

Some “Big” Social Science Research Questions for the Study of Global Change

arnulf.grubler@yale.edu

Departments of Geography and Sociology,
University of Maryland
December 8, 2011

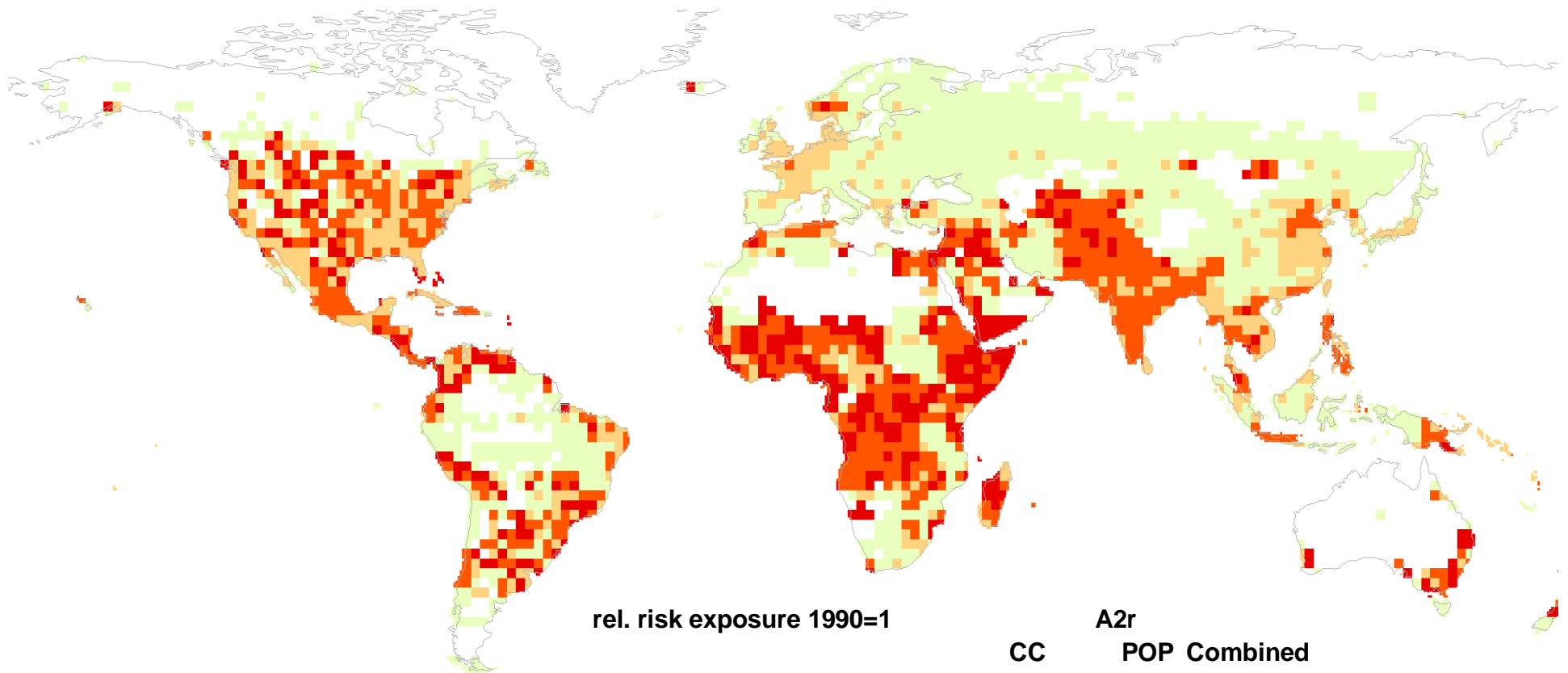
Preamble: Framing Climate Risks and **natural** & **social science** components

Risk = probability of event x consequences

CC Risk = uncertain magnitude of change x impacts

= **anthropogenic forcing** x
climate systems response x
vulnerability x
policy response

Climate Change Risk Exposure Map by 2070 (A2r)



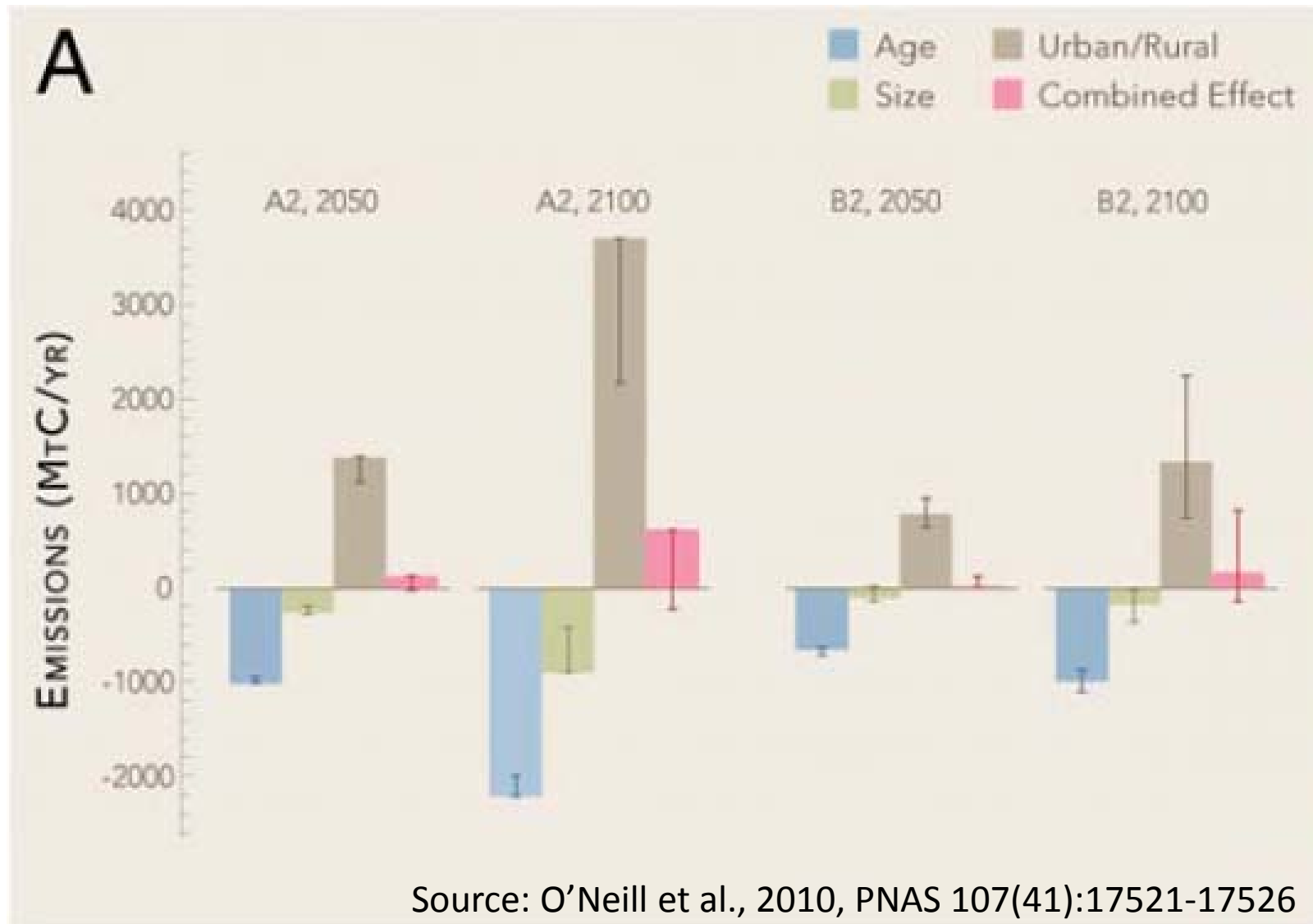
High exposure: due to high temperature change in temperate climates, or due to high population growth in hot climates, or both

Source: I. Scher, Yale FES, 2008

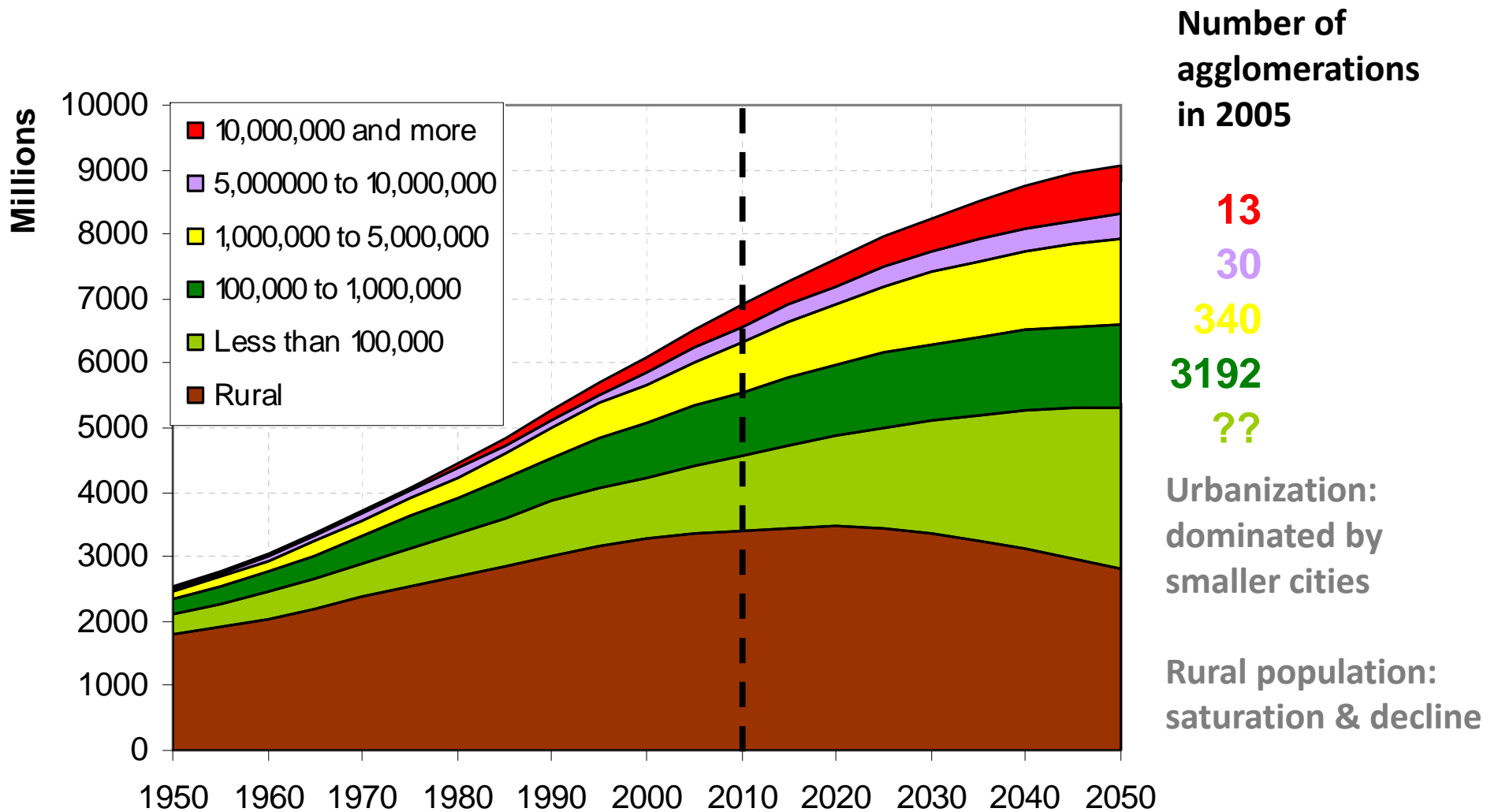
4 “Big” Social Science Research Questions

