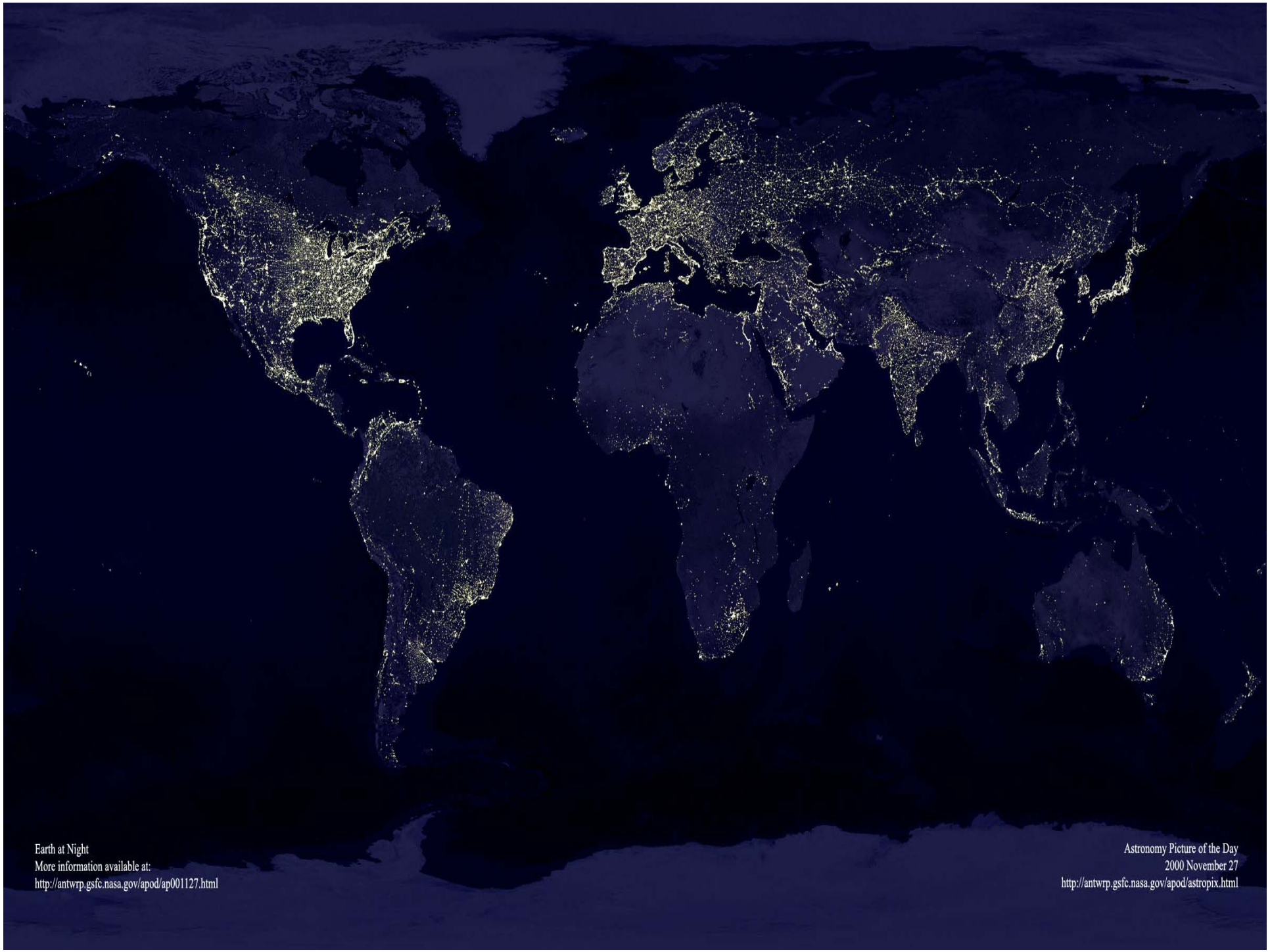
Global urbanization trends – low carbon perspectives

