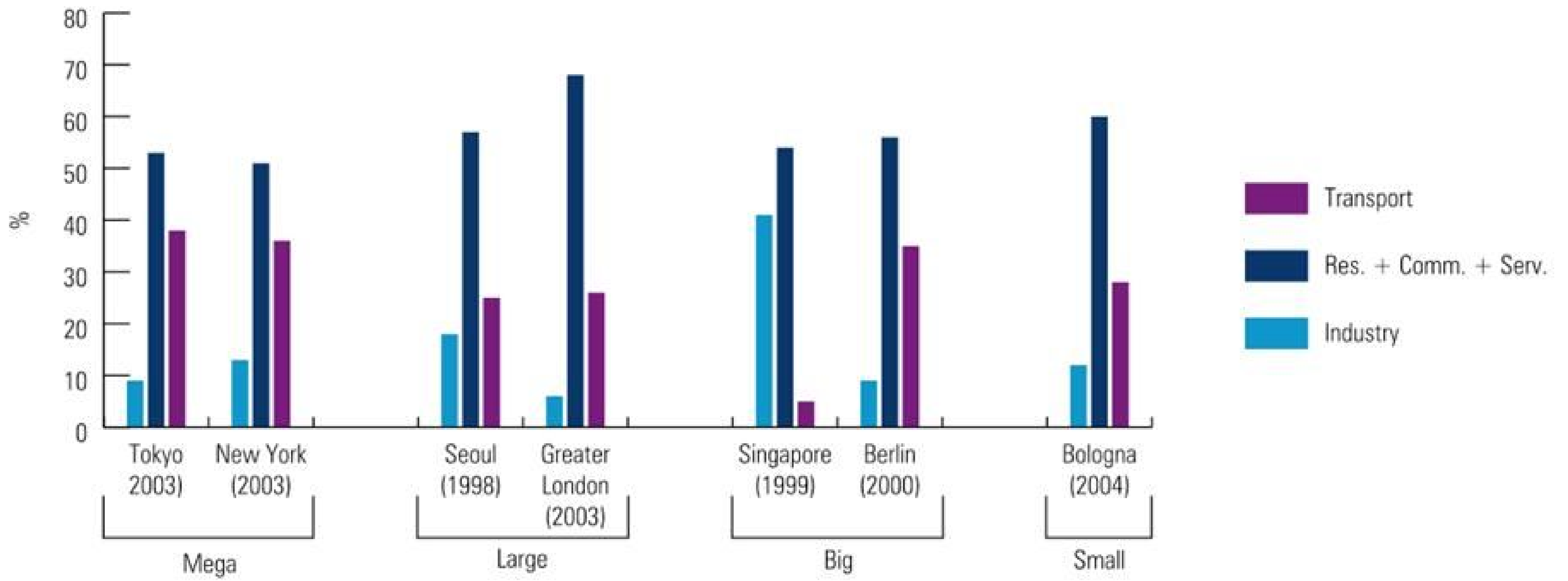
Rays of hope: sustainable cities and developments



