Industrialization in the light of climate change

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Smog in Kuala Lumpur 1997. Soaring pollution levels result as country industrializes at 8 percent annually. (AP Photo)

Industry / climate change / energy

Context

1. The paradox of industry
2. Debates around industry and development
3. Industrial capabilities and sustainability

Analysis of energy and emissions

4. Energy and Energy Transition
5. Levels of agency and inequality
6. Poverty and energy – delinked?

Conclusion

7. Climate change and industrialization / development

Paradox of industry

- Paradox: industrialization is both the cause of, and one remedy for, greenhouse gas emissions

Industrialization

- Two meanings of industry -
  - Sectoral definition: mining, manufacturing & energy sectors (not agriculture)
  - a particular way of organizing production, constant process of technical and social change which increases society's capacity to produce a wide range of goods and services.

Industrialization and development

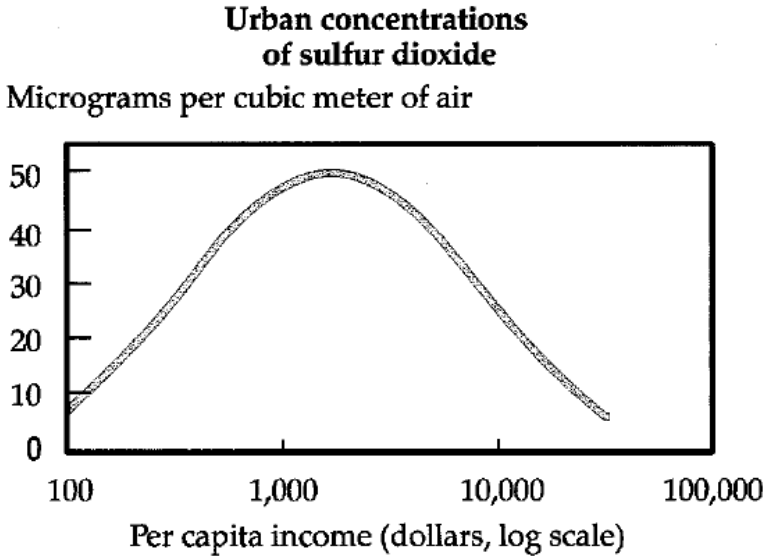
- Industrialization creates more than economic growth
  - Skills, understanding of time, education, state, collaborative processes – hence 'industrial revolution'
  - Correlation: poor / developing / Third World / low productivity = non-industrial

➔ Industrialization pre-requisite for {development}

Capacity to reduce GHG

How can industry (increased productive capabilities) relate to climate change?

- Capacity to reduce GHG emissions, decarbonize
- More energy-efficient and carbon-efficient industry
- Social movements / change lead to regulation



Some elements of environmental change follow this pattern
[World Bank: WDR 1992]

Capacity to reduce GHG II

- Regulatory capacity – democratic public action – life cycle assessment, borders of the firm, green regulations – interaction of social movements and government
- Management capacity
- Completion of investment in manufacturing and infrastructure
- Transition to services – non-material products (software, finance, video)
- How much due to trade in manufactured goods?

Environmental Performance Index (EPI)

- Two broad environmental protection objectives:
  - reducing environmental stresses on human health, and
  - promoting ecosystem vitality and sound natural resource management.

Source: http://epi.yale.edu/Contents

Environmental Performance Index– Ranking & Scores

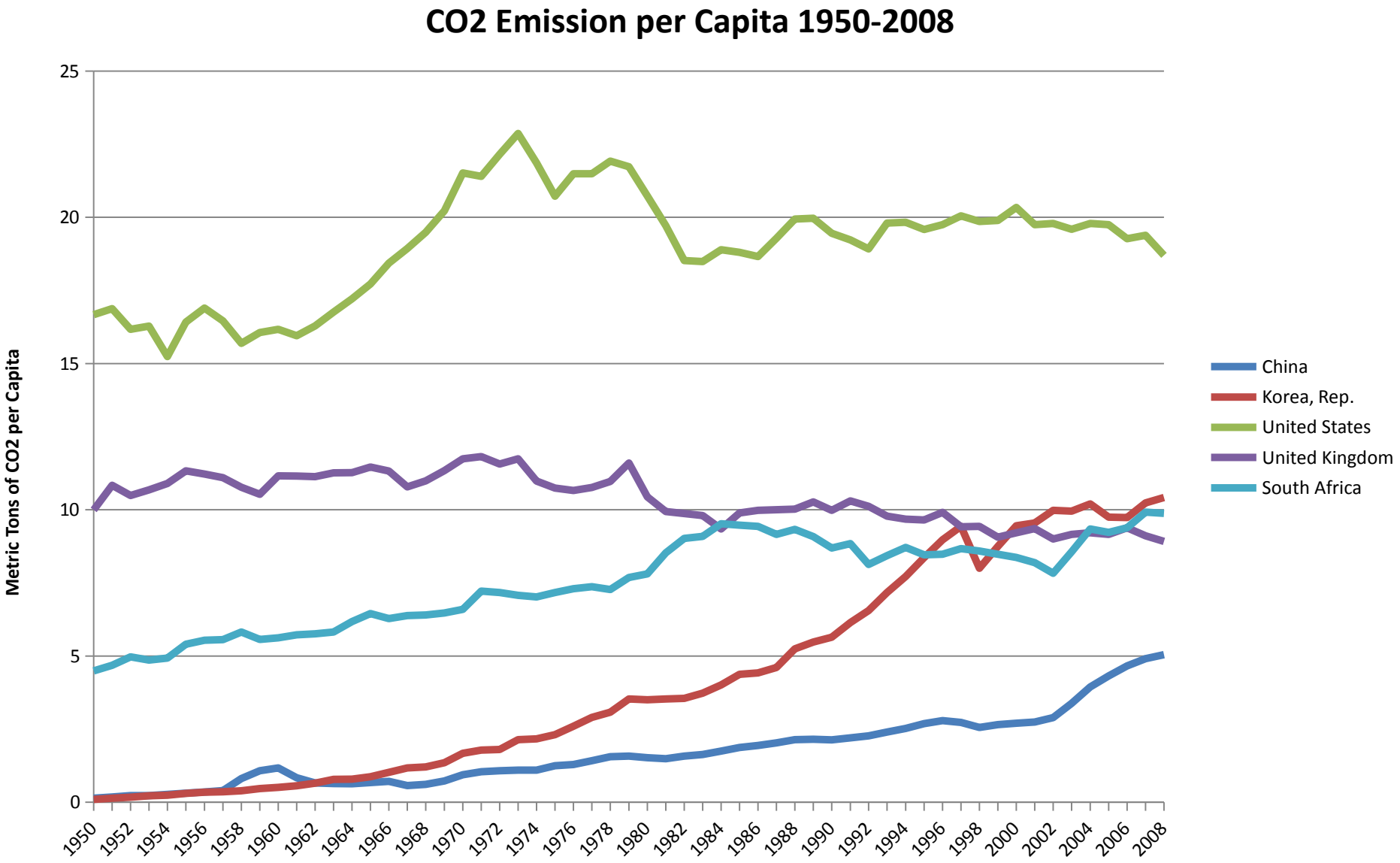
EPI Rank	Country	Trend EPI Rank
1	Switzerland	89
2	Latvia	1
3	Norway	84
4	Luxembourg	106
5	Costa Rica	113
6	France	19
7	Austria	71
8	Italy	12
9	United Kingdom	20
9	Sweden	63
11	Germany	56
12	Slovakia	7
13	Iceland	64
14	New Zealand	50
15	Albania	4
16	Netherlands	92
17	Lithuania	104
18	Czech Republic	25
19	Finland	54
20	Croatia	74
21	Denmark	45