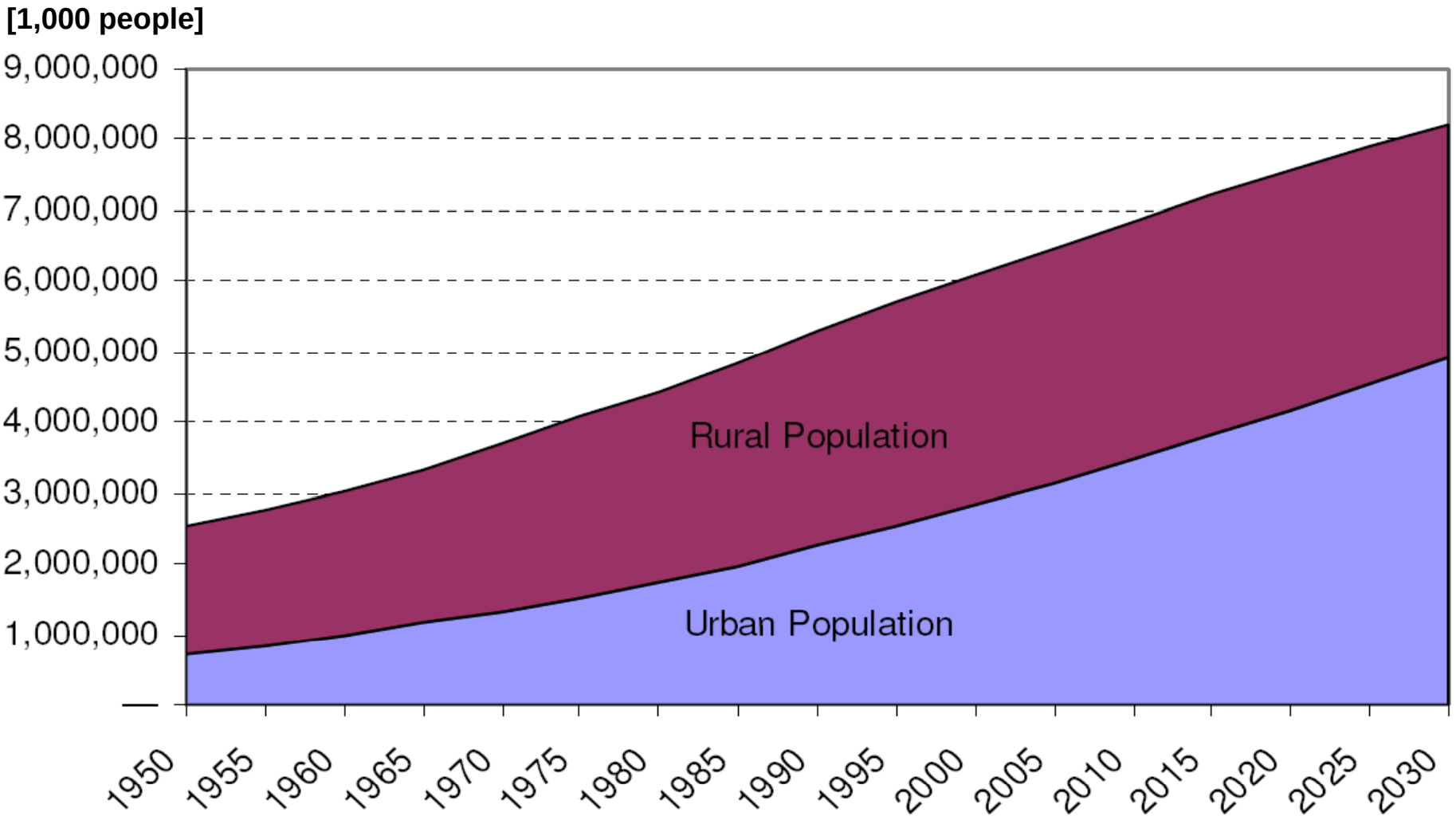
Prof. Dr. Dirk Messner

CCICED Conference on low carbon urbanization

Shanghai, 25 march 2010

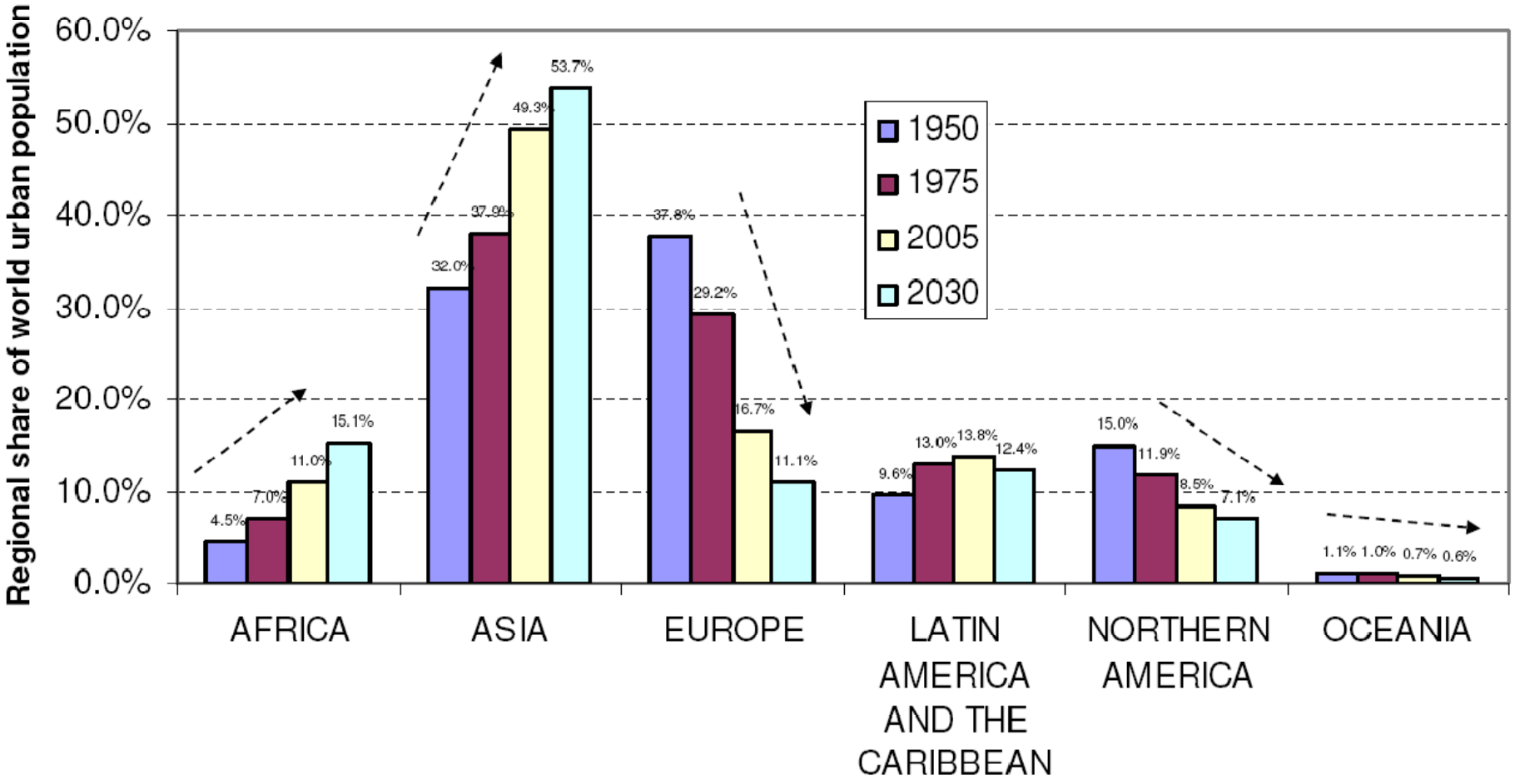

Earth at Night
More information available at:
http://antwrp.gsfc.nasa.gov/apod/ap001127.html
Astronomy Picture of the Day
2000 November 27
http://antwrp.gsfc.nasa.gov/apod/astropix.html

Global population & urbanization trends

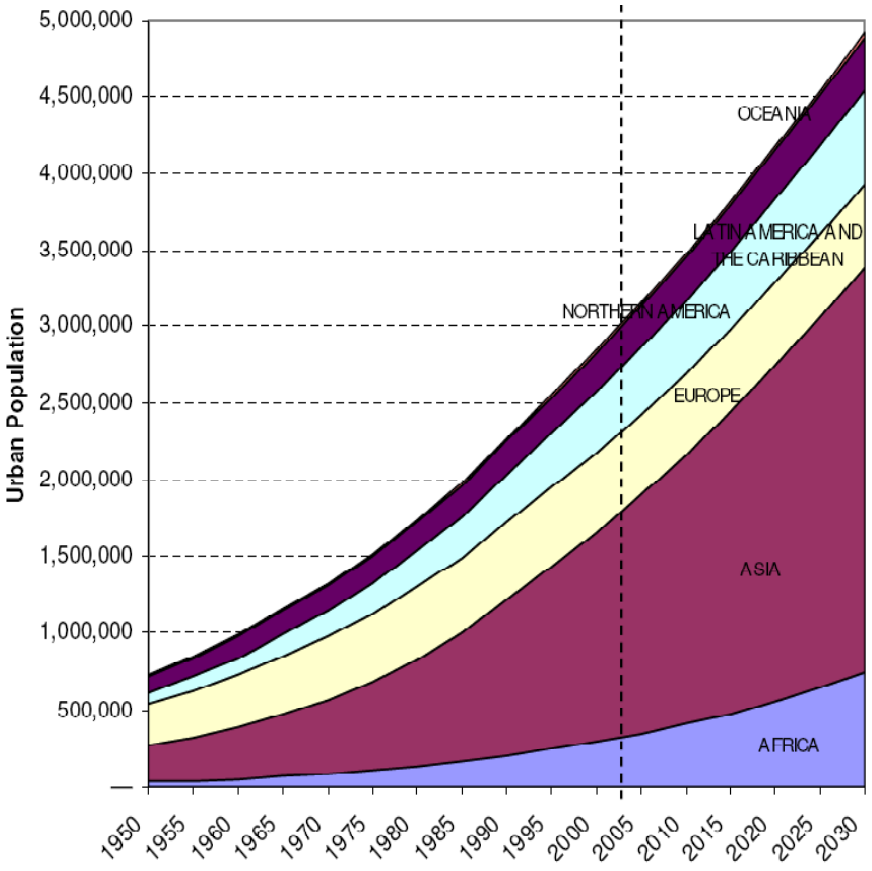


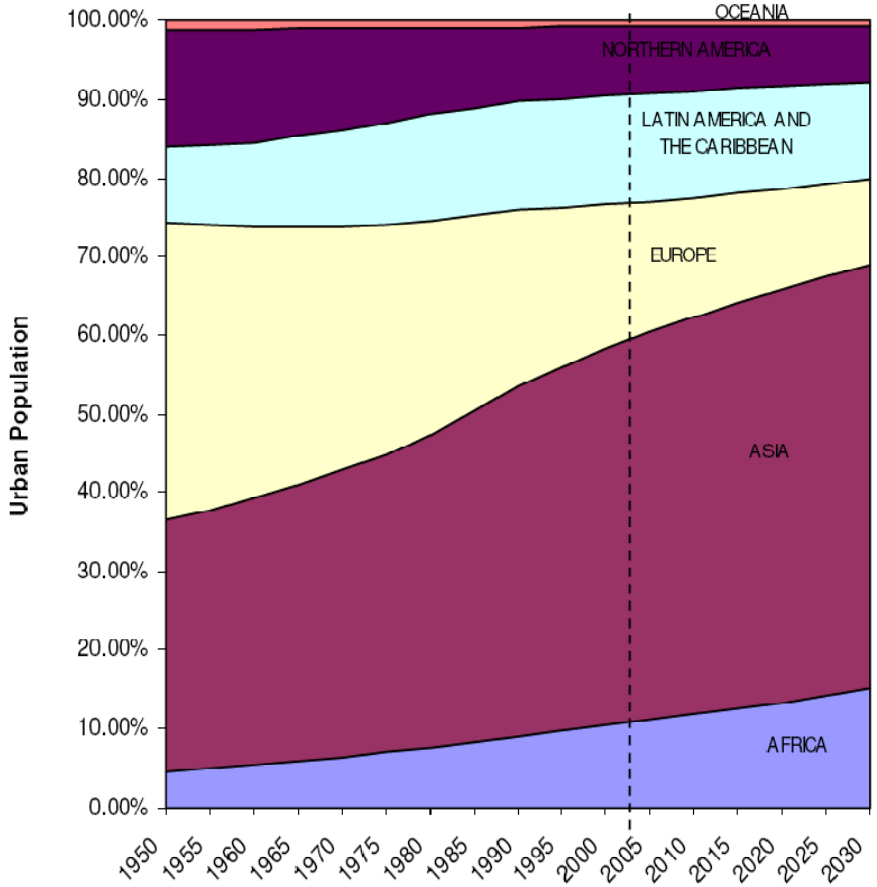
Source: United Nations, Department of Economic and Social Affairs, Population Division (2006). World Urbanization Prospects: The 2005 Revision.