- Drivers of change beyond aggregate, proxy drivers
- Spatial and social heterogeneity
- Behavioral/organizational vs. technological change
- Self-organization (stability of macro-patterns with spatial and social heterogeneity & diversity)

Influence of Demographic Variables on Emissions for 2 IPCC scenarios



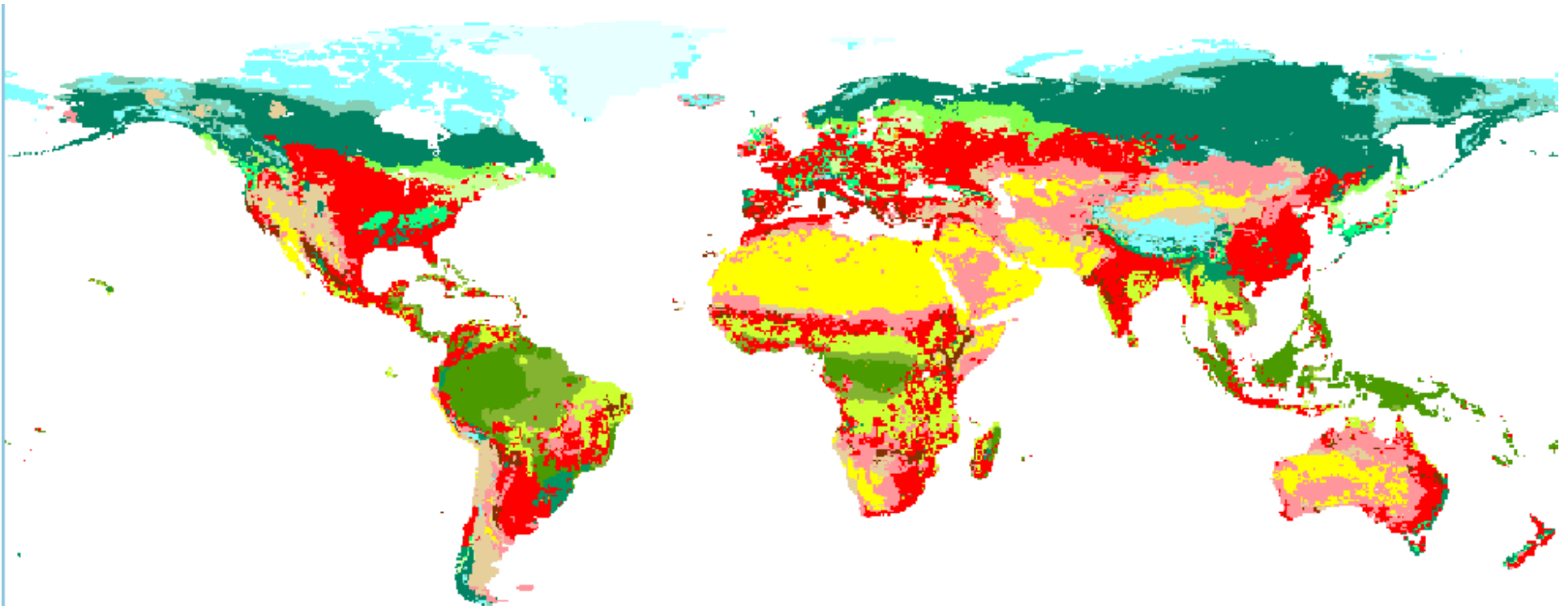
Population by Settlement Type/Size (UN, 2011)



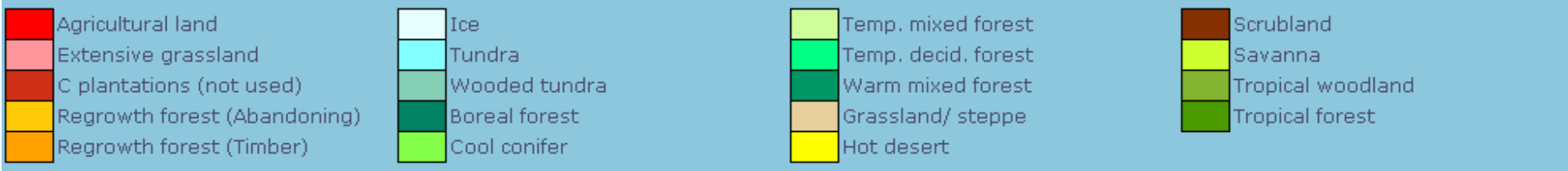
Source: GEA KM18 (in press)

IAM Land Cover Modeling State of Art

(ex. IMAGE Model)



Where are cities & urban areas?



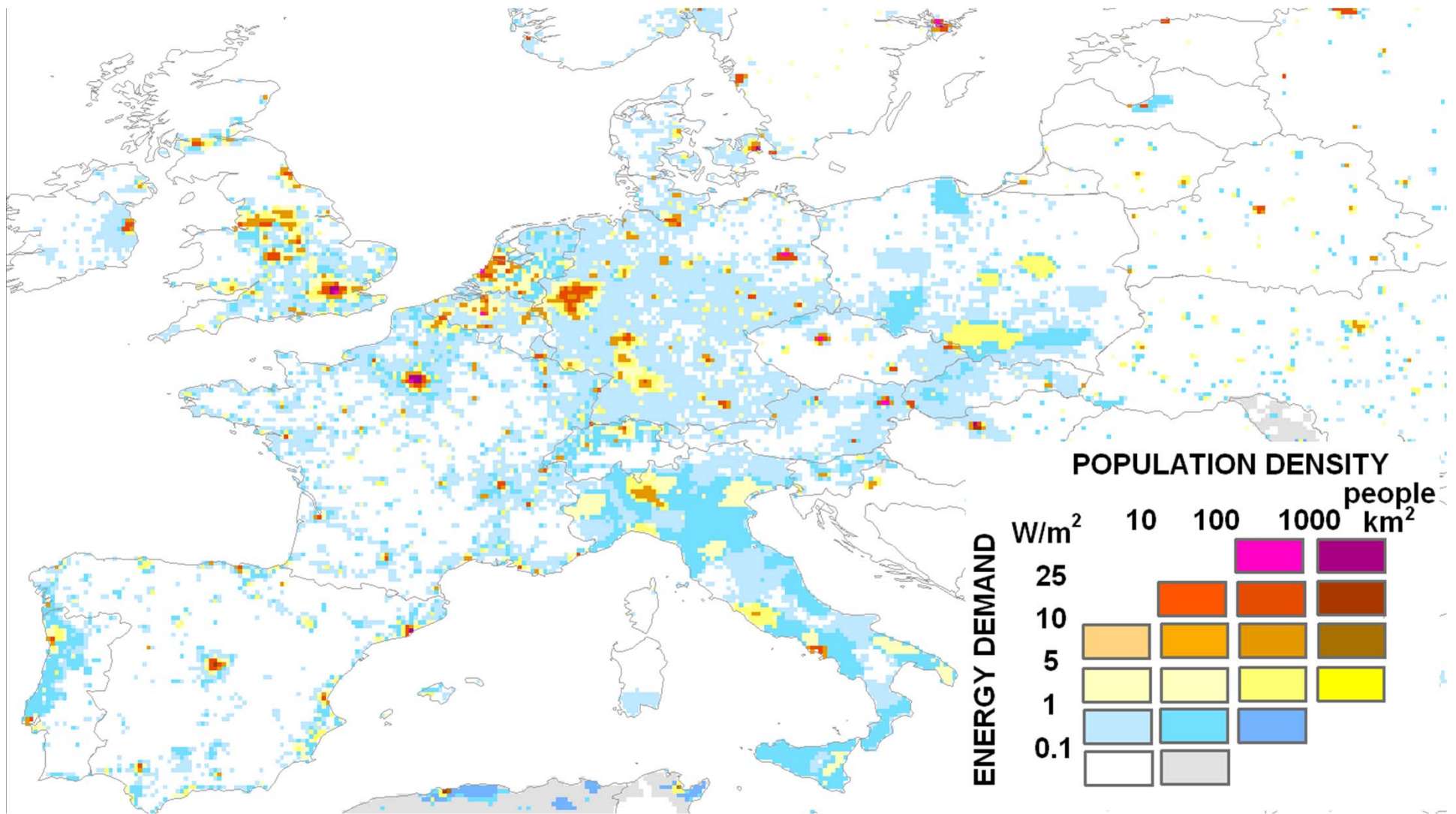
4 “Big” Social Science Research Questions

- Drivers of change beyond aggregate, proxy drivers
- **Spatial and social heterogeneity**
- Behavioral/organizational vs. technological change
- Self-organization (stability of macro-patterns with spatial and social heterogeneity & diversity)

Europe – Energy Demand Densities

blue = renewable supply density threshold $<0.5-1 \text{ W/m}^2$

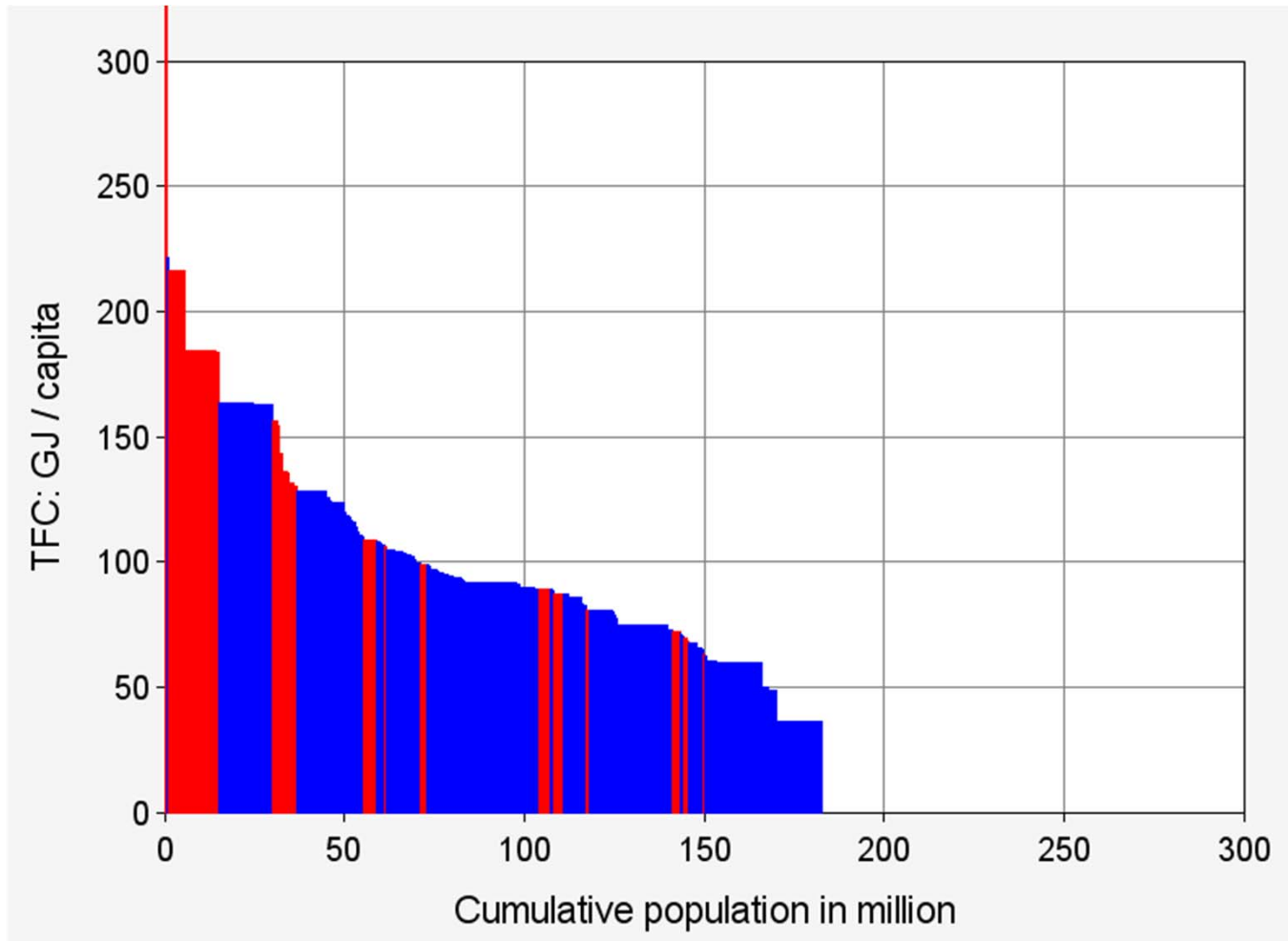
WEU $>79\%$ EEU $>66\%$ of energy demand