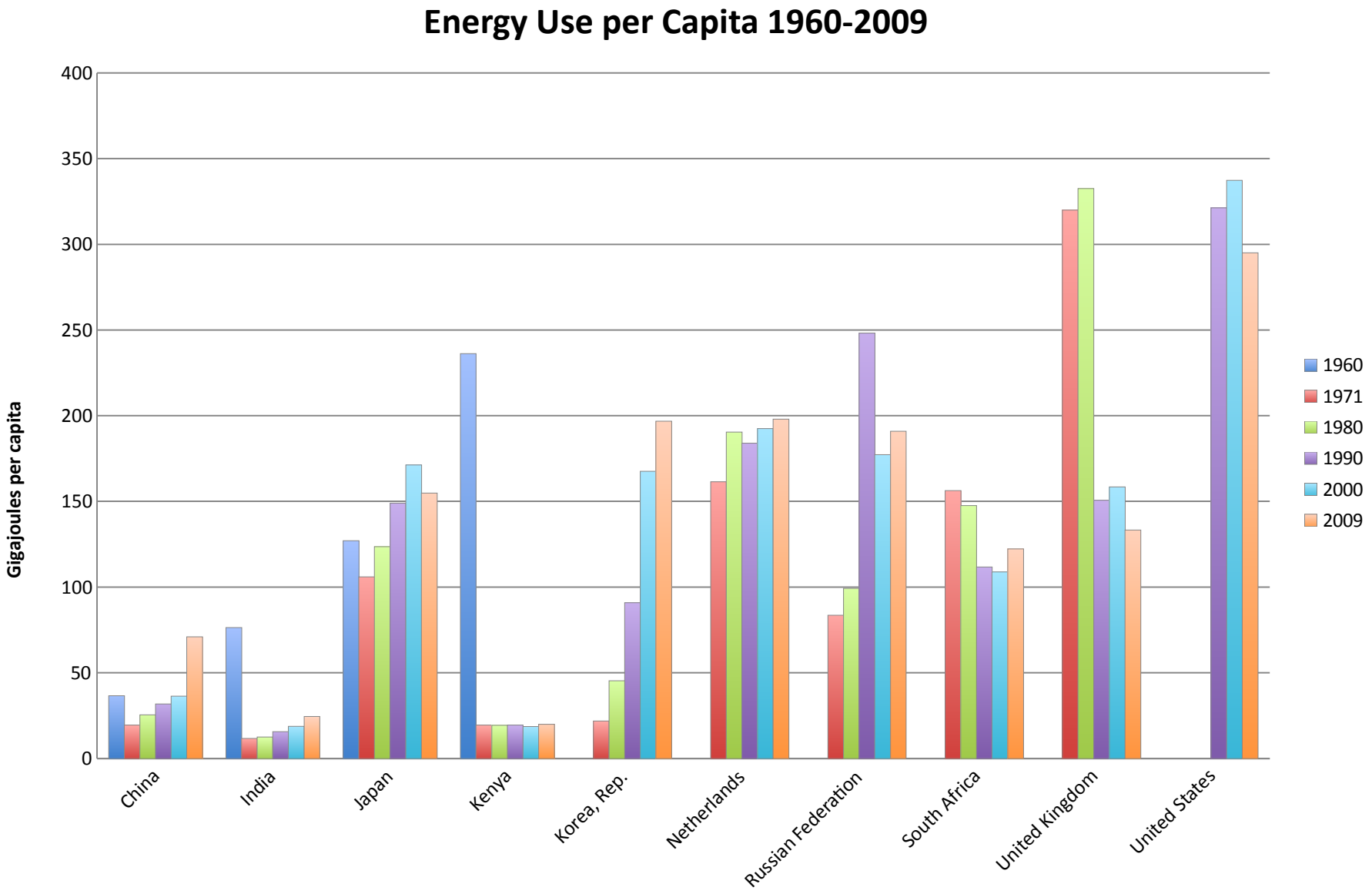
EPI Rank	Country	Trend EPI Rank
45	Hungary	18
46	Uruguay	115
47	Georgia	68
48	Australia	79
49	United States of America	77
50	Argentina	112
50	Cuba	101
52	Singapore	36
53	Bulgaria	16
54	Estonia	128
55	Sri Lanka	11
56	Venezuela	85
57	Zambia	48
58	Chile	117
59	Cambodia	44
60	Egypt	5
61	Israel	78
62	Bolivia	122
63	Jamaica	53
64	Tanzania	93
65	Belarus	40