Ecological footprint

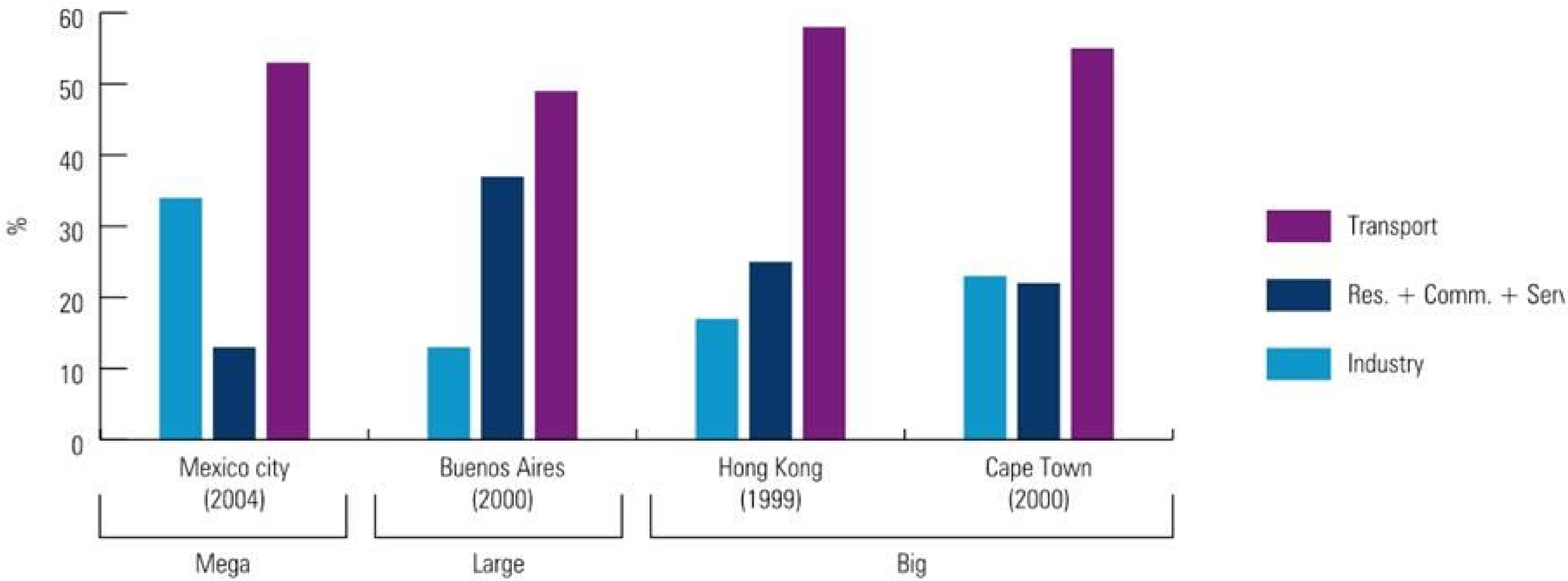


ENERGY CONSUMPTION IN SELECTED CITIES IN HIGH-INCOME, INDUSTRIALIZED ECONOMIES



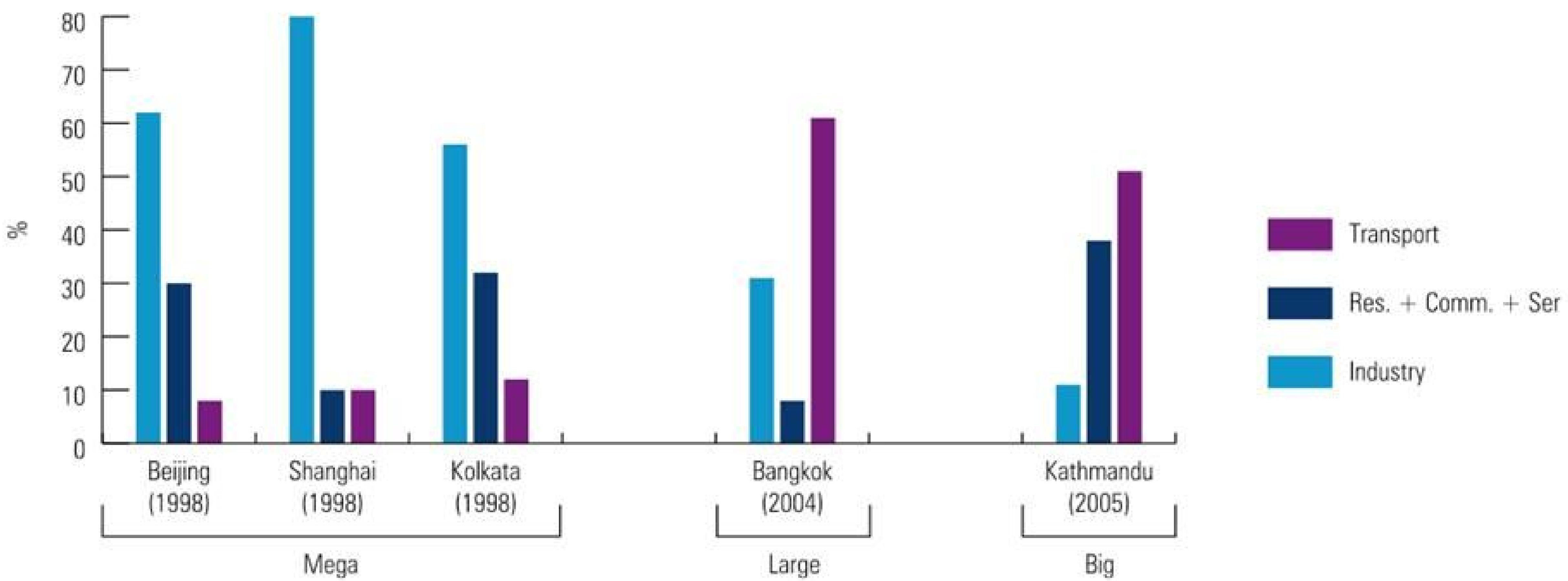
Source: UN-HABITAT Global UrbanObservatory 2008
Note : Data from various sources, 1999-2004