Source: GEA KM18 (in press)

Annex-I: Per Capita Urban Direct Final Energy Use

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

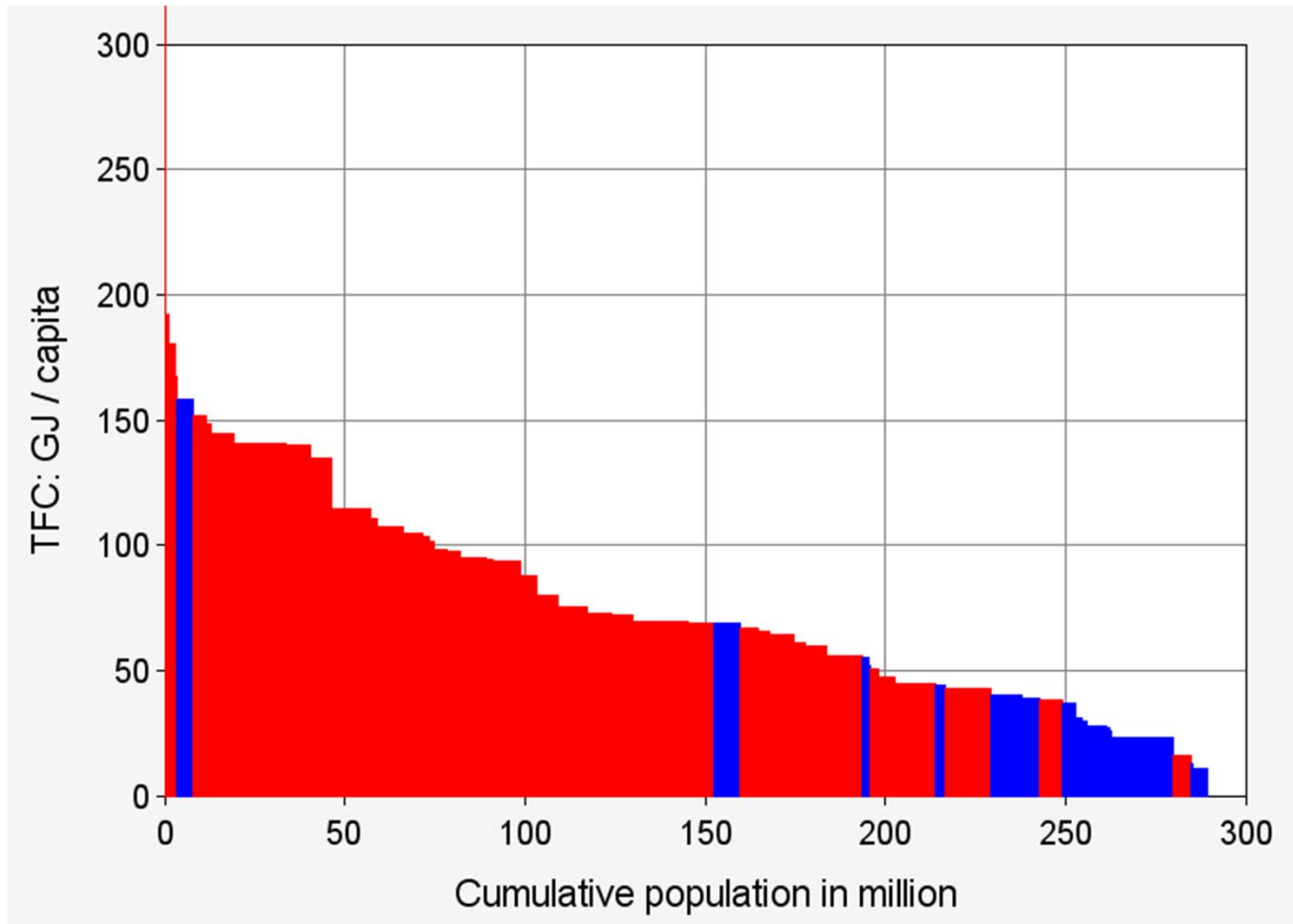


$n=132$

Source: GEA KM18 (in press)

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

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



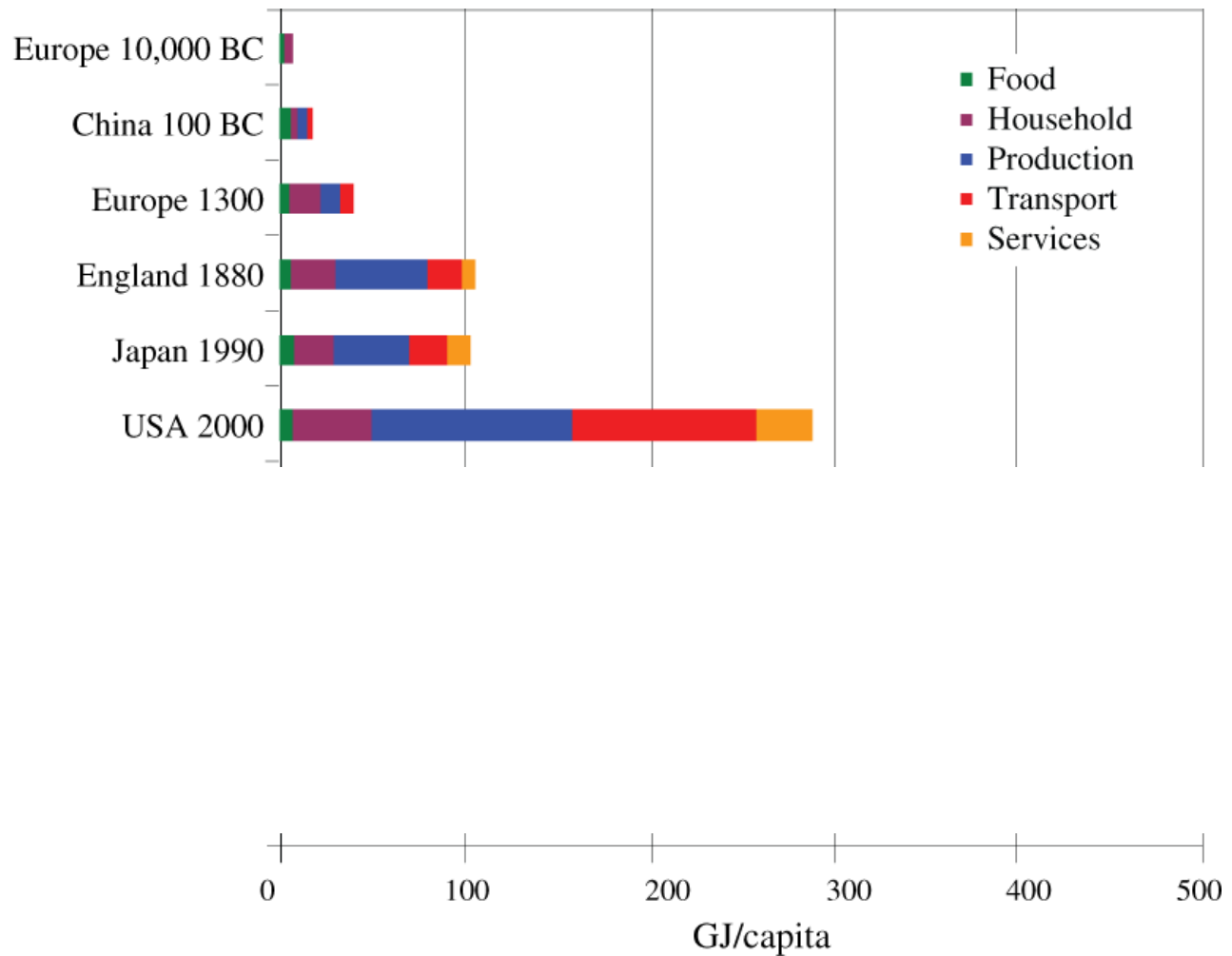
$n=68$

Source: GEA KM18 (in press)

Importance of Social Heterogeneity in IA Models of CC

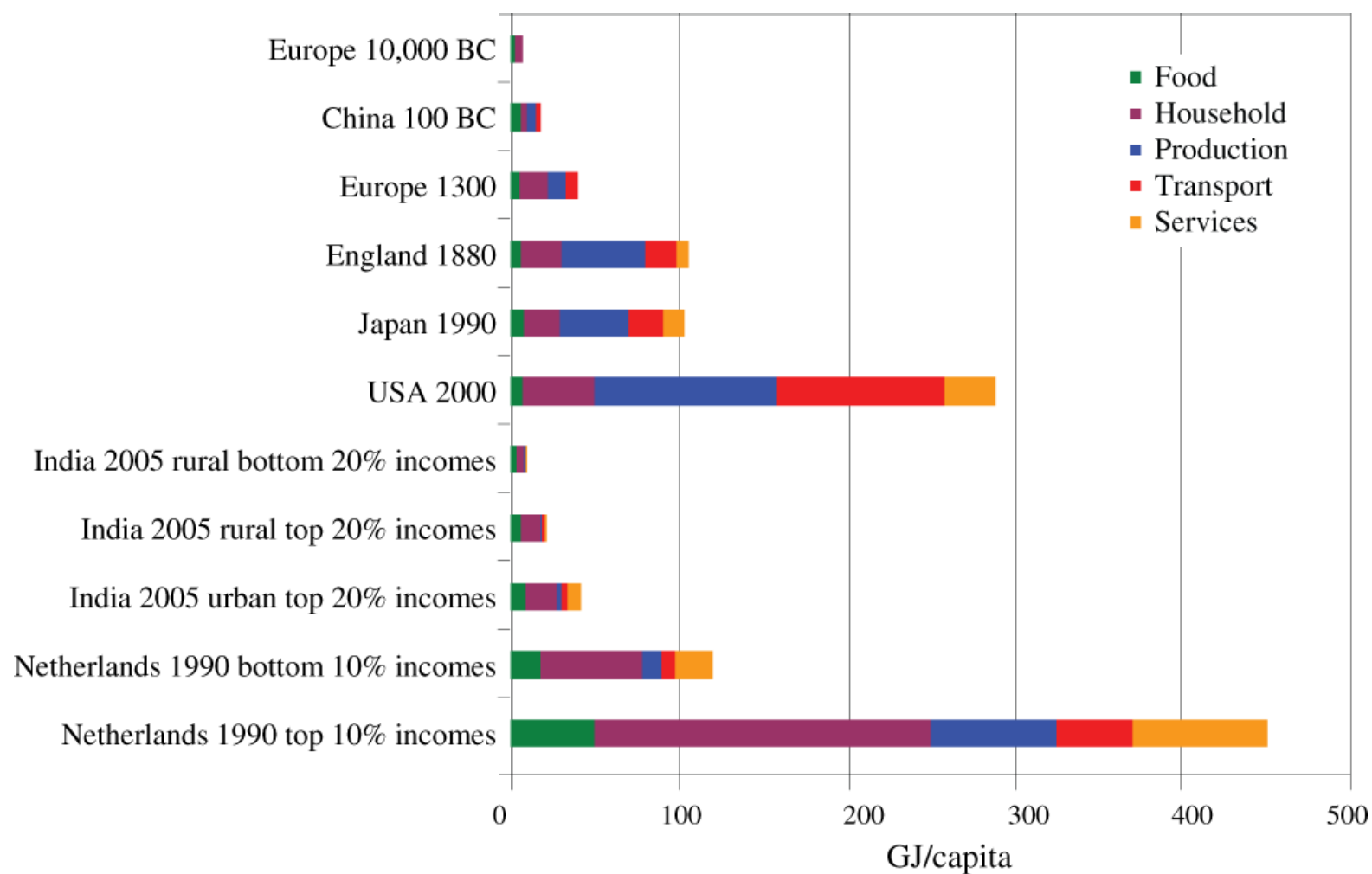
- “upstream” (emissions): growth potentials much higher than for country/regional aggregates
- “downstream” (impacts): Damages and adaptation potentials much larger
- “feedbacks” (mitigation): barriers and policy costs significantly underestimated by IA and policy models