Regional distribution of world's urban population

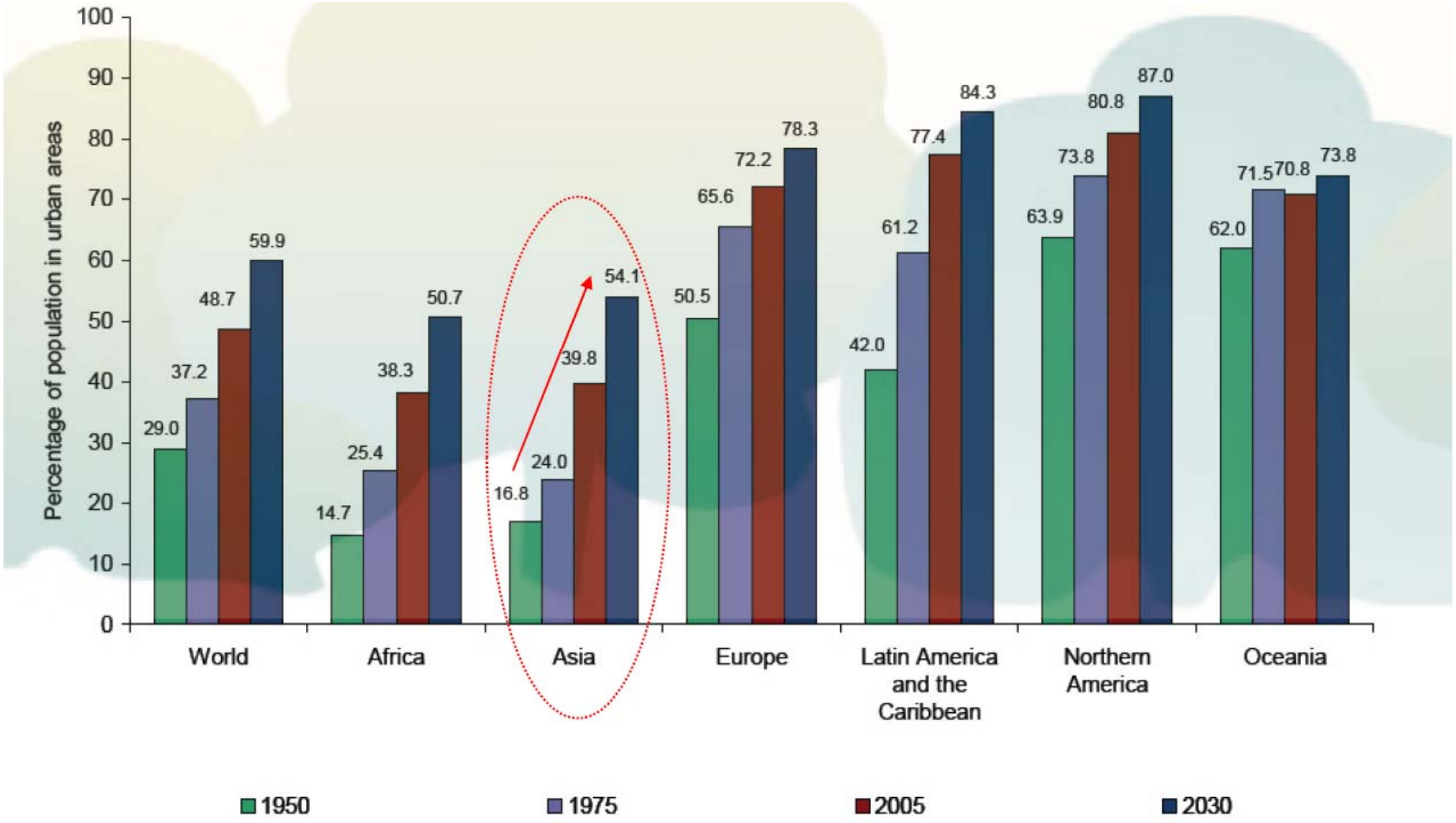


Regional share of world urban pop

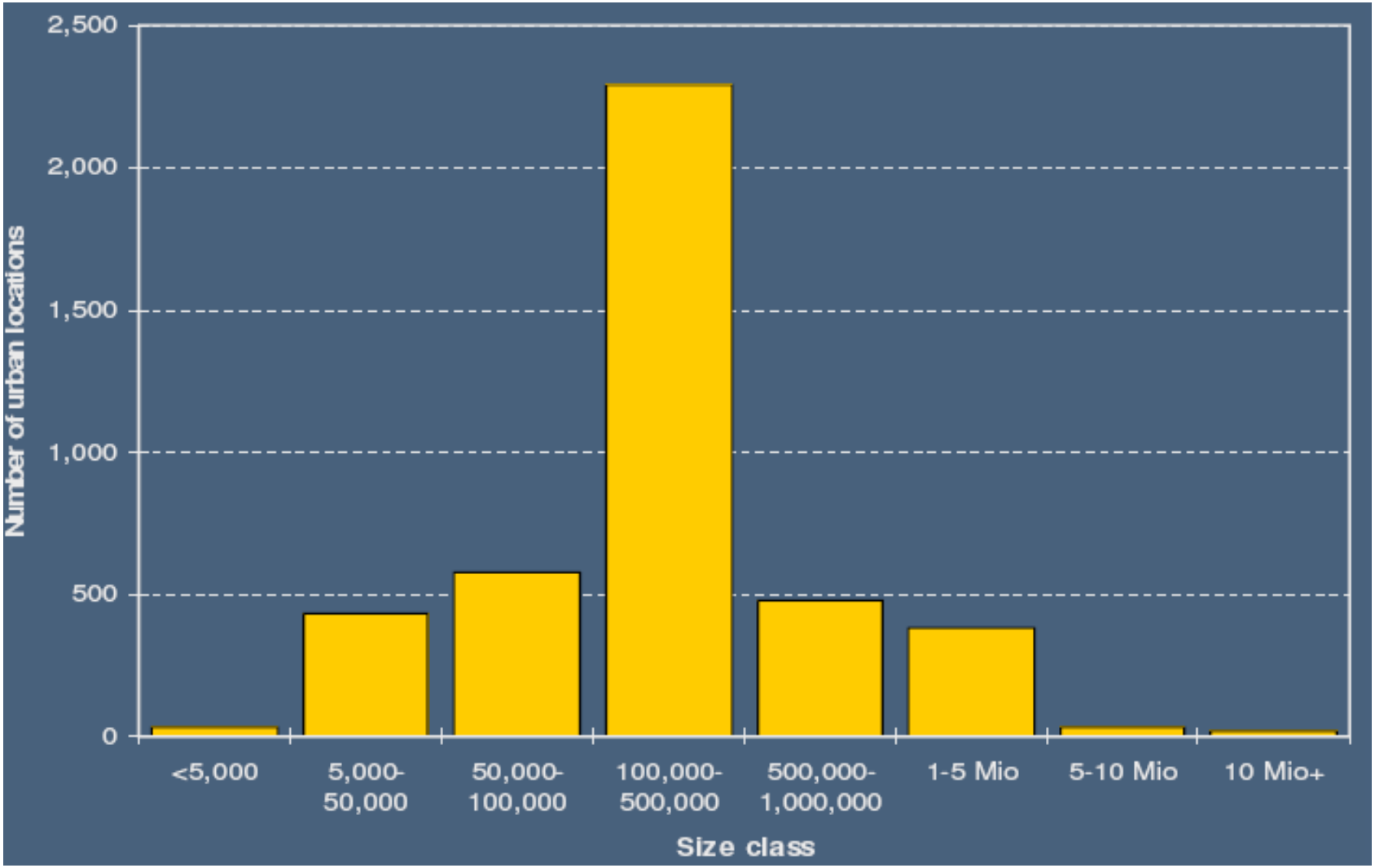




Urbanisation % within regions

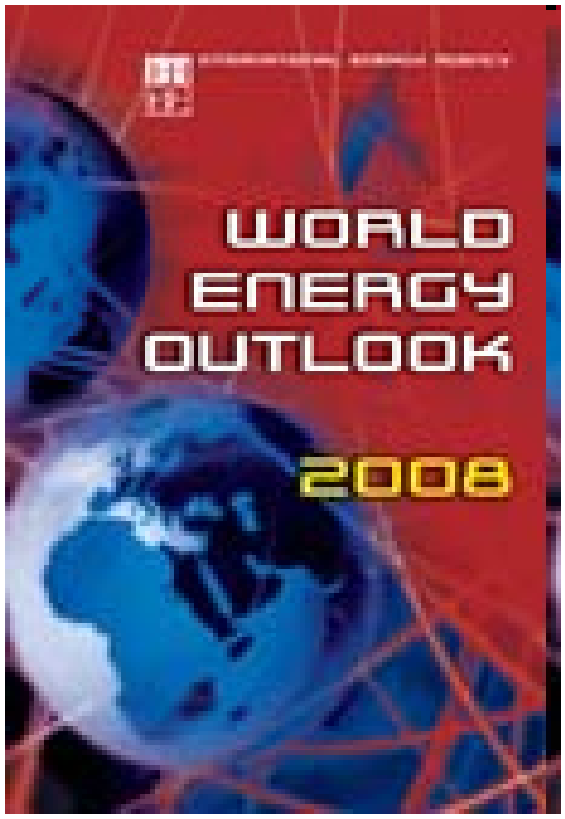


Urban locations by size class



Buettner, UN Database

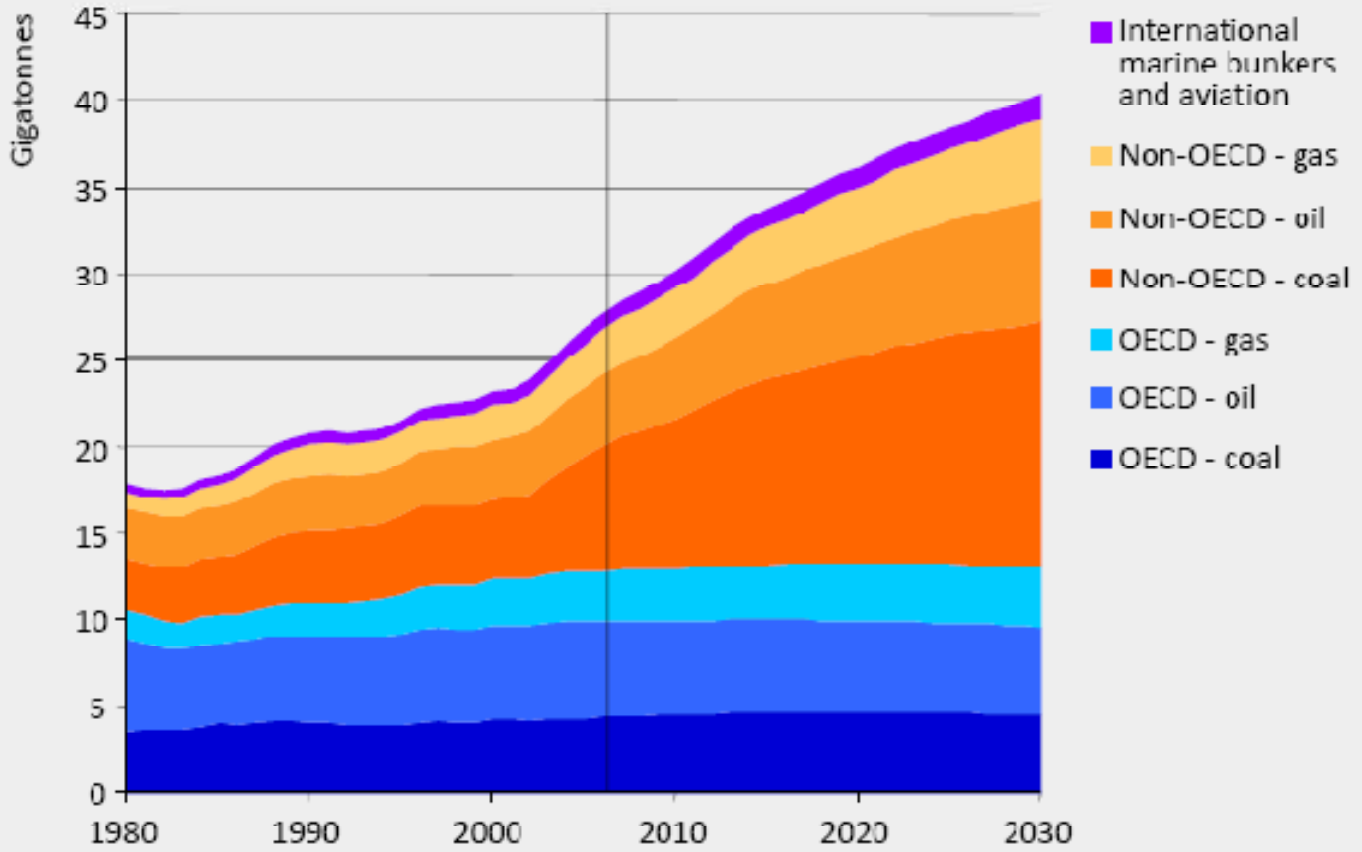
WEO 2008



- Flagship publication of the international energy organisation (IEA / OECD)
- Published annually