ENERGY CONSUMPTION IN SELECTED CITIES IN MIDDLE-INCOME COUNTRIES

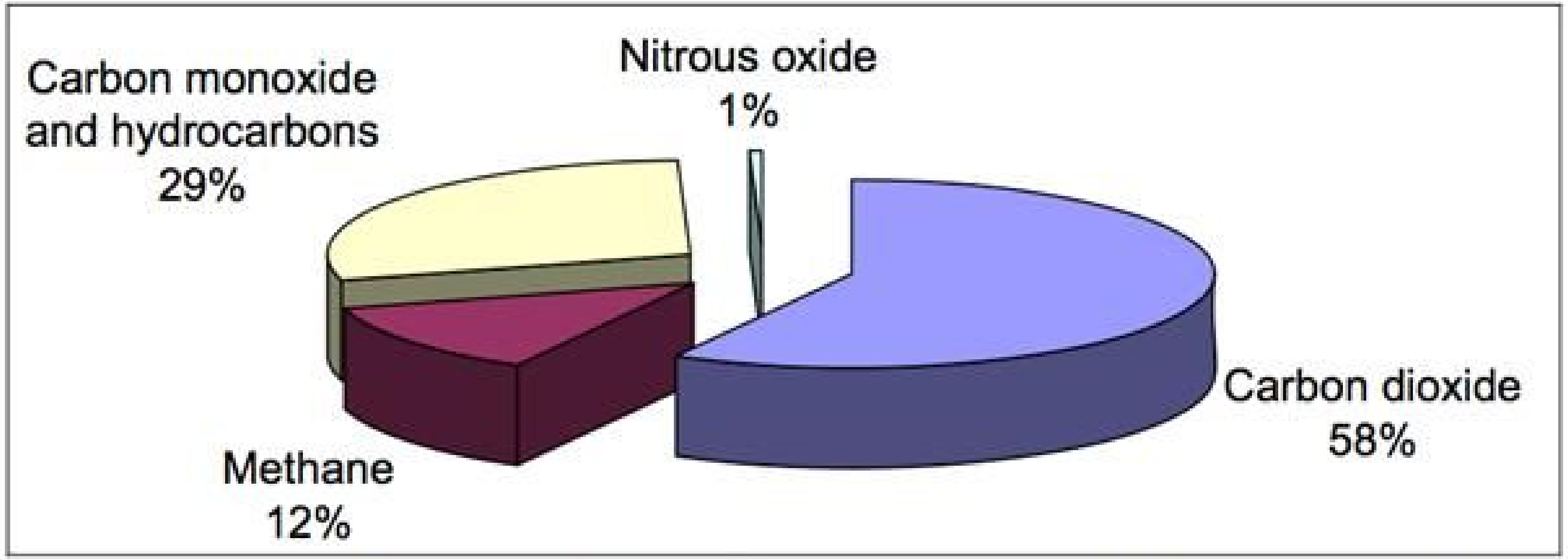


Source: UN-HABITAT Global Urban Observatory 2008
Note: Data from various sources 1999-2004