Energy Transitions: Past



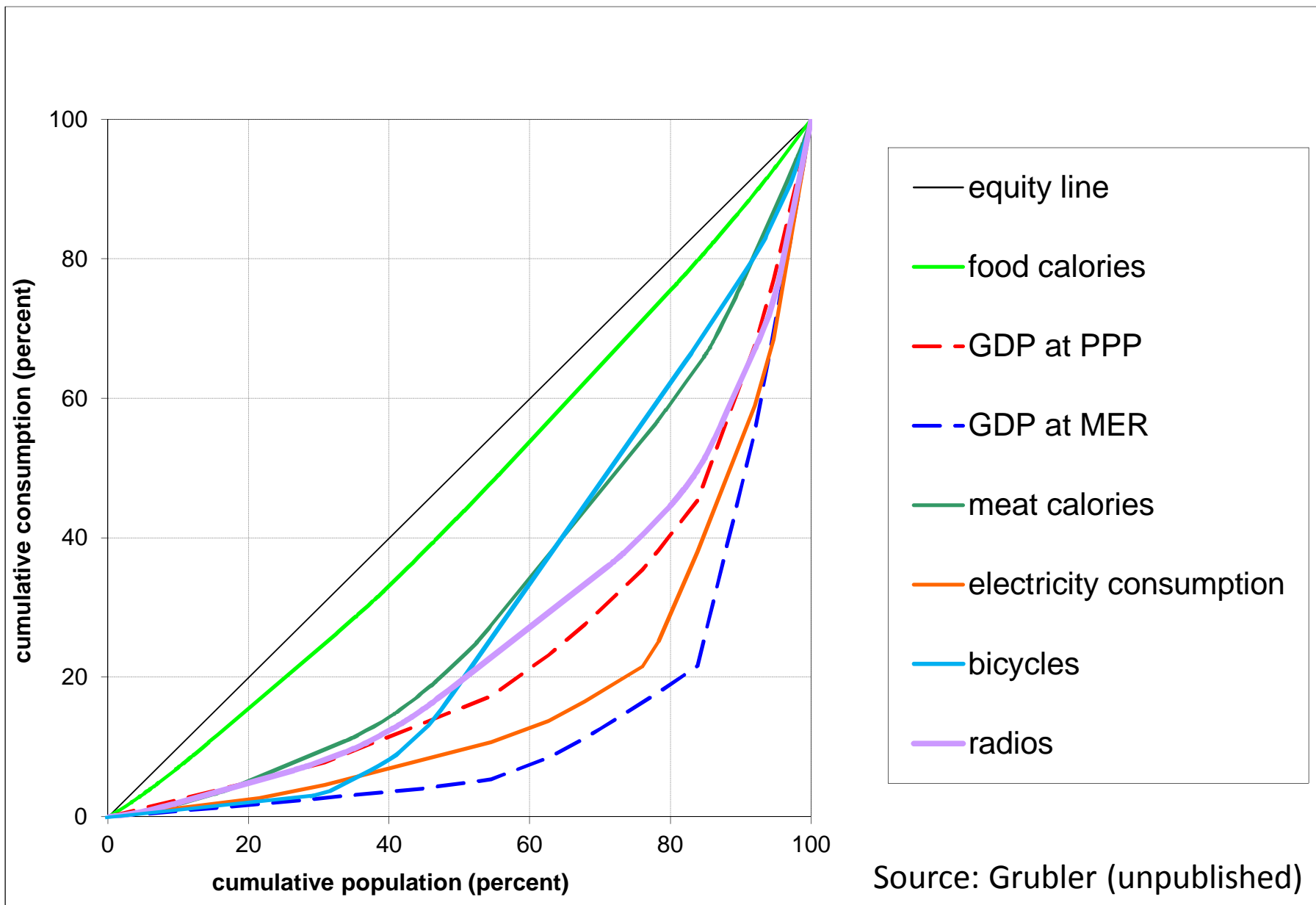
Source: adapted from V. Smil, 1994

Energy Transitions: Present (unfinished business)



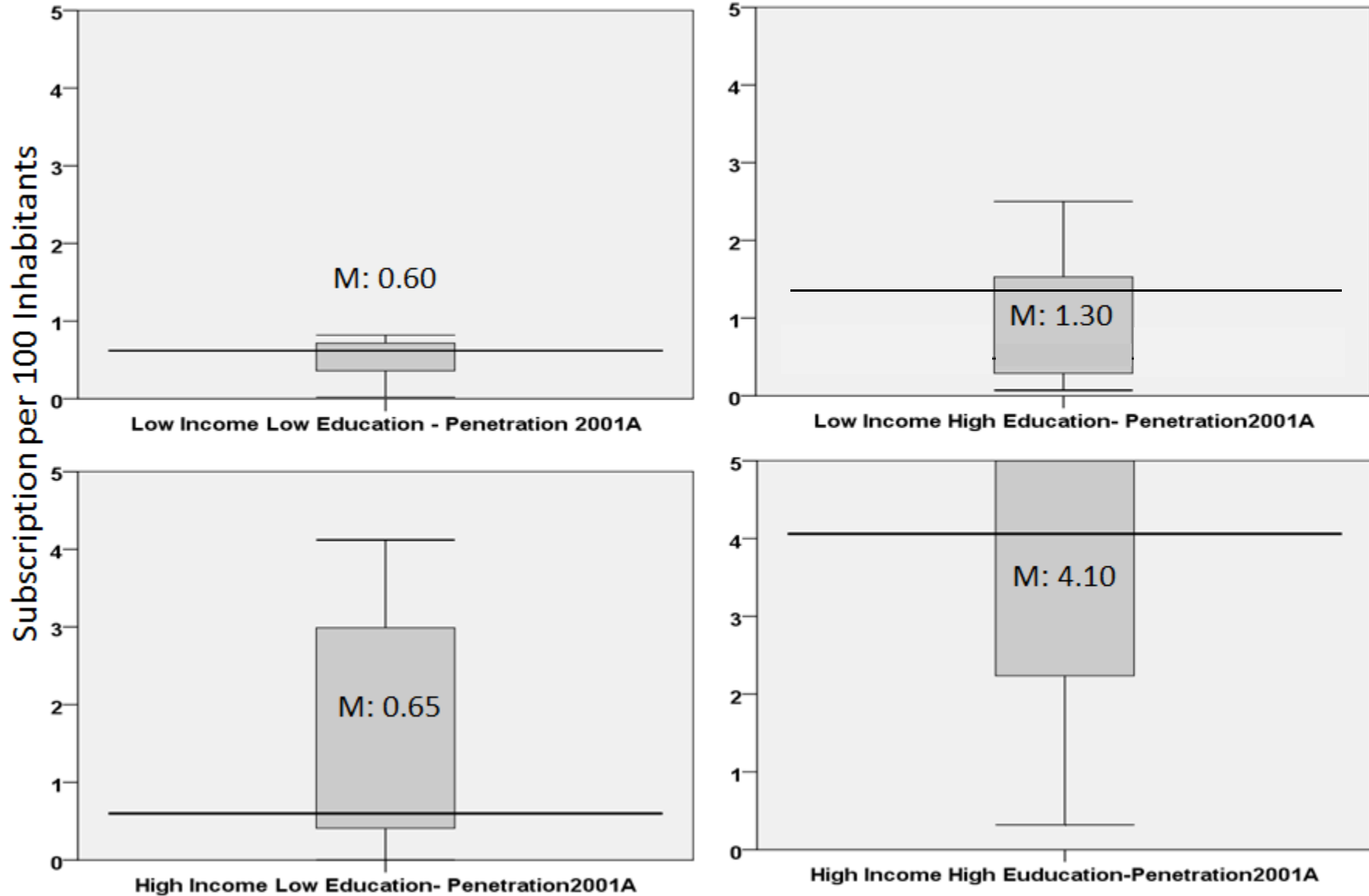
Source: Global Energy Assessment (GEA) KM1 (in press)

Global Development Gaps (Lorenz Curves)



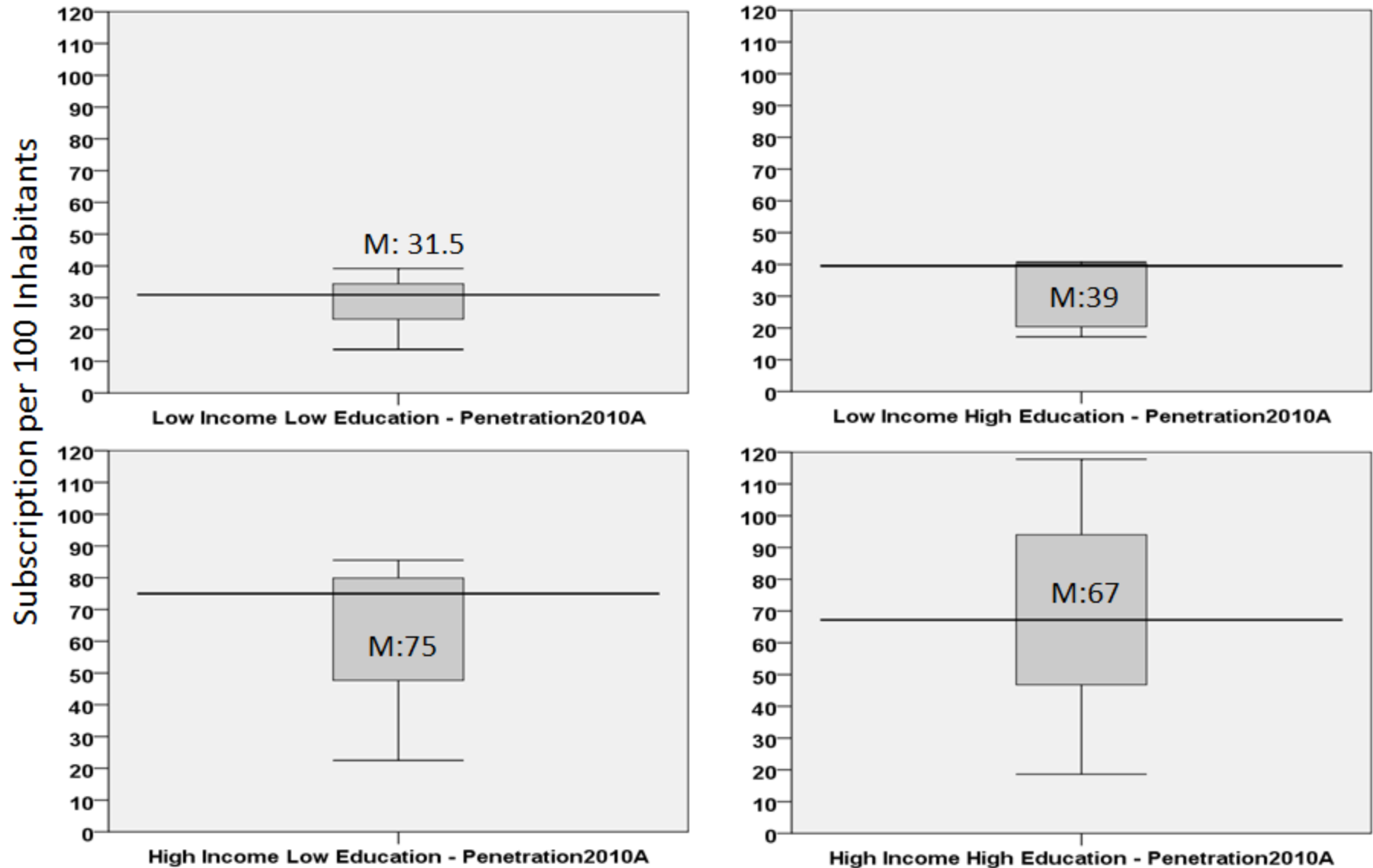
Mobile Phones (phones/1000) in SS Africa vs. Education and Income 2001