EPI Rank	Country	Trend EPI Rank
89	Mozambique	102
90	Angola	6
91	Ghana	28
92	Dem. Rep. Congo	83
93	Armenia	49
94	Lebanon	91
95	Congo	99
96	Trinidad & Tobago	114
97	Macedonia	75
98	Senegal	39
99	Tunisia	40
100	Qatar	121
101	Kyrgyzstan	127
102	Ukraine	82
103	Serbia	109
104	Sudan	94
105	Morocco	37
106	Russia	132
107	Mongolia	54
108	Moldova	67
109	Turkey	17

Analysis of energy and emissions

4. Energy and Energy Transition
5. Levels of agency and inequality
6. Poverty and energy – delinked


CO2 Emission per Capita 1950-2008
Metric Tons of CO2 per Capita
25
20
15
10
5
0
1950
1952
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
China
Korea, Rep.
United States
United Kingdom
South Africa


Energy Use per Capita 1960-2009
Gigajoules per capita
400
350
300
250
200
150
100
50
0
China
India
Japan
Kenya
Korea, Rep.
Netherlands
Russian Federation
South Africa
United Kingdom
United States
1960
1971
1980
1990
2000
2009

Energy transition hypothesis

- Energy transition – comparable to demographic transition (mortality decline followed by fertility decline)
- Energy transition hypothesis –
  1. Changes in supply (biomass – fossil fuel - ?)
  2. Structural shifts in share of commercial fuels
  3. Structural shifts in consumer use and sectoral distribution
  4. Changes in energy density / quality / productivity
- with industrialization, industrial energy use declines as proportion of total, residential and transport use become dominant

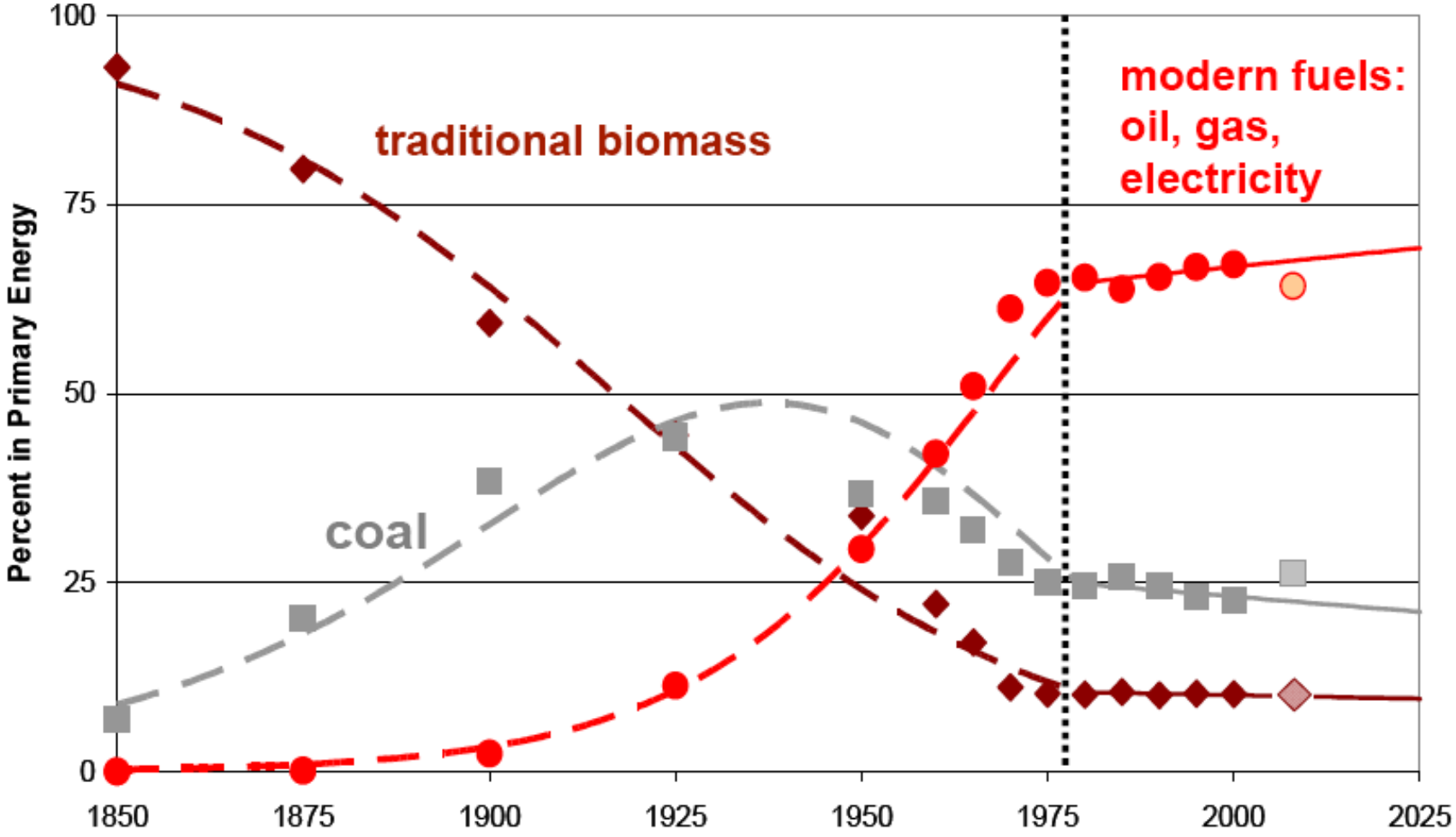
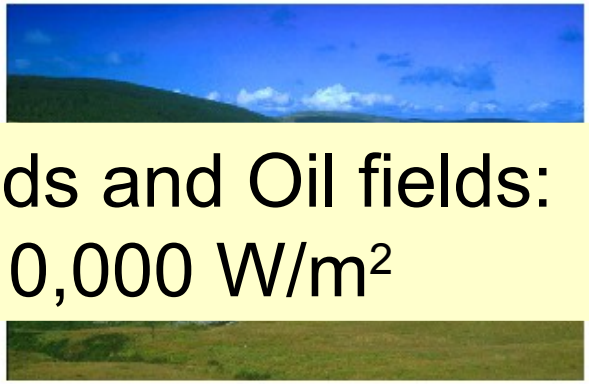