- projection of trends in supply and demand for 21 world regions, horizon to 2030
- Includes post 2012 policy scenarios (constrained to 550 and 450 ppm CO2)

Energy-related CO_2 emissions in the Reference Scenario

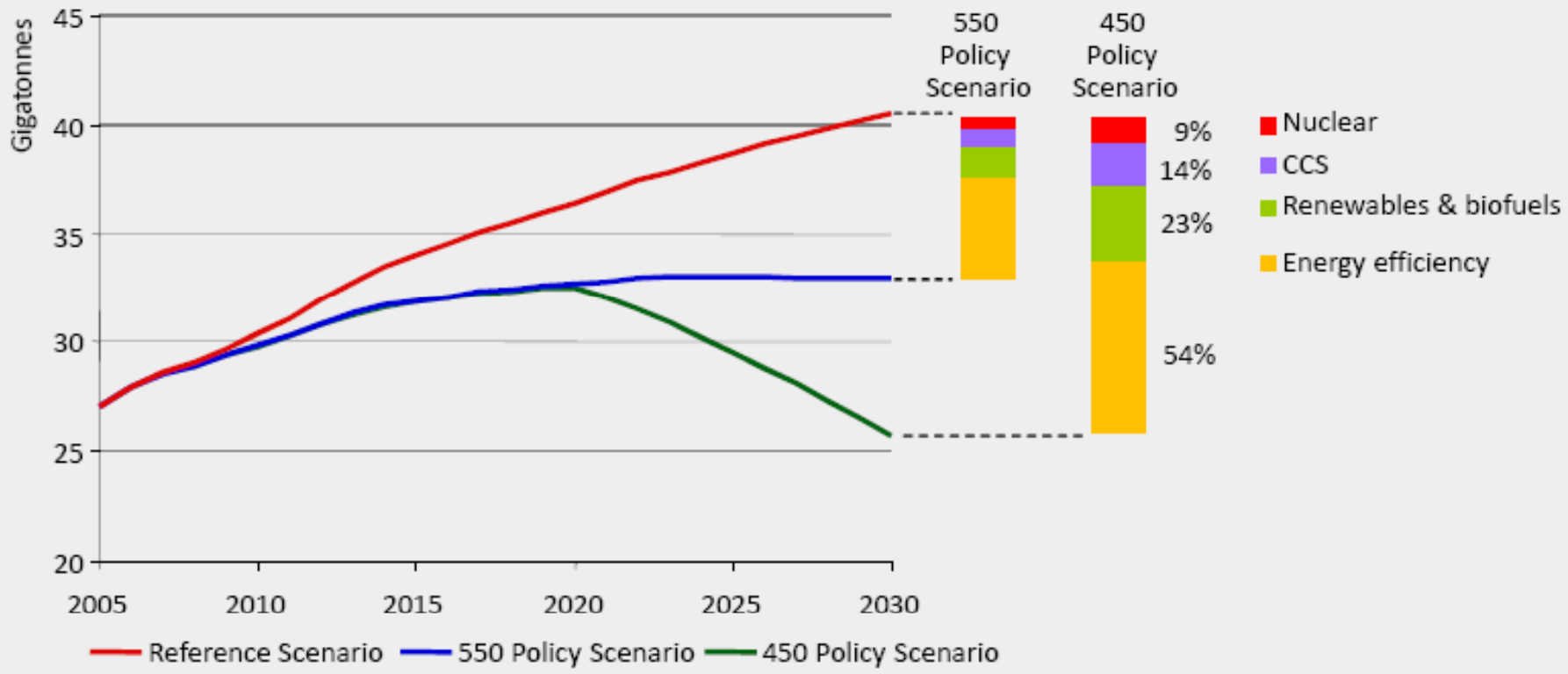
World Energy Outlook 2008



97% of the projected increase in emissions between now & 2030 comes from non-OECD countries – three-quarters from China, India & the Middle East alone