ENERGY CONSUMPTION IN SELECTED ASIAN CITIES

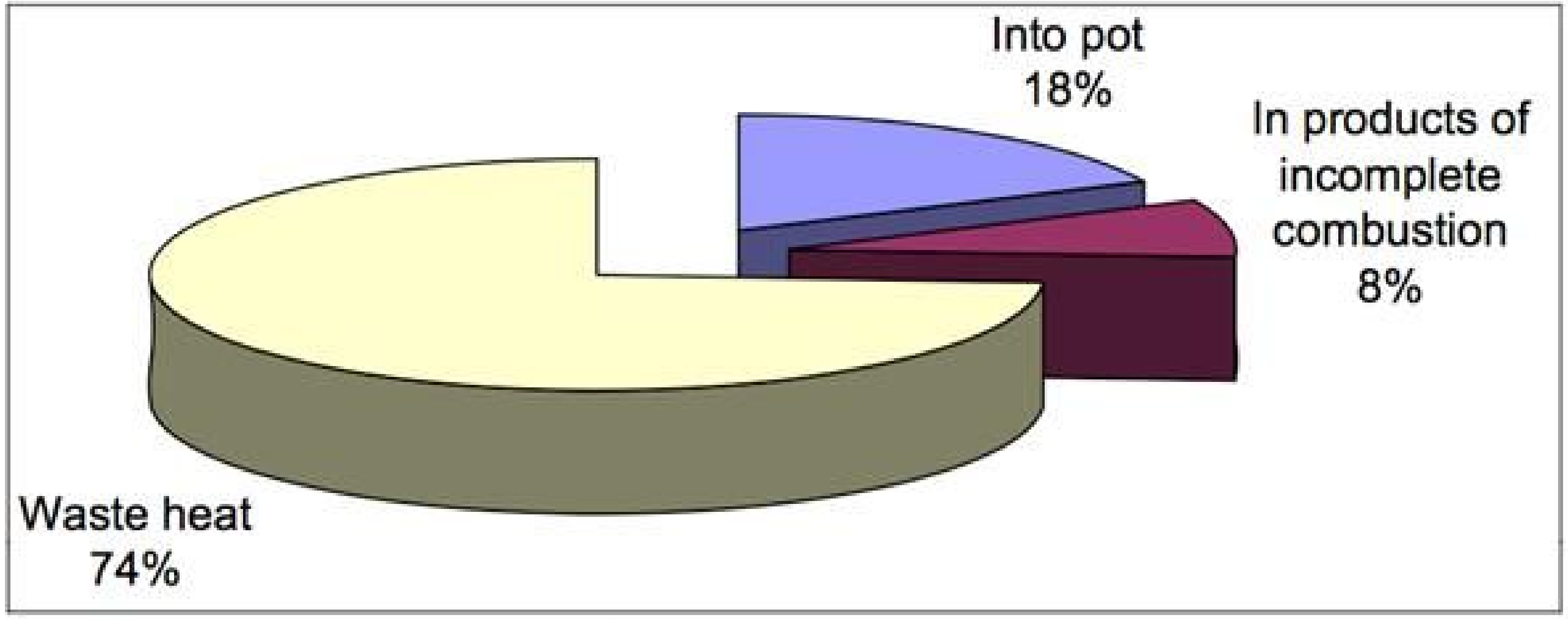


Source: UN-HABITAT Global Urban Observatory 2008
Note : Data from various sources, 1998-2005