Figure 3. Two Grand Transitions in Global Energy Systems (1850-2008). Data from: (Grubler 2008) updated for 2008 (light shaded symobls) using (BP 2010; IEA 2010). Data prior to 1950 are estimates.

All renewables are diffuse

Power per unit land area	
Wind	2.5 W/m^2
Plants	0.5 W/m^2
Solar PV panels	5–20 W/m^2
Tidal pools	3 W/m^2
Tidal stream	8 W/m^2
Rain-water (highlands)	0.24 W/m^2
Concentrating solar power (desert)	15–20 W/m^2



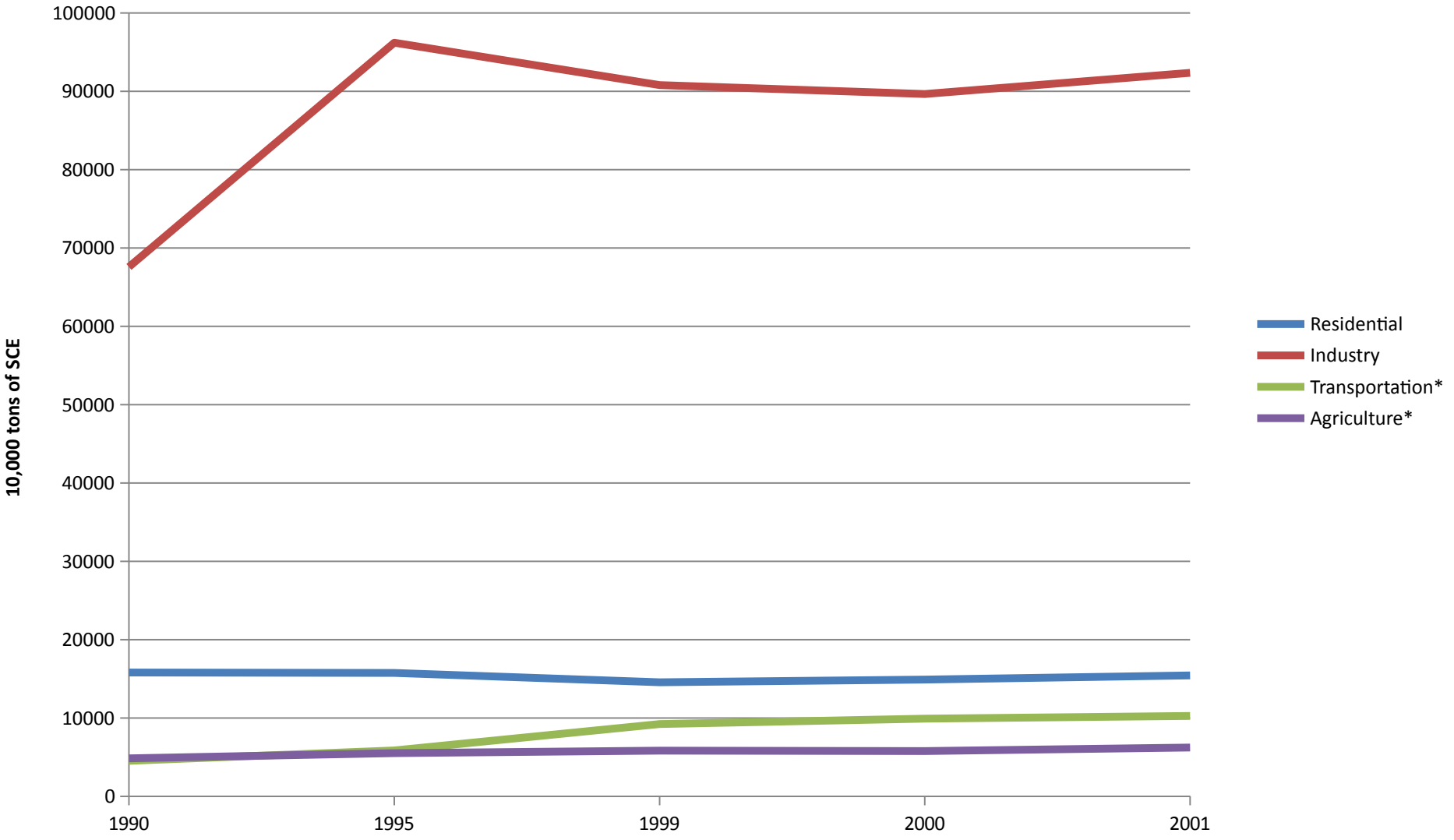
Nant-y-Moch by Dave Newbould
www.origins-photography.co.uk