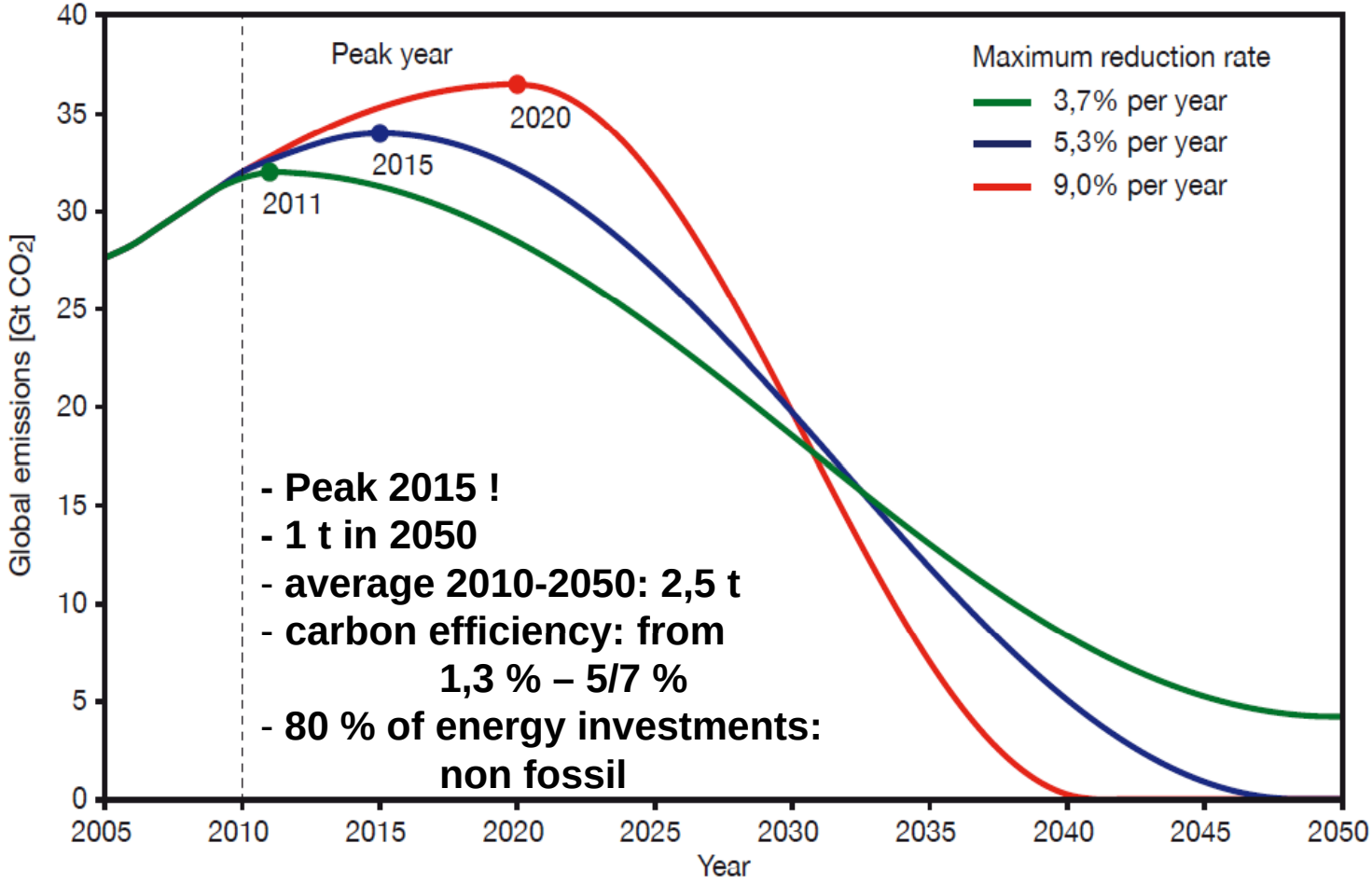
Reductions in energy-related CO_2 emissions in the climate-policy scenarios

World Energy Outlook 2008



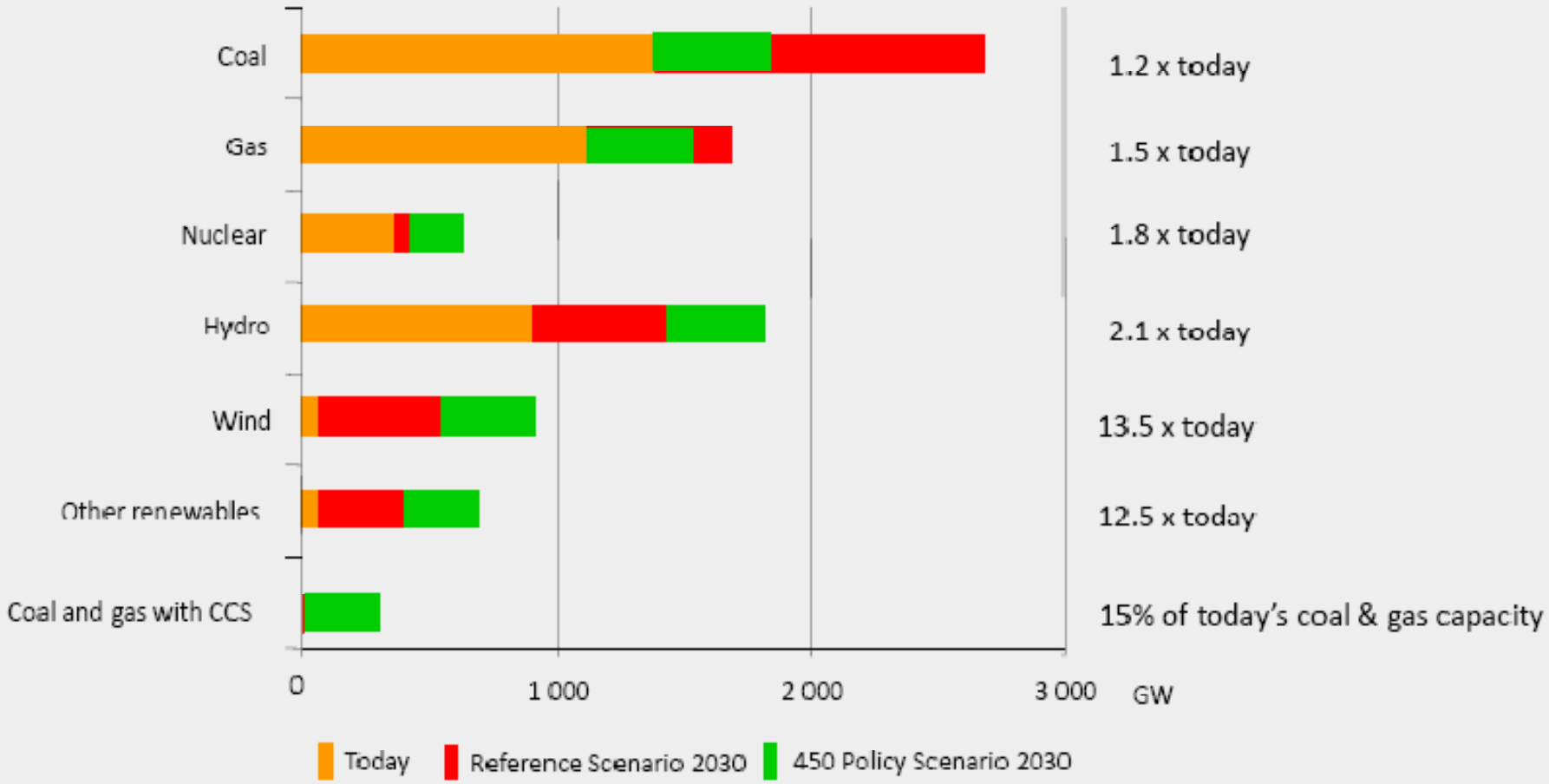
While technological progress is needed to achieve some emissions reductions, efficiency gains and deployment of existing low-carbon energy accounts for most of the savings