Data source: ITU, 2011

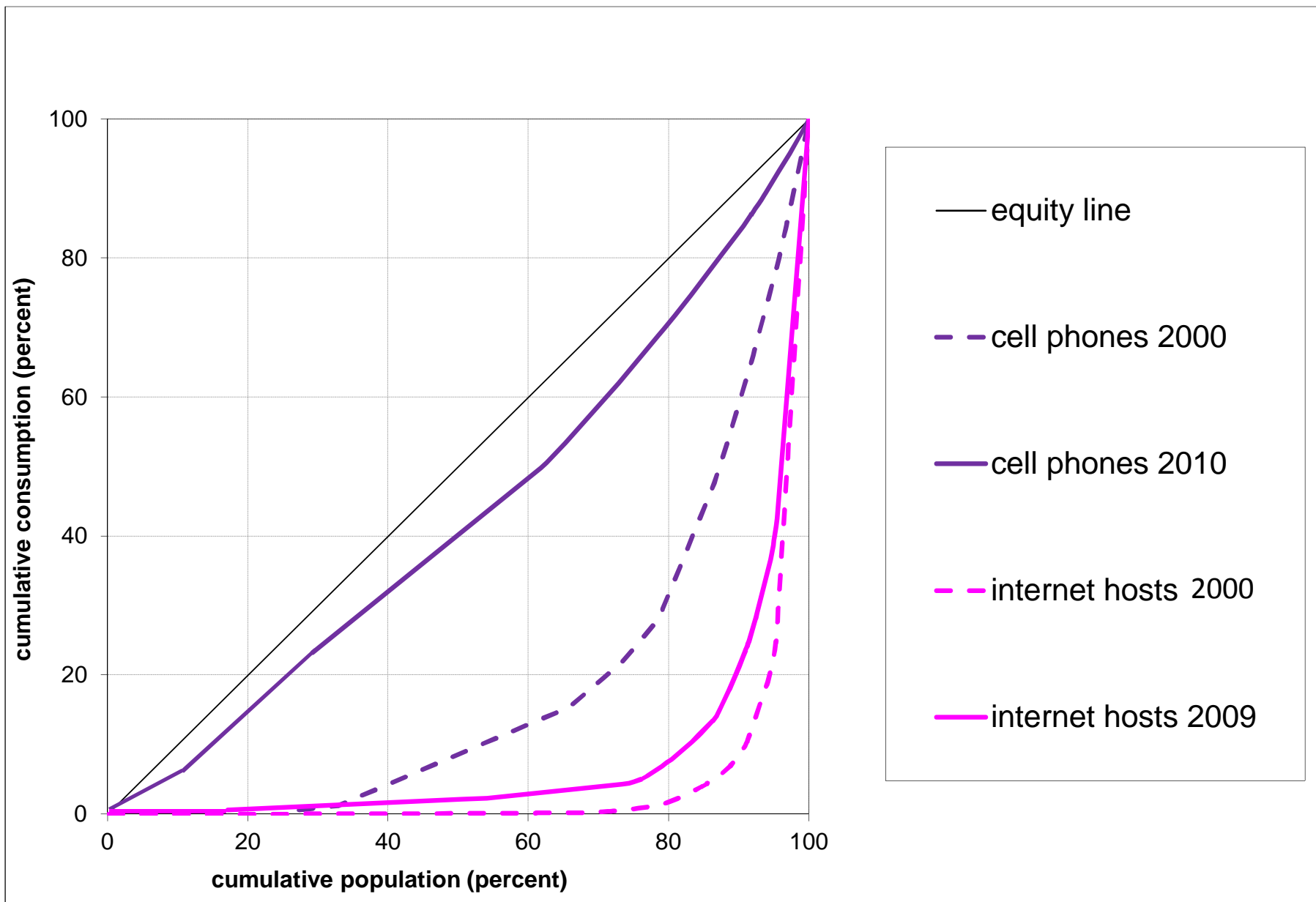


Mobile Phones (phones/1000) in SS Africa vs. Education and Income 2010

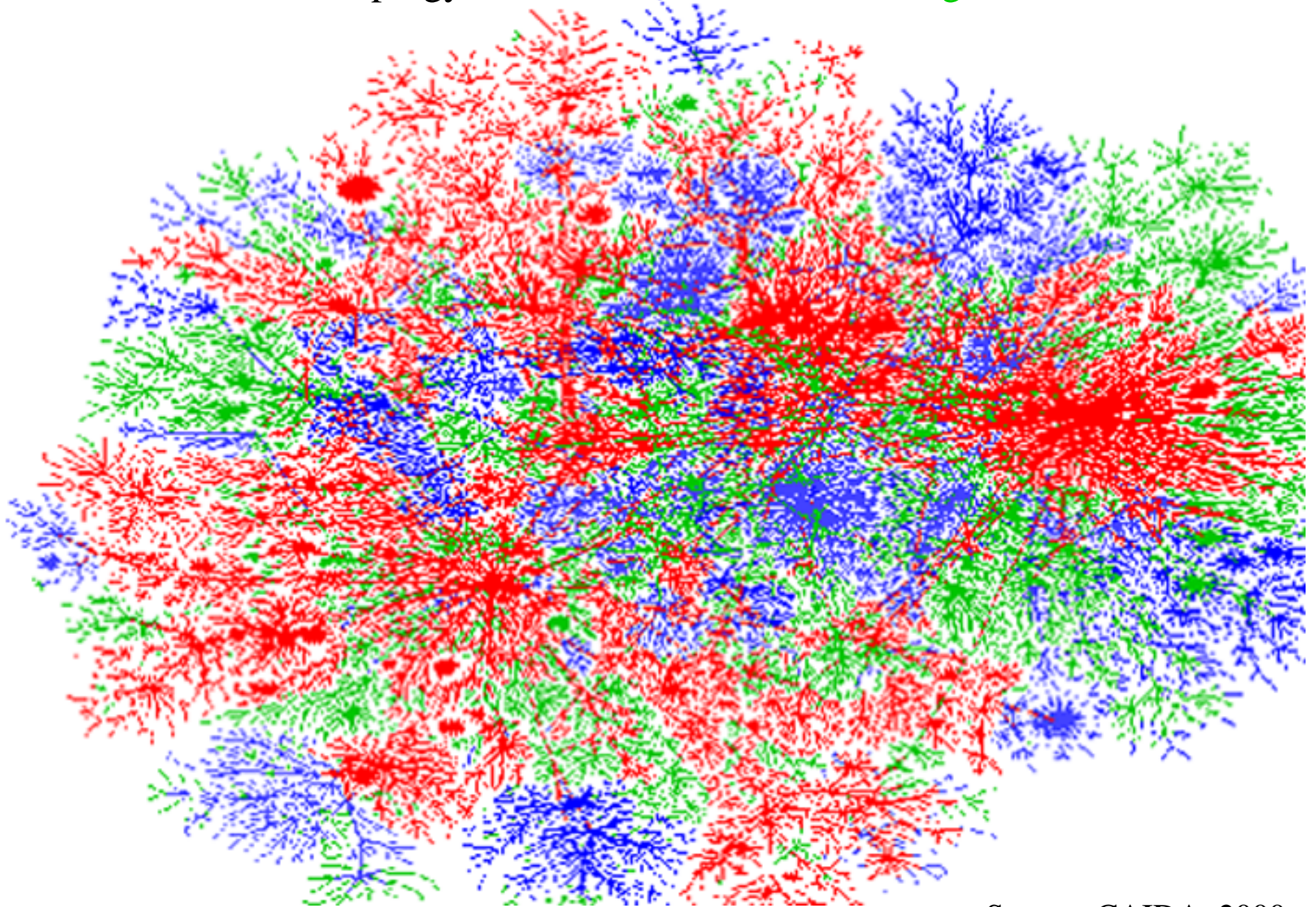
Data source: ITU, 2011



The Digital Divide

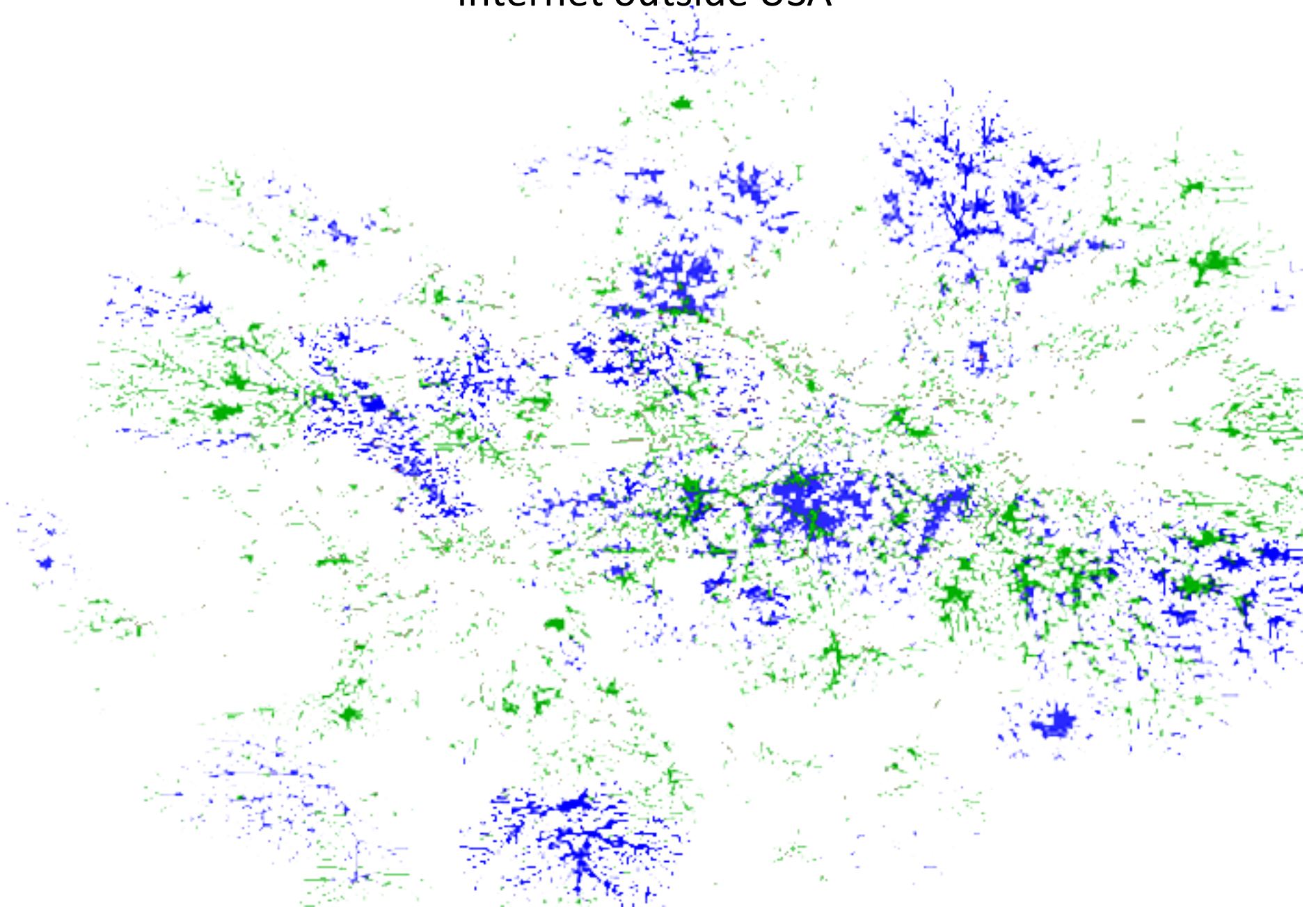


The Web's Topology: red=US blue=other OECD; green=ROW

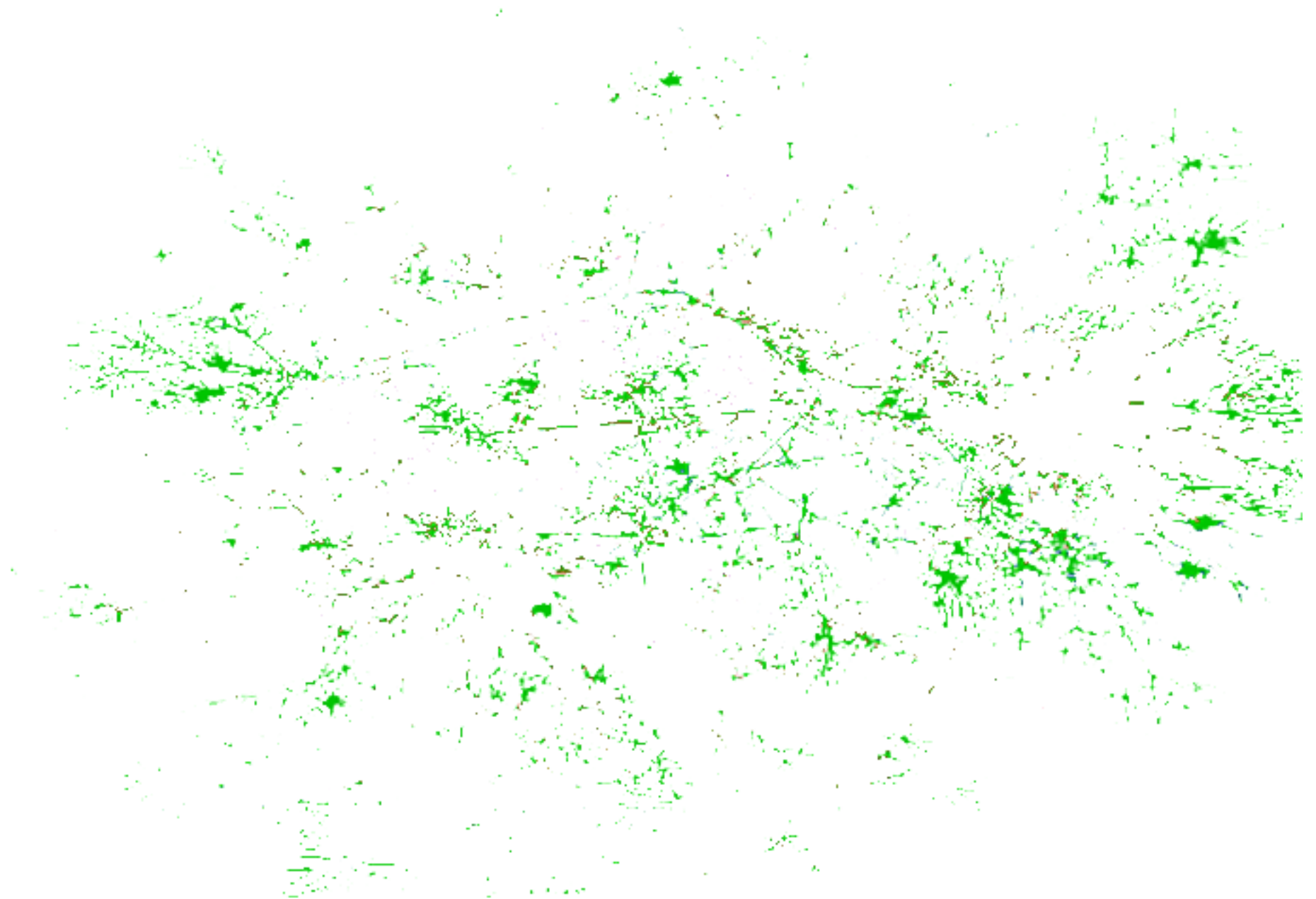


Source: CAIDA, 2000

Internet outside USA



Internet in DCs



4 “Big” Social Science Research Questions

- Drivers of change beyond aggregate, proxy drivers
- Spatial and social heterogeneity
- Behavioral/organizational vs. technological change
- Self-organization (stability of macro-patterns with spatial and social heterogeneity & diversity)

User Behavior More Powerful than Technological Efficiency: Example Energy End Use in Transport