Coal fields and Oil fields:
~ 500- 10,000 W/m^2

- To make a difference, renewable facilities have to be country-sized

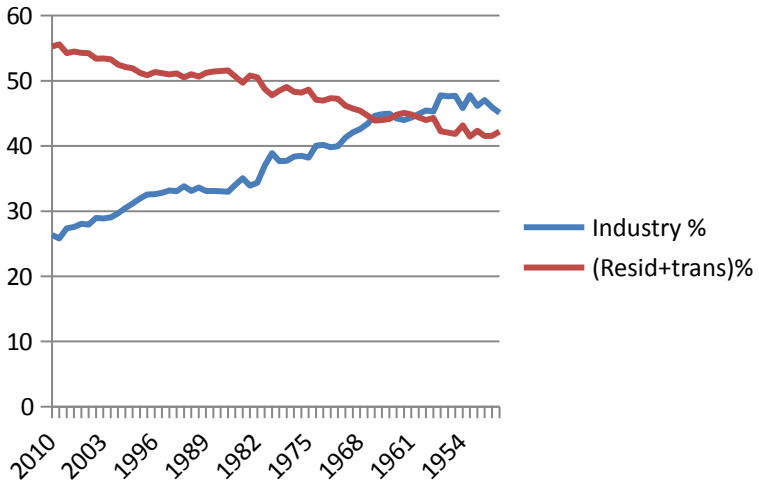
David MacKay, Sustainable Energy –Without the Hot Air

Chinese Energy Use By Sector 1990-2001



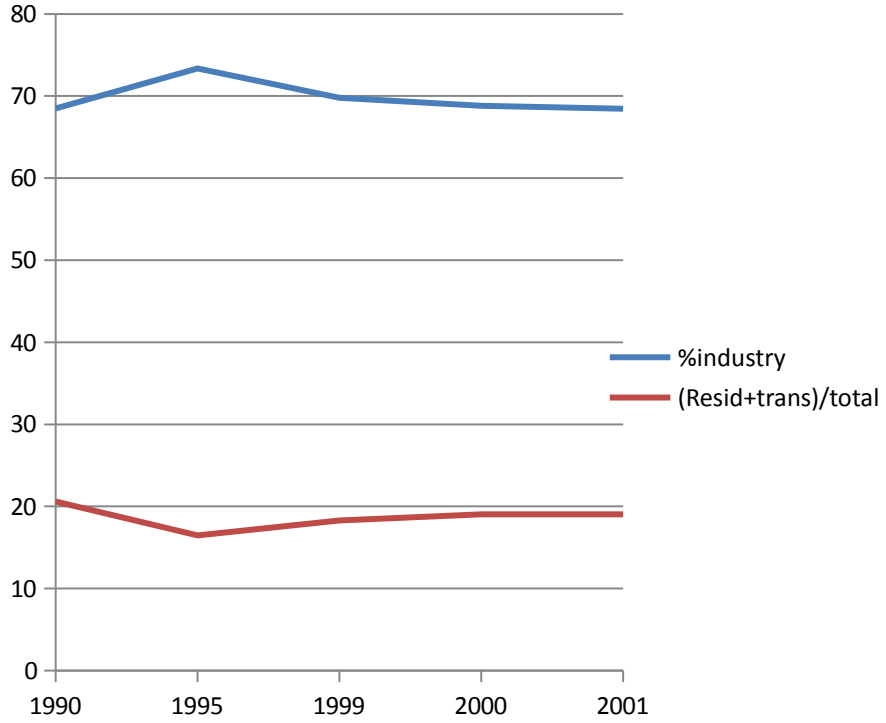
China Statistical Yearbook. 2003. National Bureau of Statistics of China Energy consumption pp. 266
*Transportation includes transport, Storage, Post, and telecommunications
*Agriculture includes farming, forestry, animal husbandry, fishing