Corridor to reach the 2 ° C target: five key coordinates



Total power generation capacity today and in 2030 by scenario

World Energy Outlook 2008



In the 450 Policy Scenario, the power sector undergoes a dramatic change – with CCS, renewables and nuclear each playing a crucial role

Key results of the post-2012 climate-policy analysis

World Energy Outlook 2008

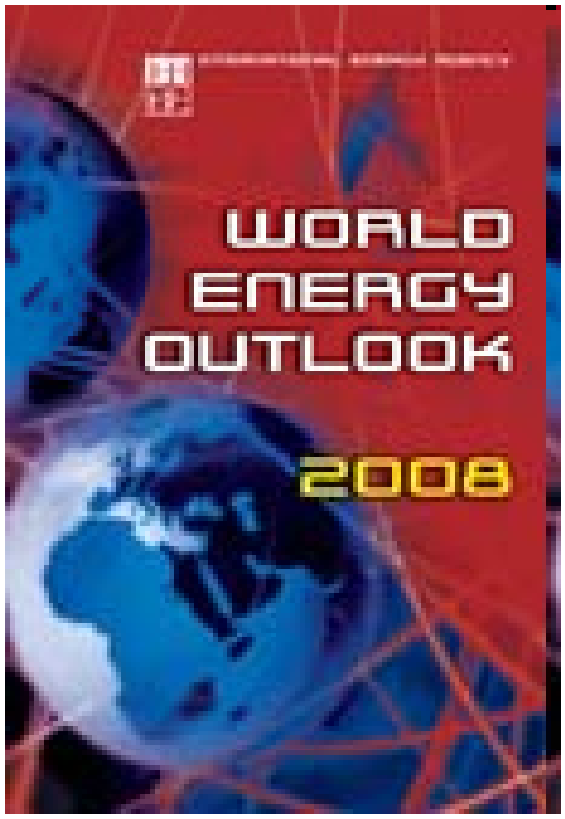
550 Policy Scenario

- Corresponds to a c.3°C global temperature rise
- Energy demand continues to expand, but fuel mix is markedly different
- CO_2 price in OECD countries reaches $90/tonne in 2030
- Additional investment equal to 0.25% of GDP

450 Policy Scenario

- Corresponds to a c.2°C global temperature rise
- Energy demand grows, but half as fast as in Reference Scenario
- Rapid deployment of low-carbon technologies – particularly CCS
- Big fall in non-OECD emissions
- CO_2 price in 2030 reaches $180/tonne
- Additional investment equal to 0.6% of GDP

Chapter 8: Energy use in cities



- Estimates of current and projected urban energy use
- Modelling of 4 world regions where at least some data is available at sub-national scale
  - US
  - Europe
  - China
  - Australasia (A & NZ)

Energy Use in Cities: results

- Currently about 67% of energy is consumed in cites, they contribute more than 70 % of global energy related CO2 emissions
- By 2030 urban energy use will increase to 73%, contributing to 76% of the global energy related CO2 emissions.
- Cities accordingly have to play a crucial role in climate change mitigation strategies

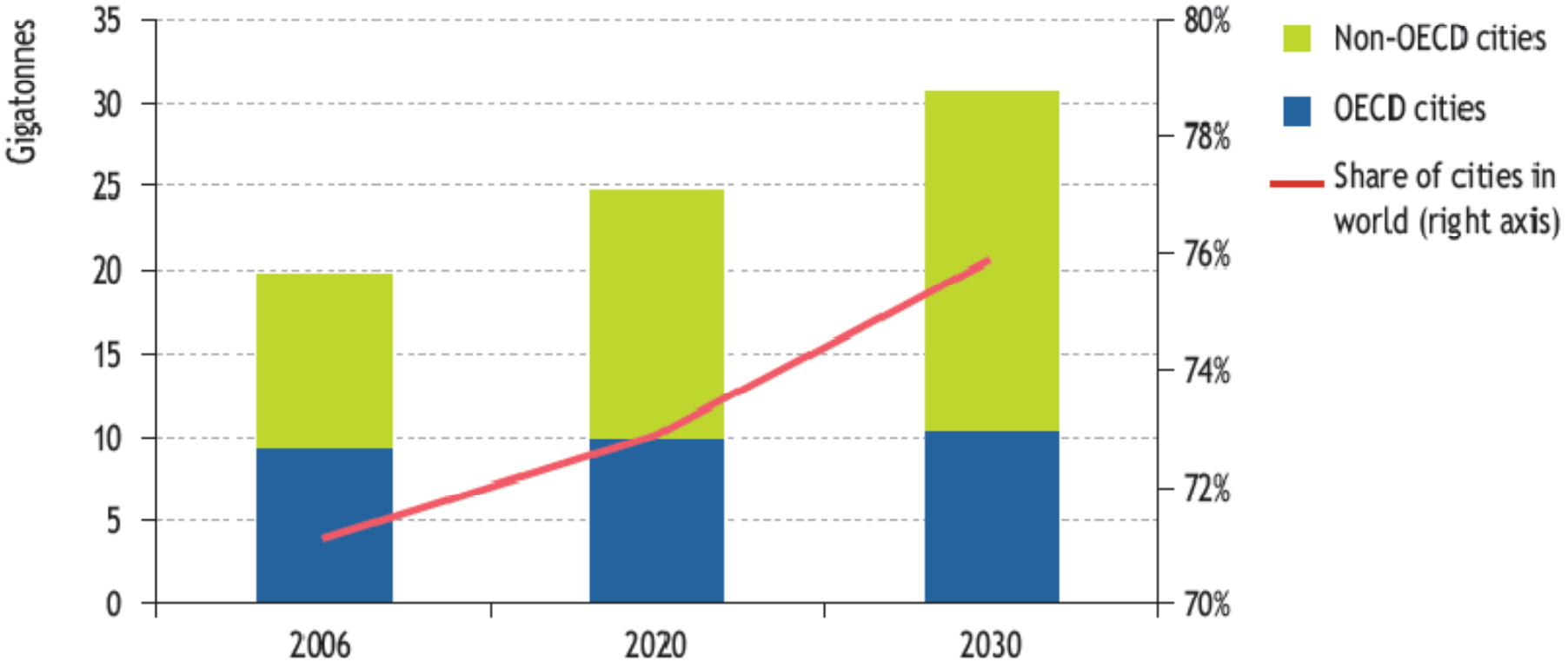
Further findings

- The fuel mix of cities in developed countries is dominated by grid based sources (gas, electricity, heat)
- In developed countries urban areas tend to have lower per capita consumption values then peri-urban and rural areas, particularly for transport fuels
- In developing countries this pattern tends to reverse due to restricted access outside of cities and income effects