Toyota Prius



50 miles/gal

1 Yalie in Zipcar

Cadillac Escalade



15 miles/gal

Soccer mom + 3 kids



8 miles/gal

Driver +
20 school children

Distance traveled (all examples) : 100 km

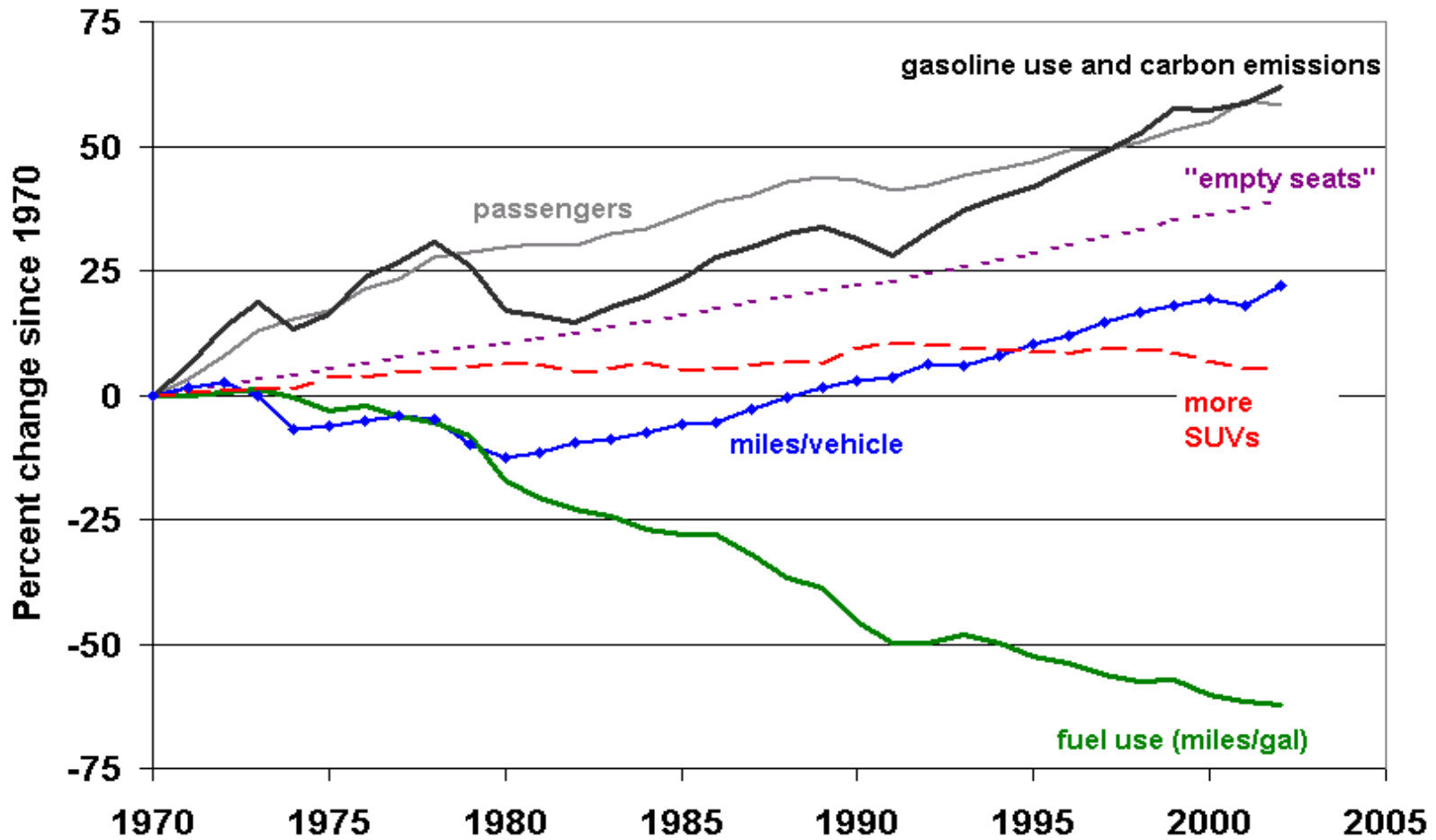
1.5

1.25

0.50

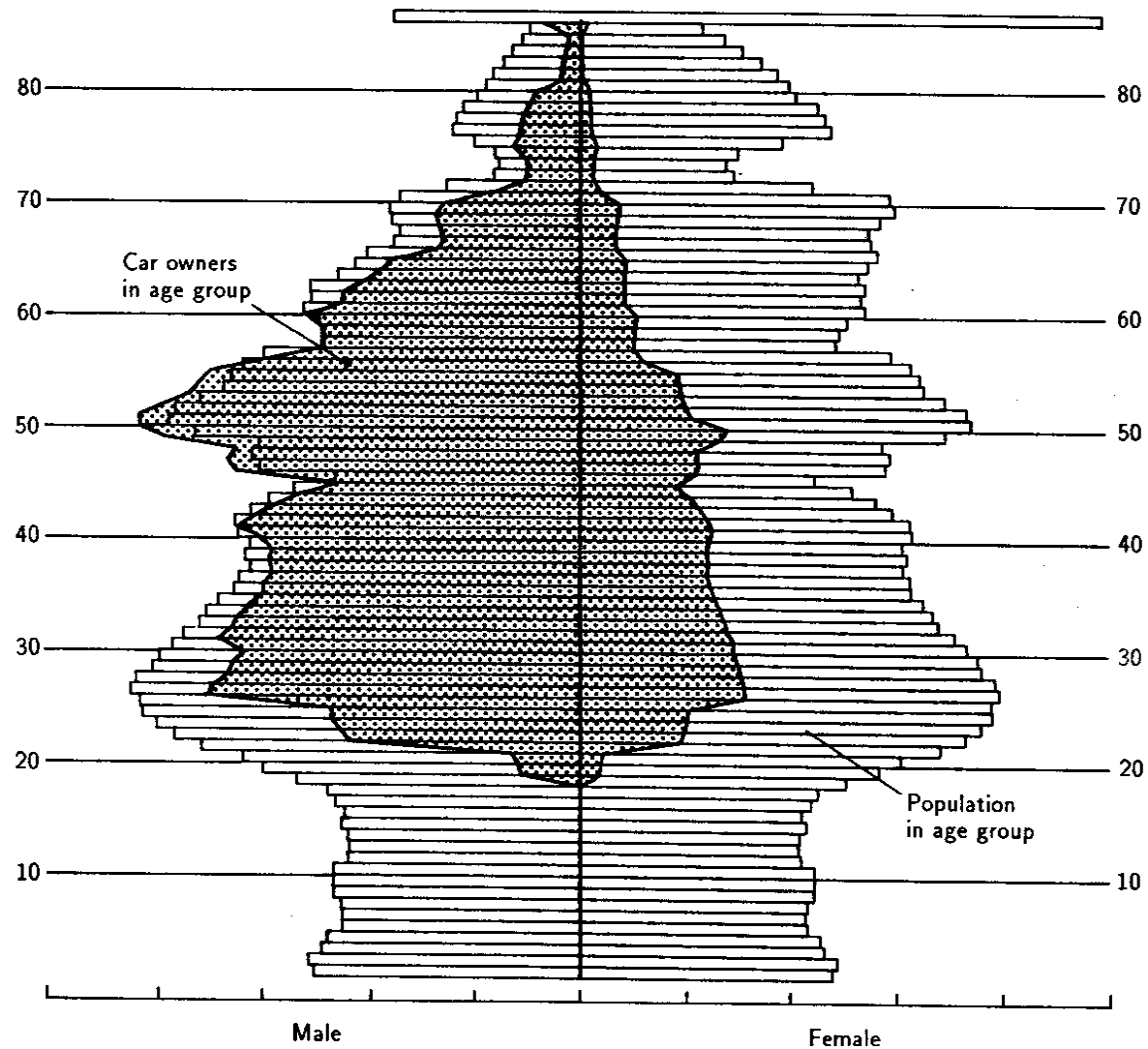
Energy use: MJ per passenger-km traveled

Percent Change since 1970 in US Automobile CO₂ Emissions and Driving Forces



Source: updated from Grubler, 1998

Germany: Car Ownership by Gender and Age Cohorts



Source: Buettner&Grubler, 1995.

4 “Big” Social Science Research Questions

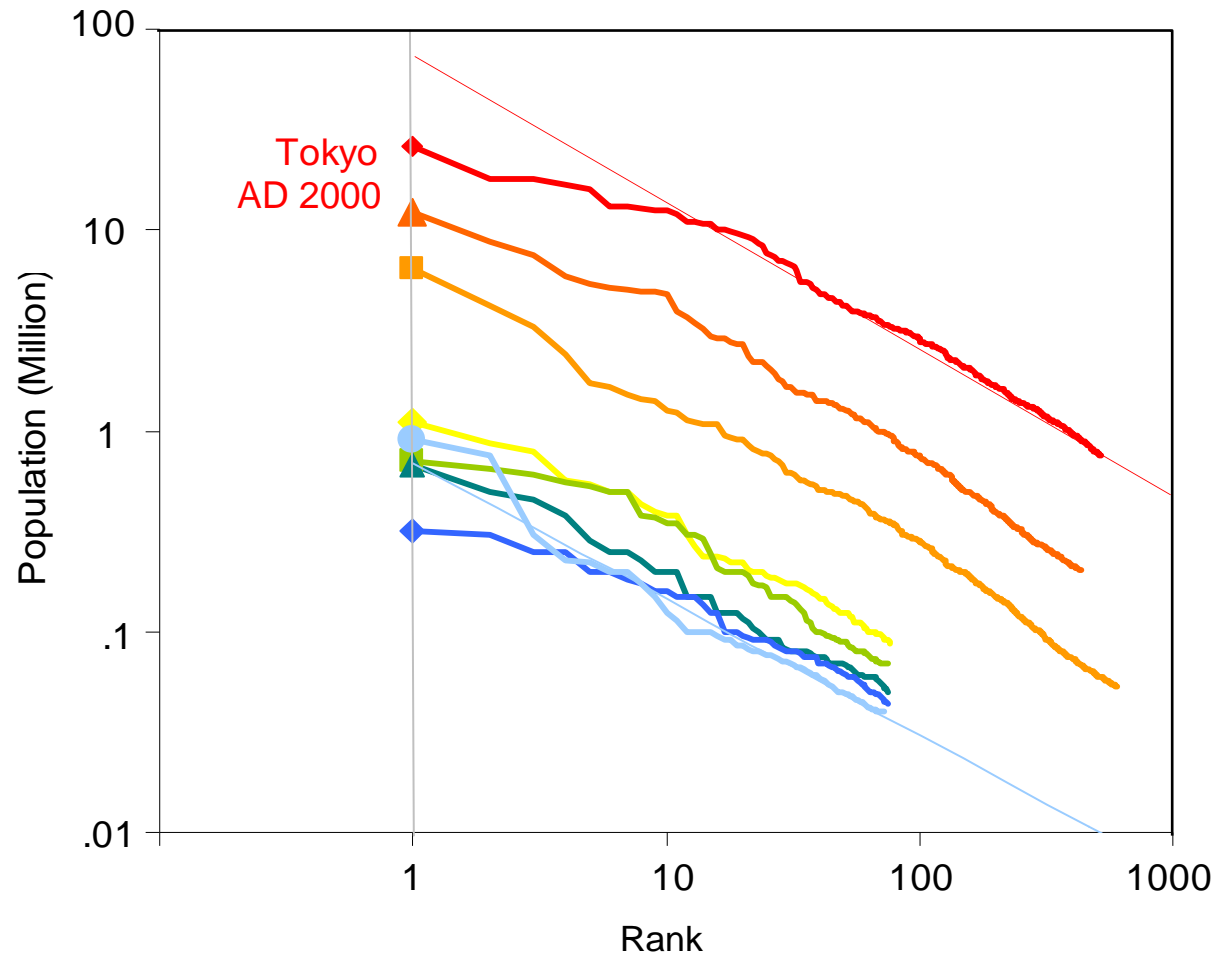
- Drivers of change beyond aggregate, proxy drivers
- Spatial and social heterogeneity