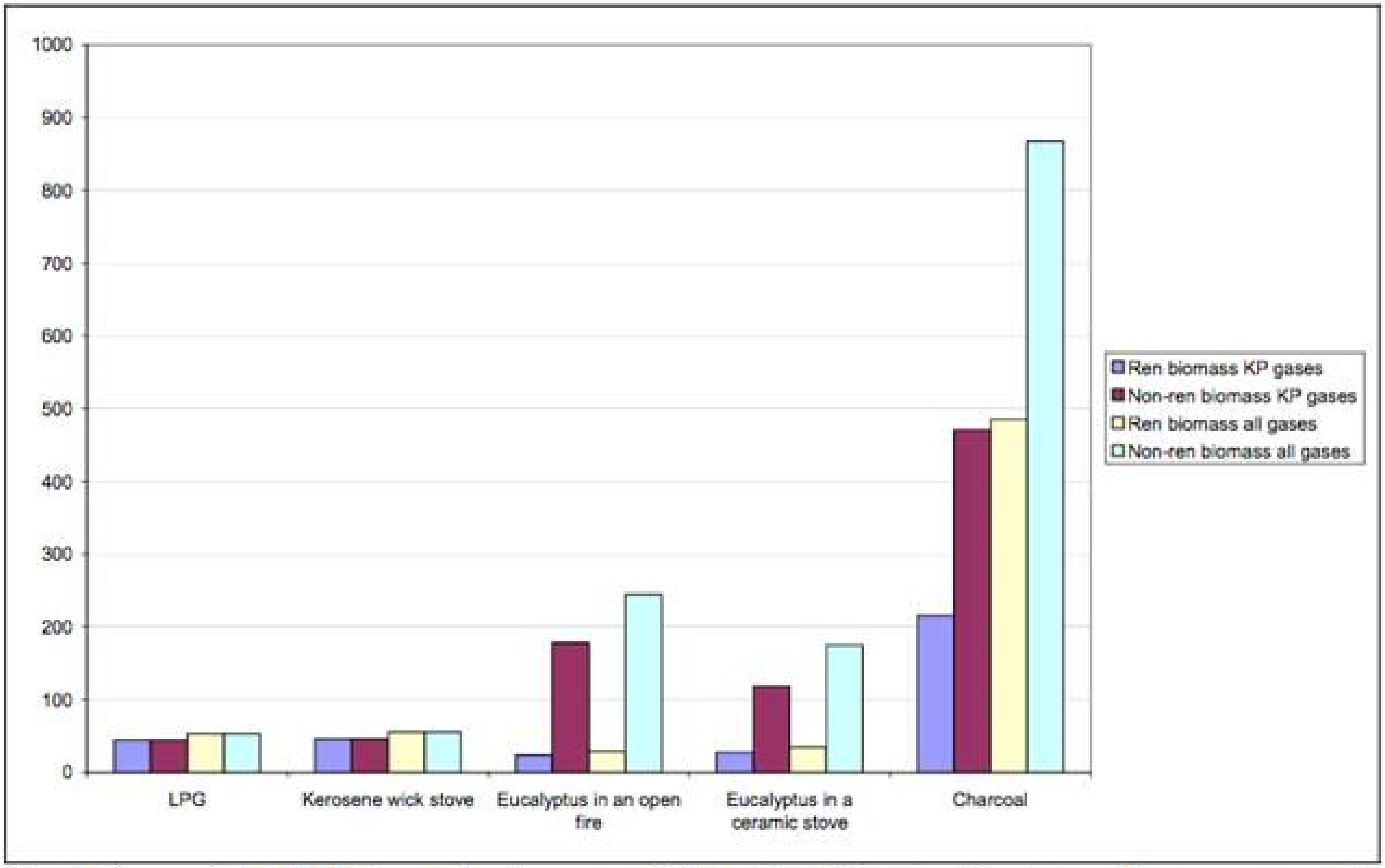
Greenhouse gas emissions from a typical biomass cookstove

Adapted from: J. P. Holdren, K. R. Smith, Energy, the environment, and health; in: UNDP, World Energy Assessment – Energy and the Challenge of Sustainability, 2000