Detailed results

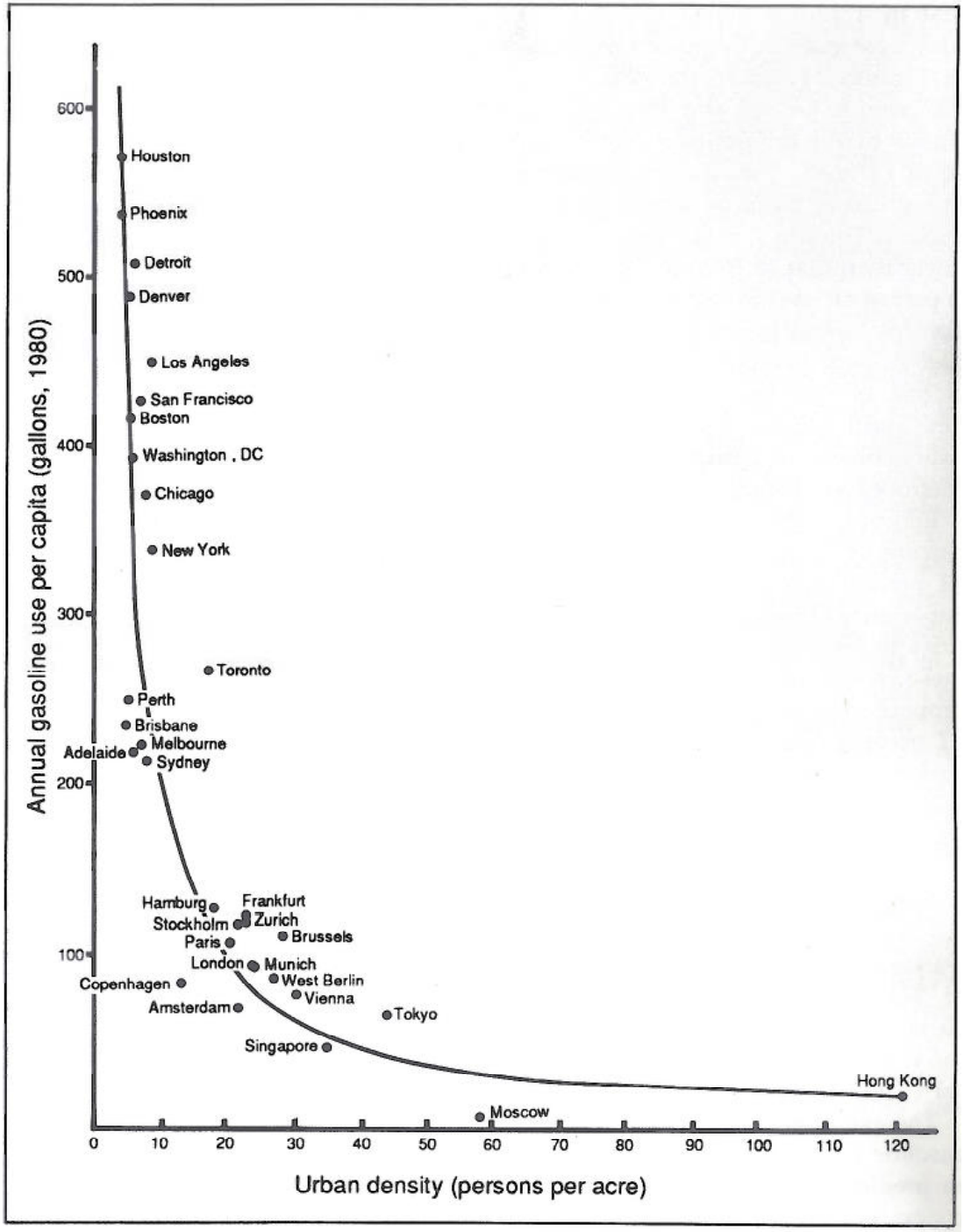
Region	Share of city primary energy demand in regional total	Ratio of city per-capita primary energy demand to regional average	Urbanisation rate
US	80%	0.99	81%
European Union	69%	0.94	73%
Australia and New Zealand	78%	0.88	88%
China	75%	1.82	41%

Energy related CO2 emissions by cities, reference scenario



Low carbon cities

- Density of cities
- Energy efficient buildings
- Energy plus buildings: buildings becoming decentralized power plants
- Supergrids to boost renewable energy
- Systemic issues: housing – transport - waste management – leisure/ culture



Interaction of settlement density and transport energy demand

[Kenworthy & Newmann 1989]