China and US compared



US Carbon emissions by sector

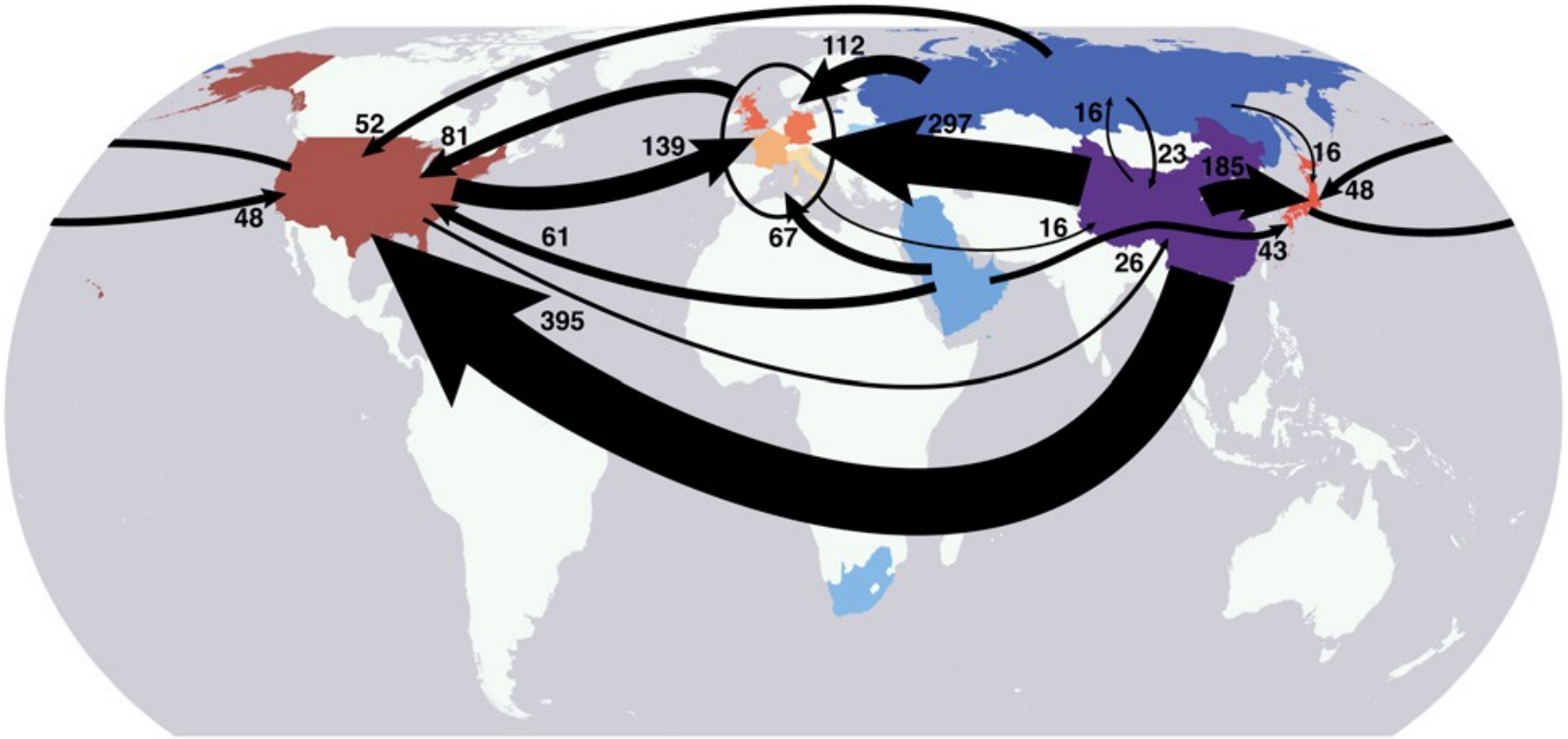
China energy consumption by sector



Sectoral dimension of transition

- Shift in sectoral use of energy from industrial dominance in industrializing to residential / transport dominance in industrialized because:
  - Industrializing economies: Industrial energy use high during industrialization – investment in manufacturing growth, infrastructure (roads, airports, communications)
  - Mature industrialized economies – rise of services (production of non-material goods like finance, software, education…); greater efficiency in manufacturing
  - And, what else…?

Emissions embodied in trade



Emissions implied by trade - Mt CO2 / yr