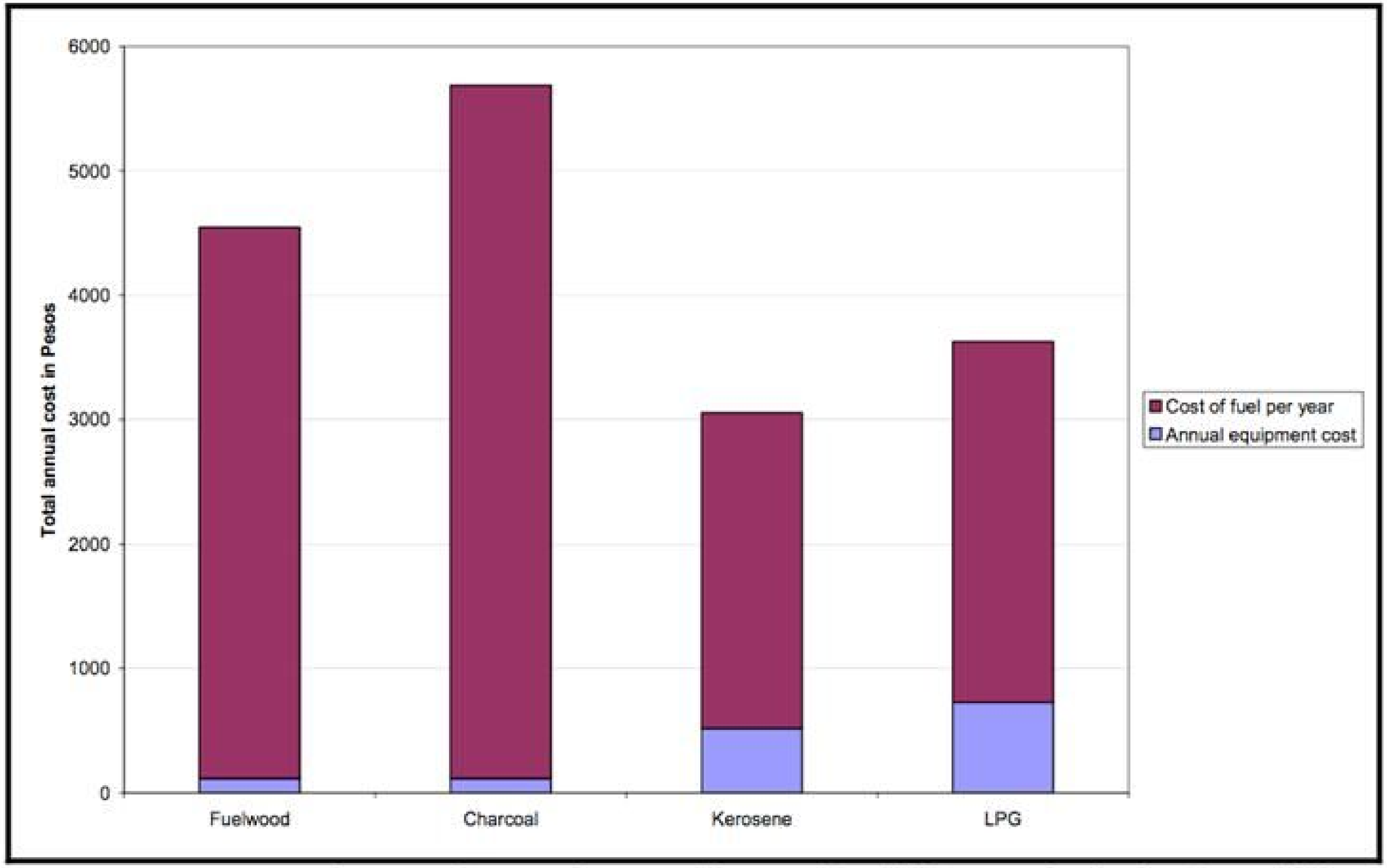
Energy flows in a typical wood-fired cooking stove

Adapted from: J. P. Holdren, K. R. Smith, Energy, the environment, and health; in: UNDP, World Energy Assessment – Energy and the Challenge of Sustainability, 2000



Net life cycle GHG emissions within the Kyoto Protocol expressed in terms of g-C (CO_2 equivalent units) per MJ delivered to the pot.

Adapted from: Robert Bailis, David Pennise, Majid Ezzati, Daniel M. Kammen, Evans Kituyi, *Impacts of Greenhouse Gas and Particulate Emissions from Woodfuel Production and End-Use in Sub-Saharan Africa*, http://rael.berkeley.edu/old-site/OA5.1.pdf



Total annual cost for cooking with different fuels in the Philippines

Adapted from: NREL – National Renewable Energy Laboratory, *Strategies for Enhancing Biomass Energy Utilization in the Philippines*, NREL/SR-510-30813, October 2001

Cooking is more expensive for the poor than for the rich.

The meal of the poor releases, comparatively, more greenhouse gases than the meal of the rich

Is improved stoves promotion a sensible policy?