Case study: Office buildings

Tsinghua school
4650m^2，34kWh/m^2·a

Tsinghua art school
64k m^2，65.7kWh/m^2·a

Government office A
16k m^2，70.1kWh/m^2·a

Government office B
37k m^2，113kWh/m^2·a

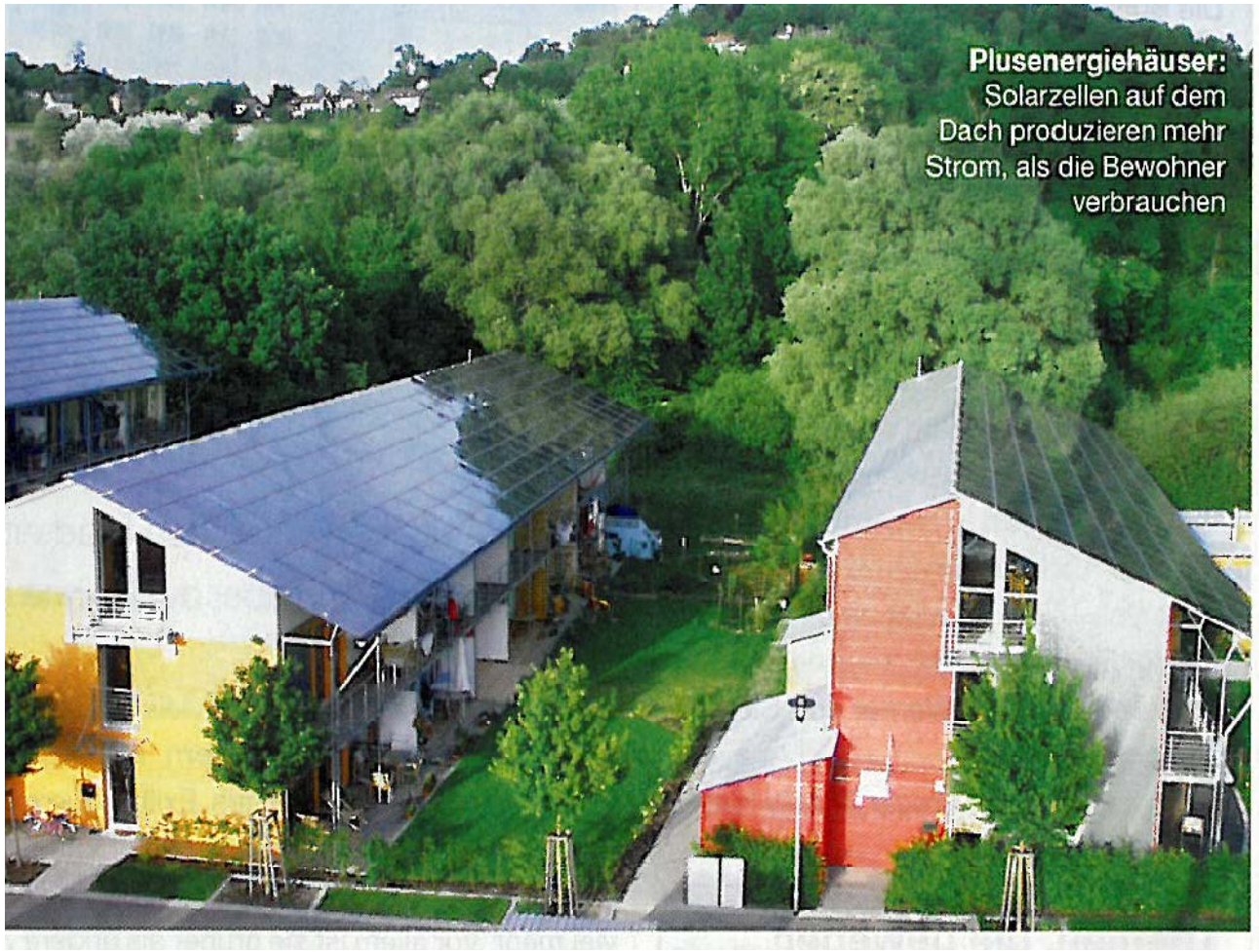
Towel in Shanghai
287k m^2，215kWh/m^2·a

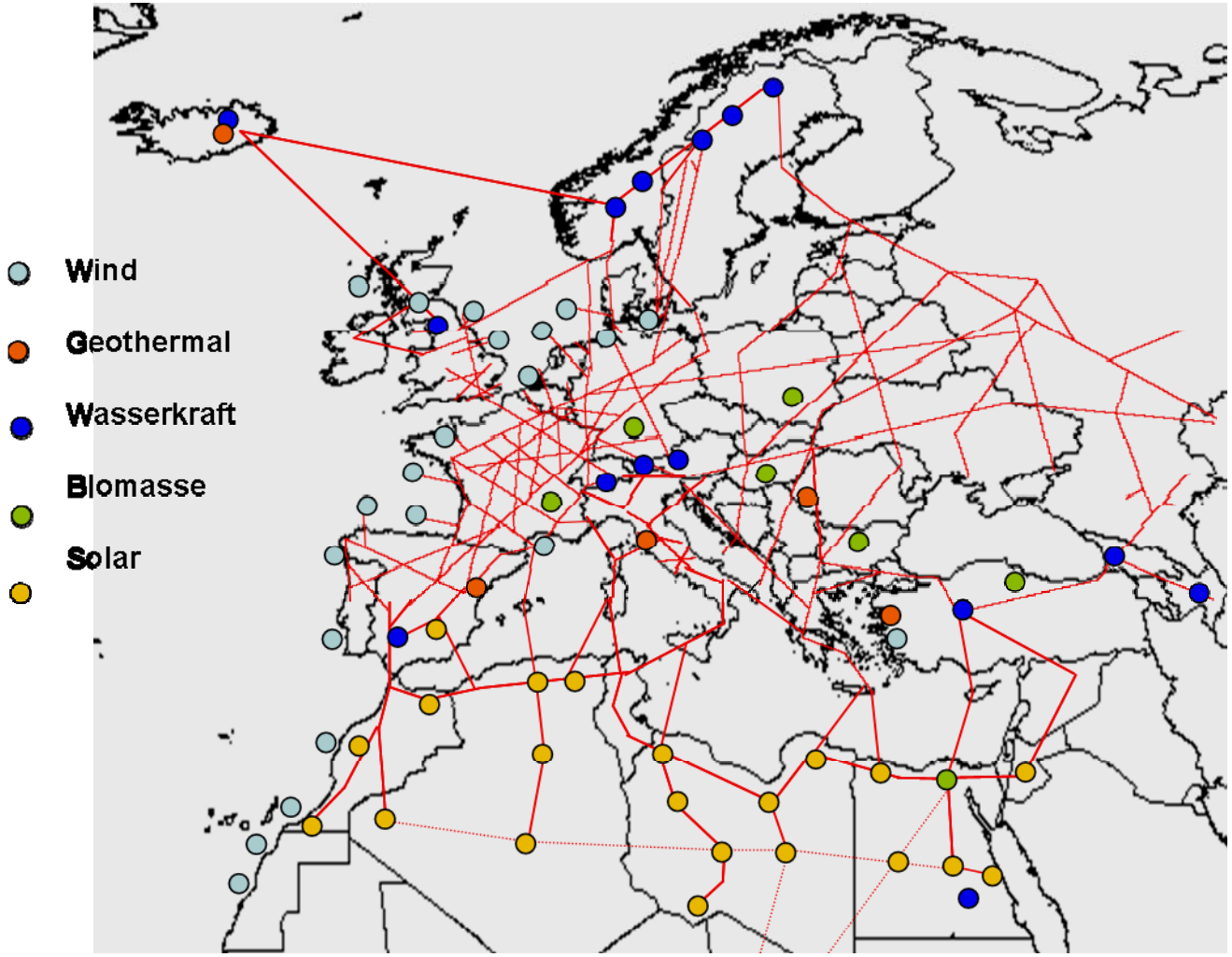
Office building A, USA
6425m^2，364kWh/m^2·a

Office building B, USA
30k m^2，356kWh/m^2·a

Office building, Lyon
17k m^2，165kWh/m^2·a

Vom Niedrigenergiehaus zum Plusenergiehaus
Aus Energienutzern werden dezentrale Kraftwerke

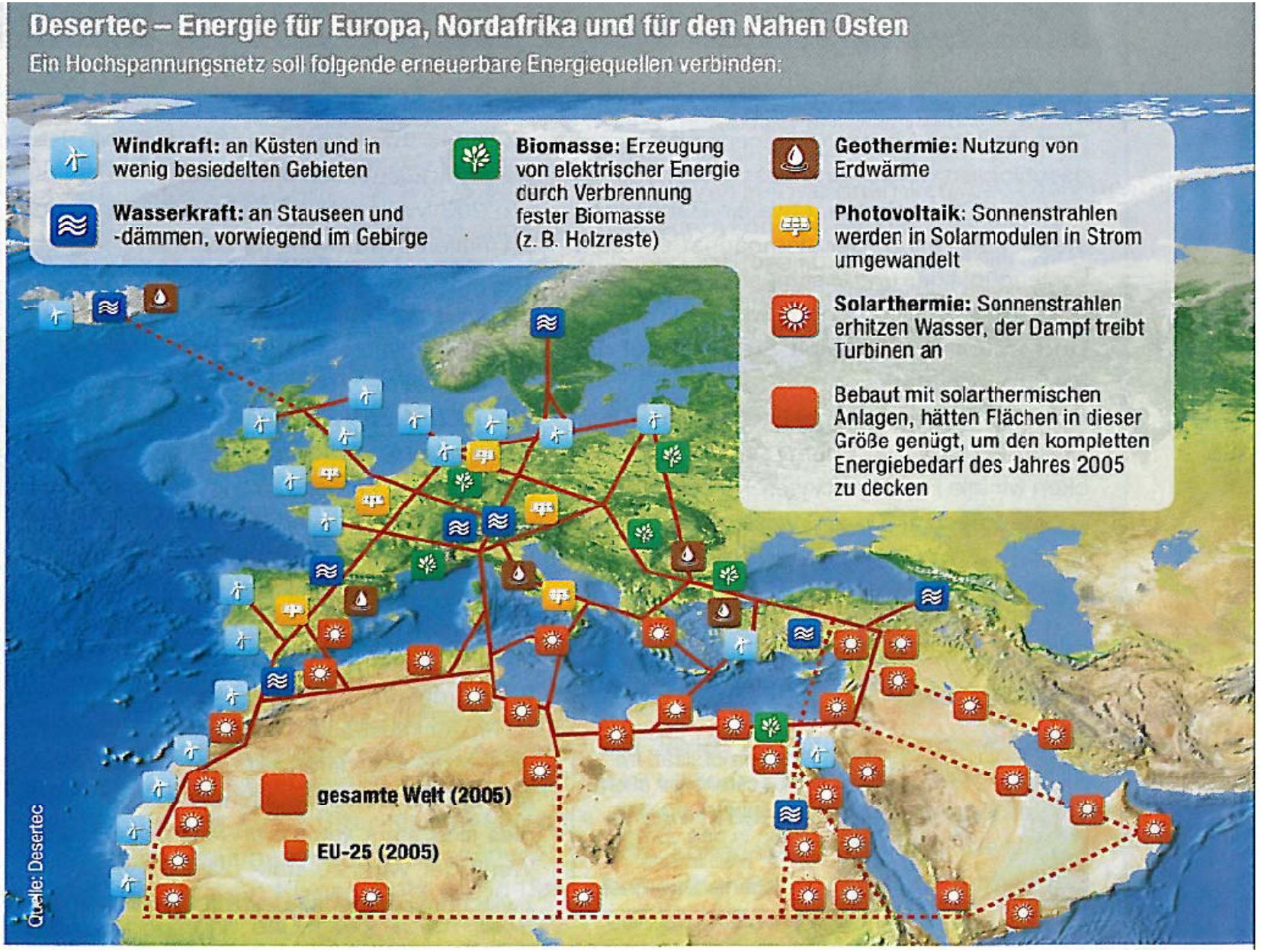




Vision eines Hochspannungs-Gleichstromnetzes als Rückgrat eines trans-europäischen/ nord-afrikanischen Stromverbunds

Quelle: DLR, Dr: F. Trieb

Smart grids: aus Niedrigenergiehäusern werden dezentrale Kraftwerke


Desertec – Energie für Europa, Nordafrika und für den Nahen Osten
Ein Hochspannungsnetz soll folgende erneuerbare Energiequellen verbinden:
Windkraft: an Küsten und in wenig besiedelten Gebieten
Wasserkraft: an Stauseen und -dämmen, vorwiegend im Gebirge
Biomasse: Erzeugung von elektrischer Energie durch Verbrennung fester Biomasse (z. B. Holzreste)
Geothermie: Nutzung von Erdwärme
Photovoltaik: Sonnenstrahlen werden in Solarmodulen in Strom umgewandelt
Solarthermie: Sonnenstrahlen erhitzen Wasser, der Dampf treibt Turbinen an
Bebaut mit solarthermischen Anlagen, hätten Flächen in dieser Größe genügt, um den kompletten Energiebedarf des Jahres 2005 zu decken
gesamte Welt (2005)
EU-25 (2005)
Quelle: Desertec

Main Messages

- 50% of world population is urban
  but uses ~70% of all final energy
- Rural populations are likely to peak at 3.5 billion
  and decline after 2020
- Urban population projected to continue to grow to 6-8 billion by 2050.
- Urban energy dominance projected to increase even further
- Both generic as well as specific urban sustainability challenges (high density calls for zero-impact systems)
- Vast improvement potentials, but most require systemic change (recycling, cascading, transport systems integration,..)
- New sustainability criteria needed, considering the functional interdependence among different systems that are geographically separated
- Leverage Paradox:
  - largest leverage from systems integration, but
  - most difficult to implement in view of policy fragmentation and dispersed, decentralized decision making