Exporting countries (blue) to dominant net importing countries (red).

[Davis and Caldeira 2010]

Energy transition implications

- China ‘transformation paradox’ – emissions high because of transition (industrial growth), and exports of manufactures to industrialized / advanced countries – emissions will reduce after transition
- Changing focus of energy production – with energy transition, emissions arise from residence/transport
- Changing modality from government agencies / corporations to rich individuals
- Sociotechnical transition – each of these end uses have different sets of dynamics.

Energy sources to final services

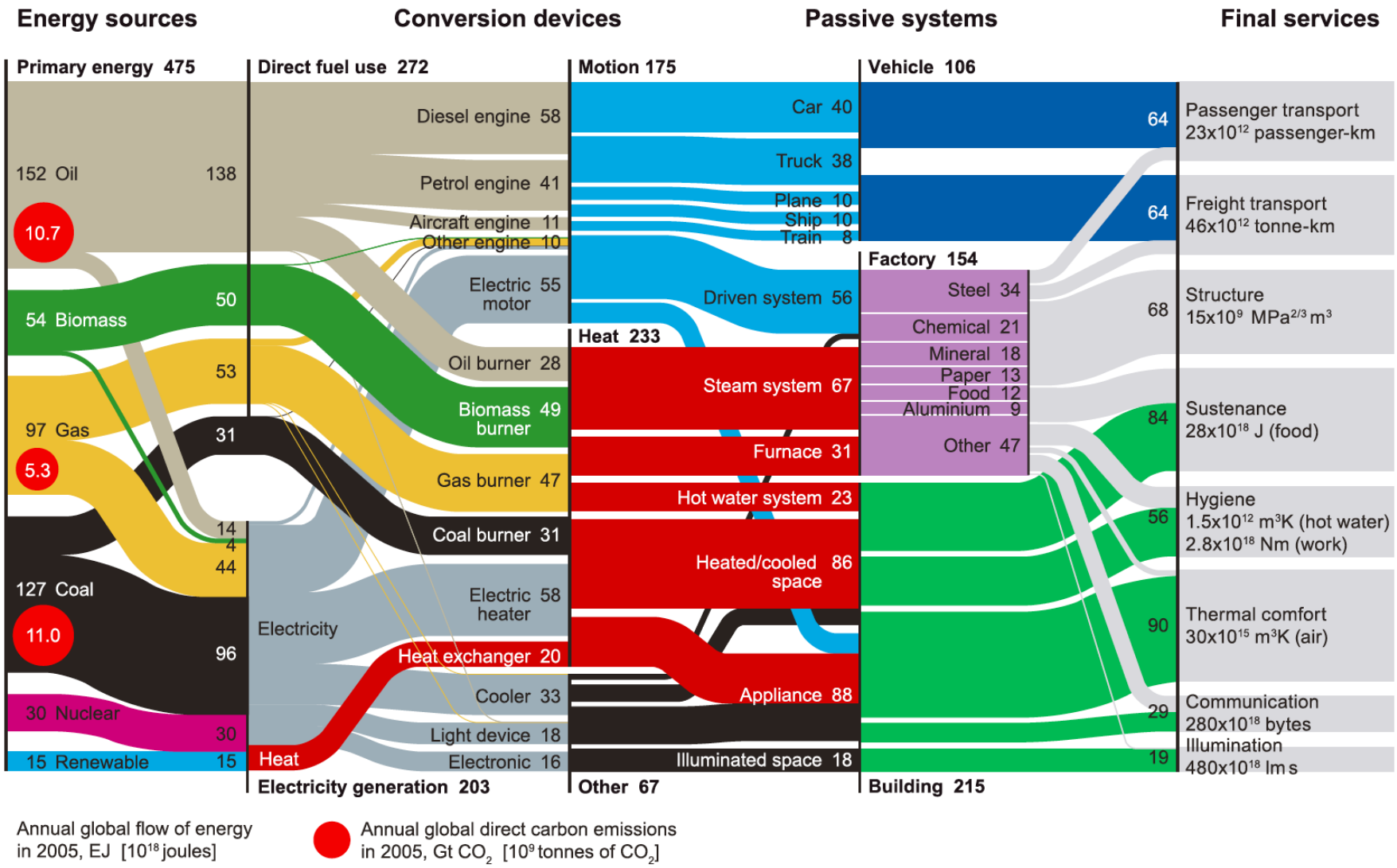
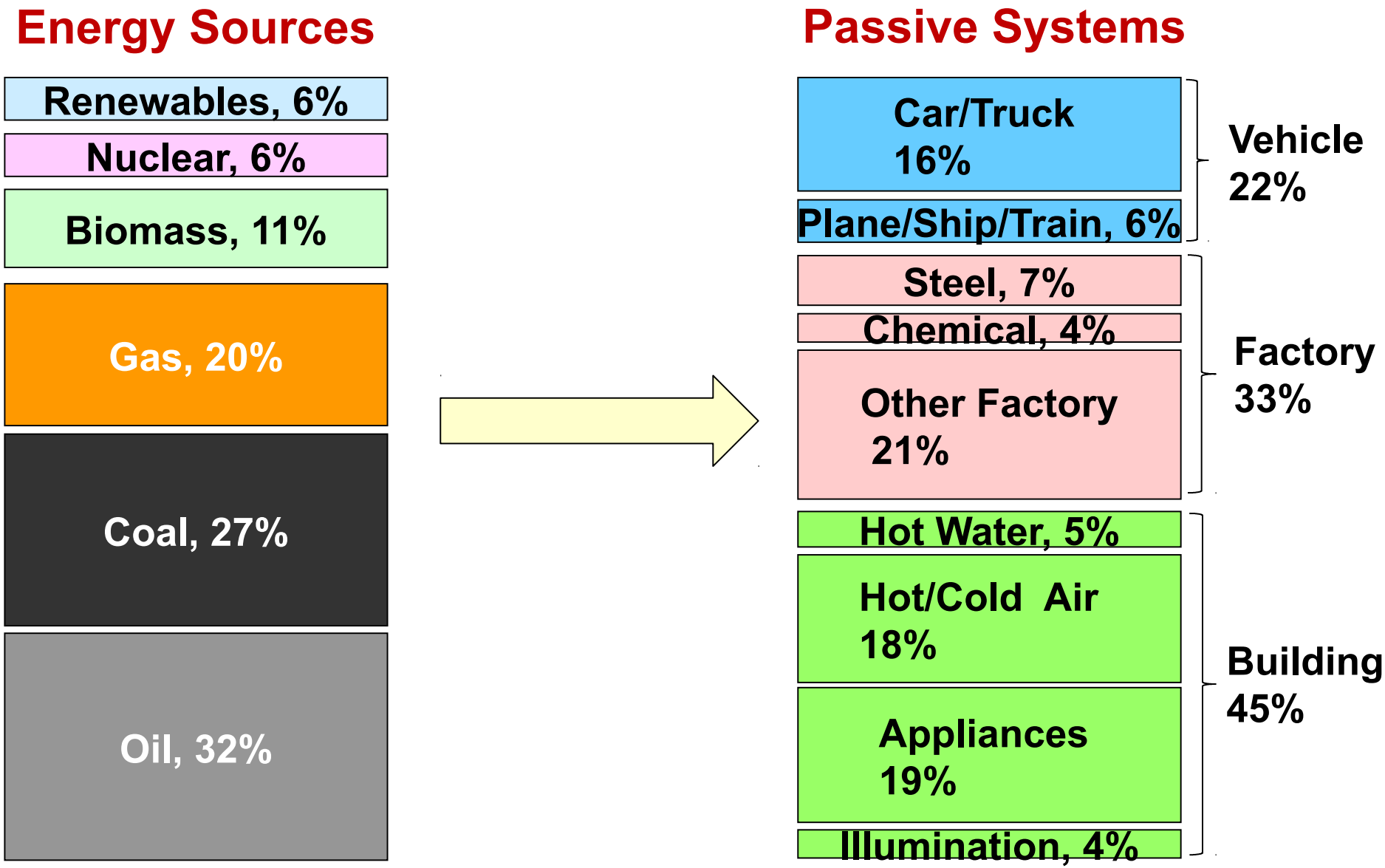