- Behavioral/organizational vs. technological change
- Self-organization (stability of macro-patterns with spatial and social heterogeneity & diversity)

Self-organizing Regularities

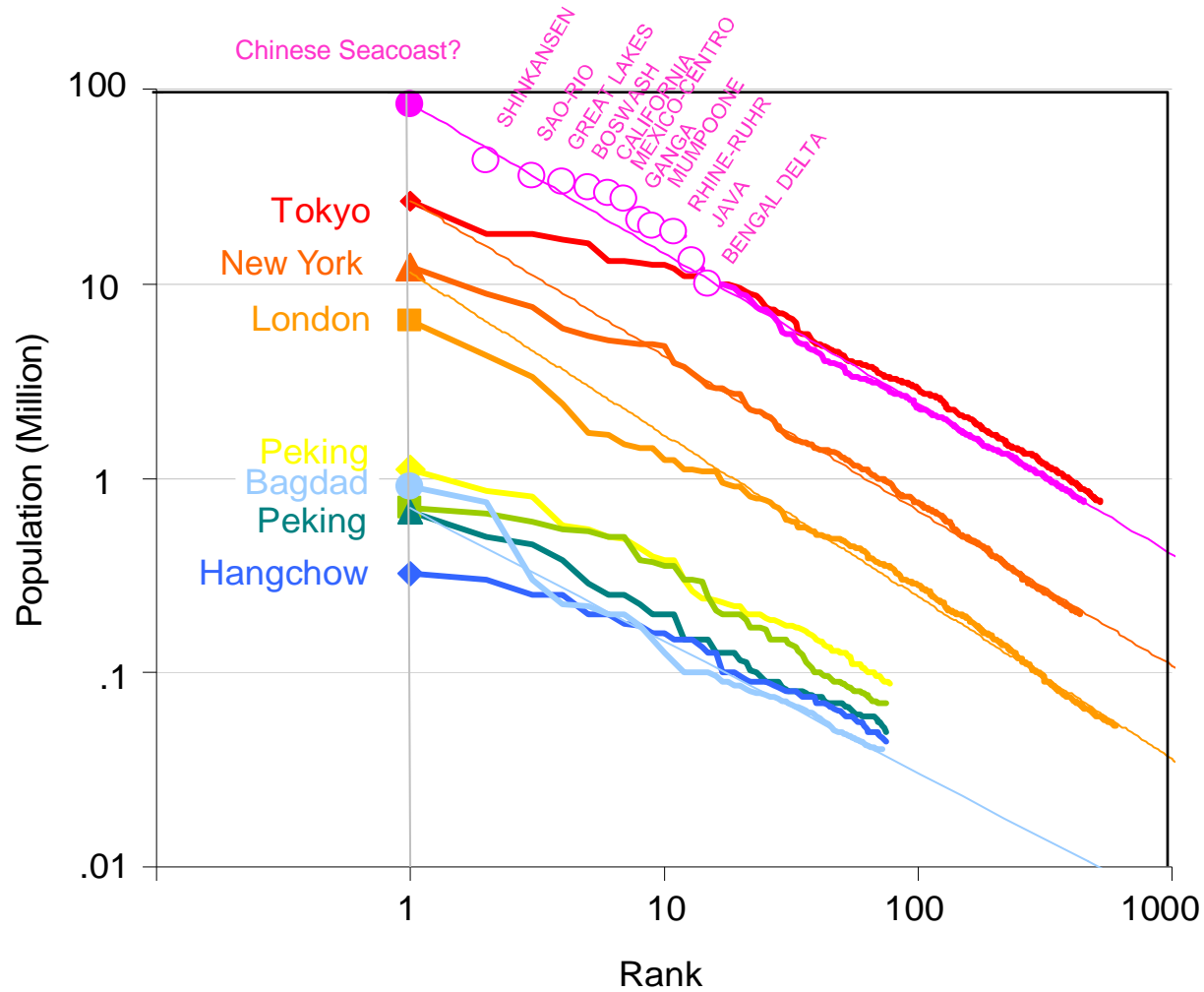
- 1000 years of city Rank-size (stability)
- Energy use of cities (RS symmetry breaking)
- Technology growth and scaling (speed & size interrelated)
- Technological complexity (longevity due to interdependence)

- Research questions:
 - drivers of stability at macro-level while maintaining diversity at micro-scales
 - role of agglomeration externalities (increasing returns)
 - response to major breaks (population decline, technology “forcing” (obsolescence, transitions))

City Hierarchies (Rank Size)

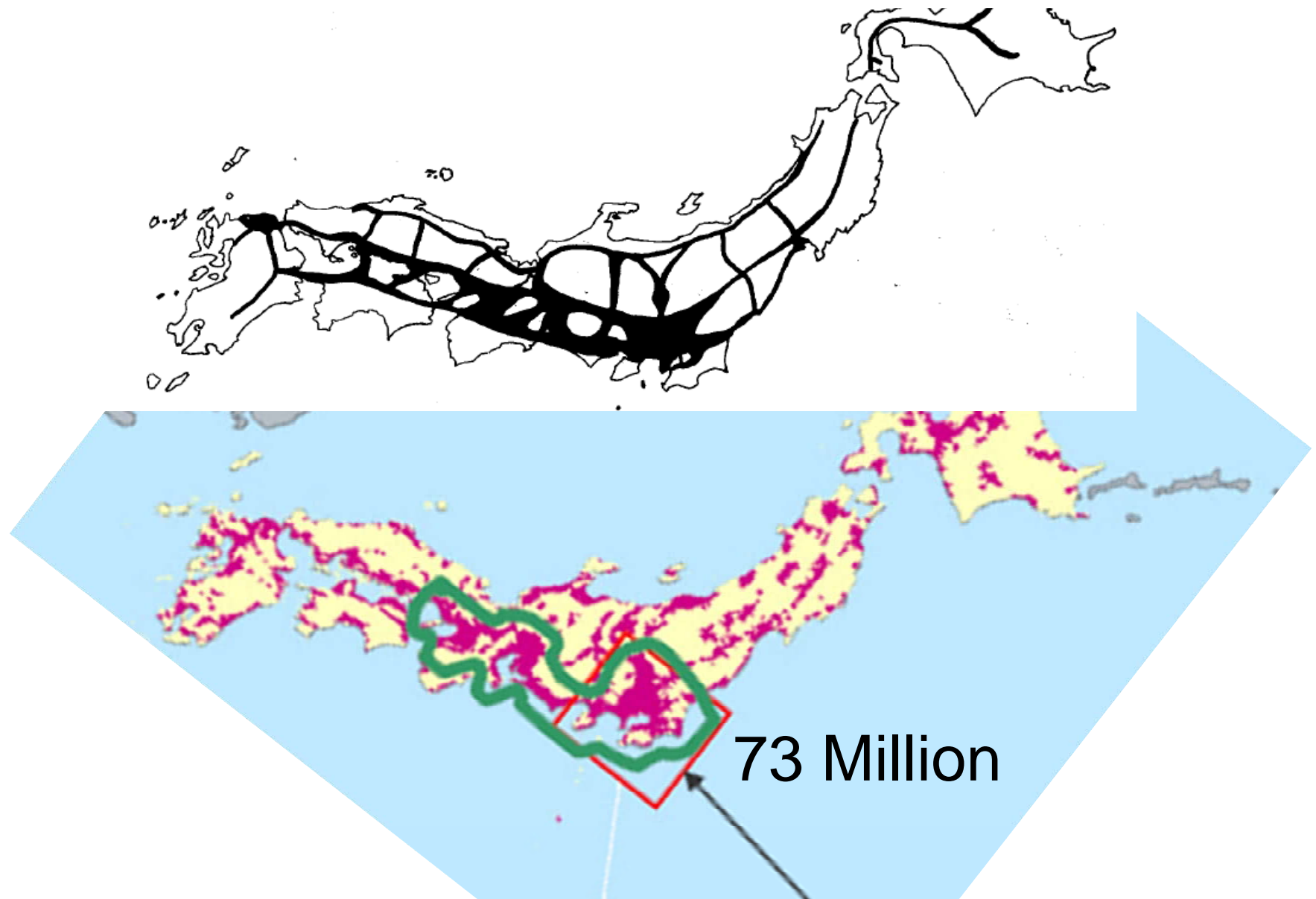


City Hierarchies (Rank Size) 900 AD to 2000 AD

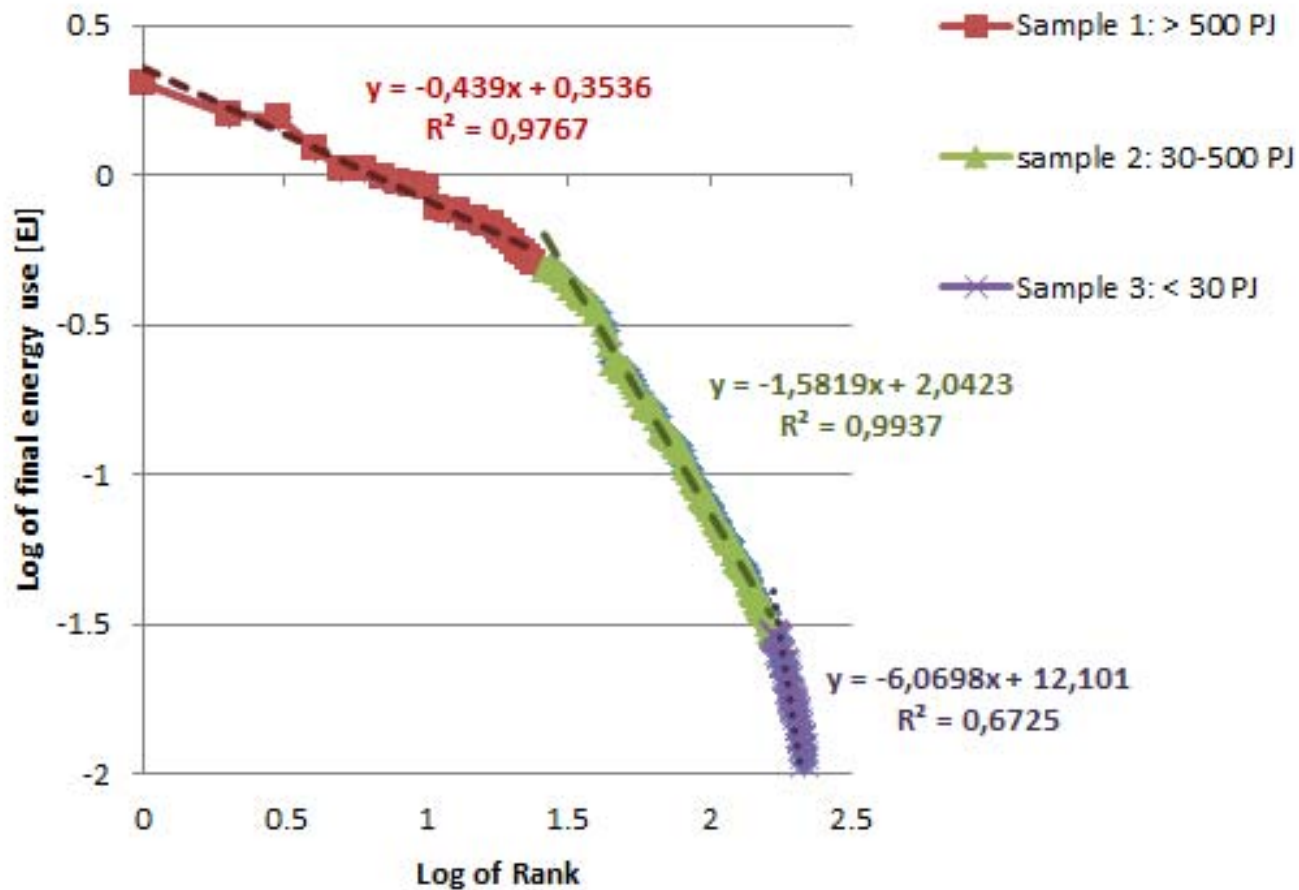


Source: GEA KM18 (in press)

Kenzo Tange 1960s View of Japan as a Megalopolis vs. Current CIESIN GRUMP Urban Area Delineation

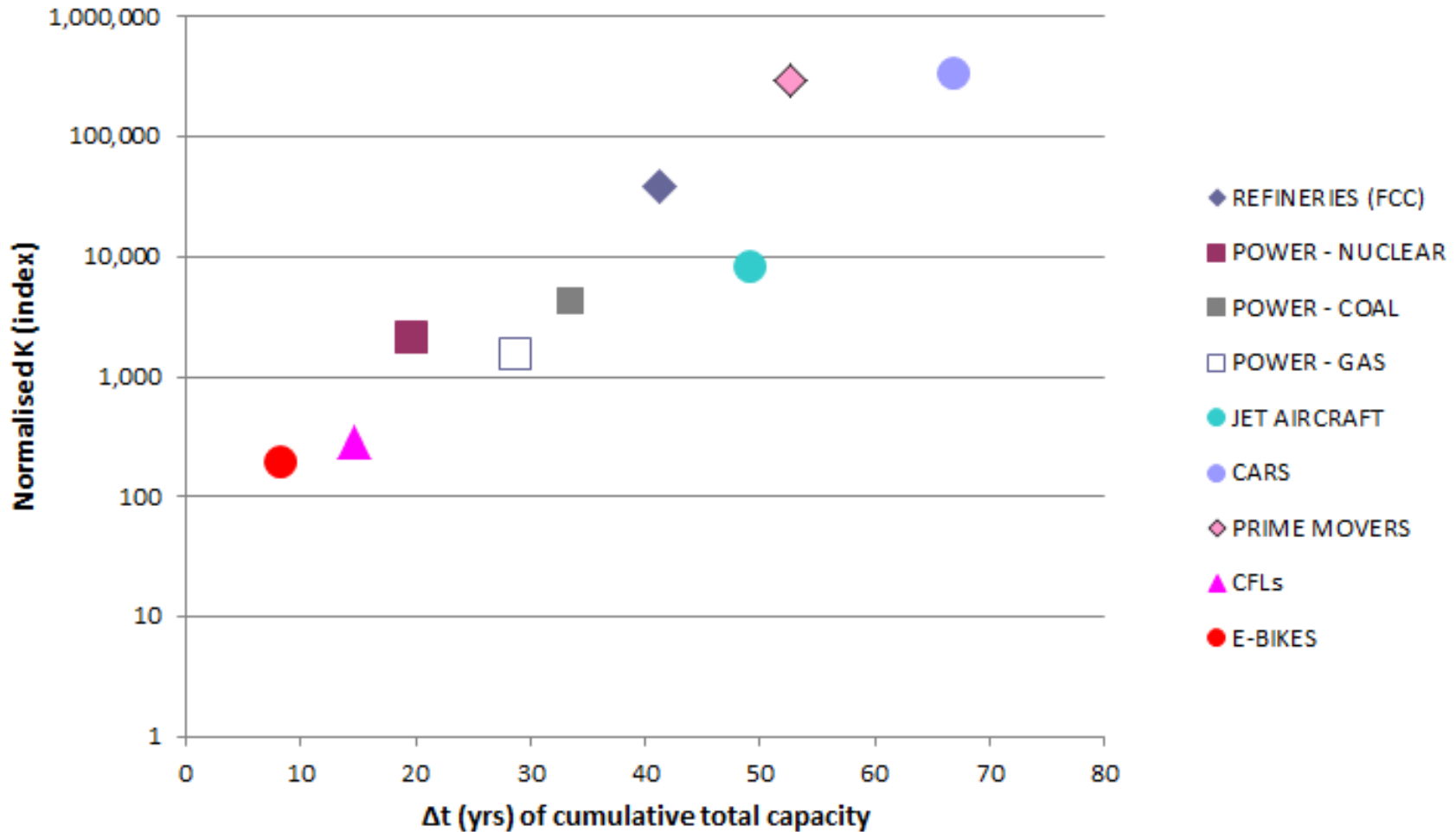


Rank-size of Urban Energy (n=230)



Source: GEA KM18 (in press)

Market Size (normalized index) vs Diffusion Speed (Δt) of Energy Technologies



Source: Charlie Wilson, 2009. E-Bikes courtesy of Nuno Bento

New CC Policy Perspectives

- Traditional CC policy framework:
 - “additionality”
 - opportunity costs (crowding out)
 - costs & benefits separated
(in space and time)
- New perspectives:
 - integration of policy frameworks
 - significant synergies possible
(if CC is used as entry point)
 - costs “malleable” in long-term

Synergies between Climate Change, Energy Security and Air Pollution Policy Objectives. McCollum/Raihi/Krey, Nature, 2011