Fig. 2. From fuel to service: tracing the global flow of energy through society.

Cullen and Allwood 2010

World Energy Use in 2005 (15TW)



Adapted from Cullen and Allwood, *Energy*, 2010

Energy sources to final services

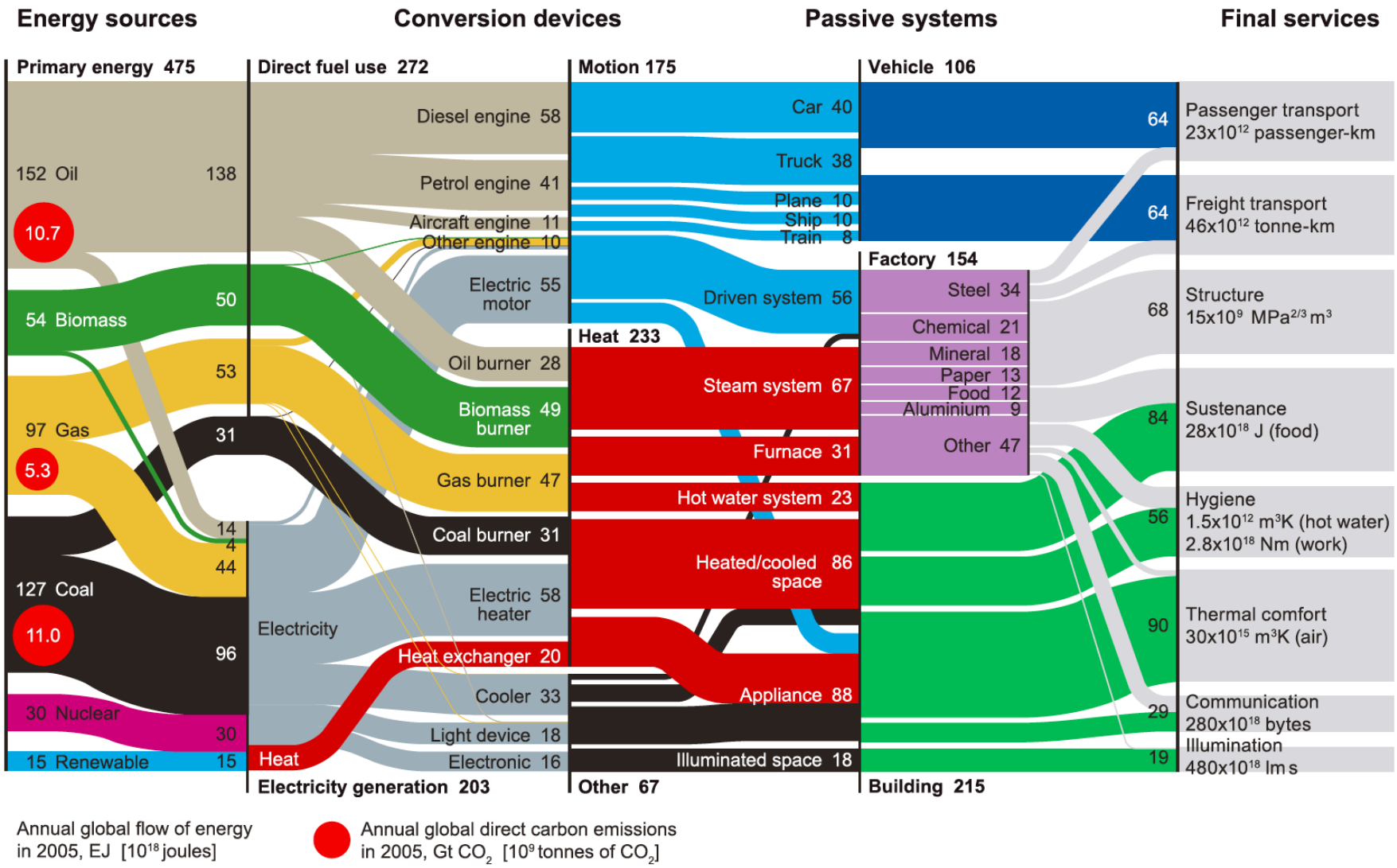
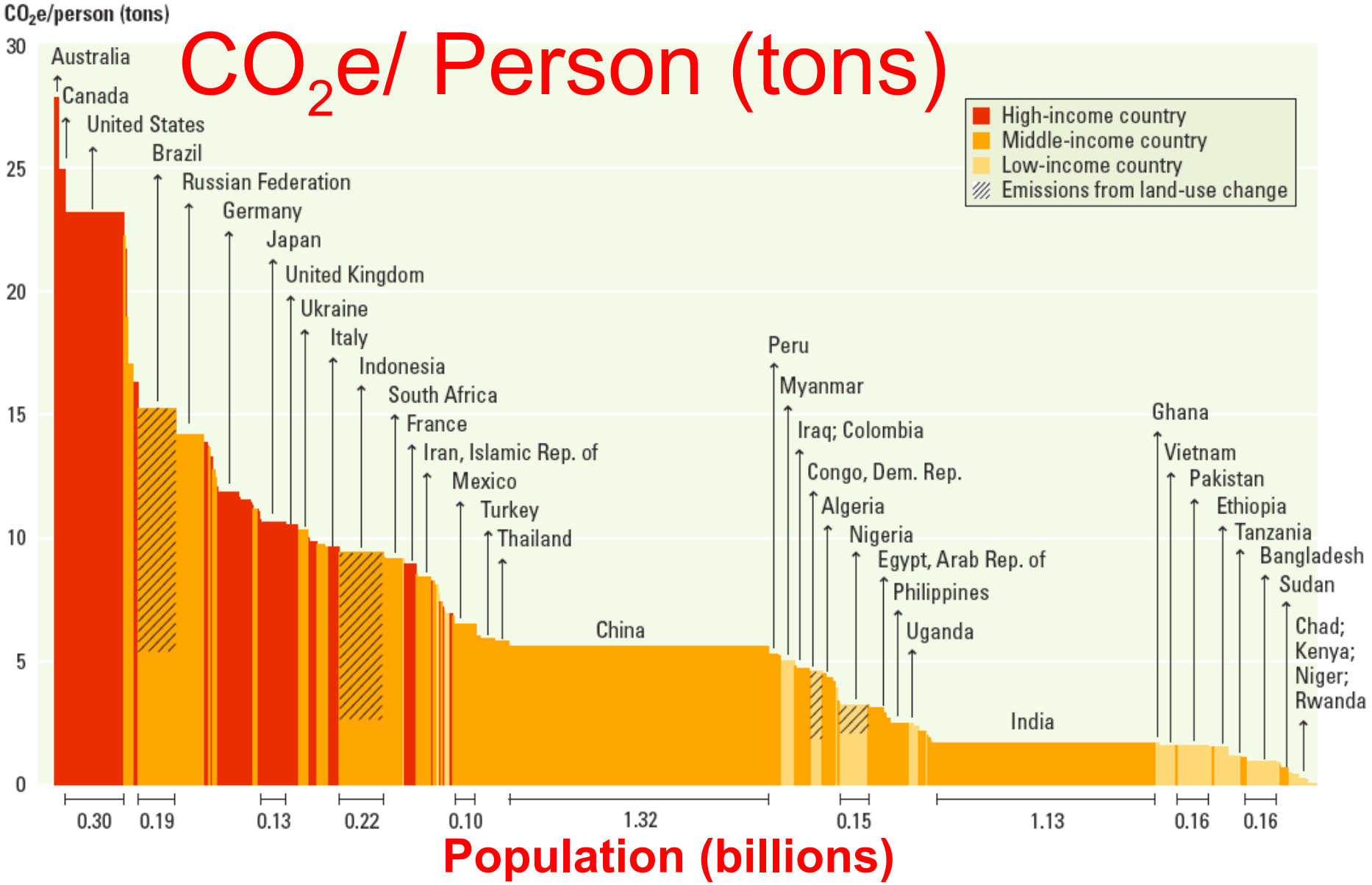


Fig. 2. From fuel to service: tracing the global flow of energy through society.

Cullen and Allwood 2010

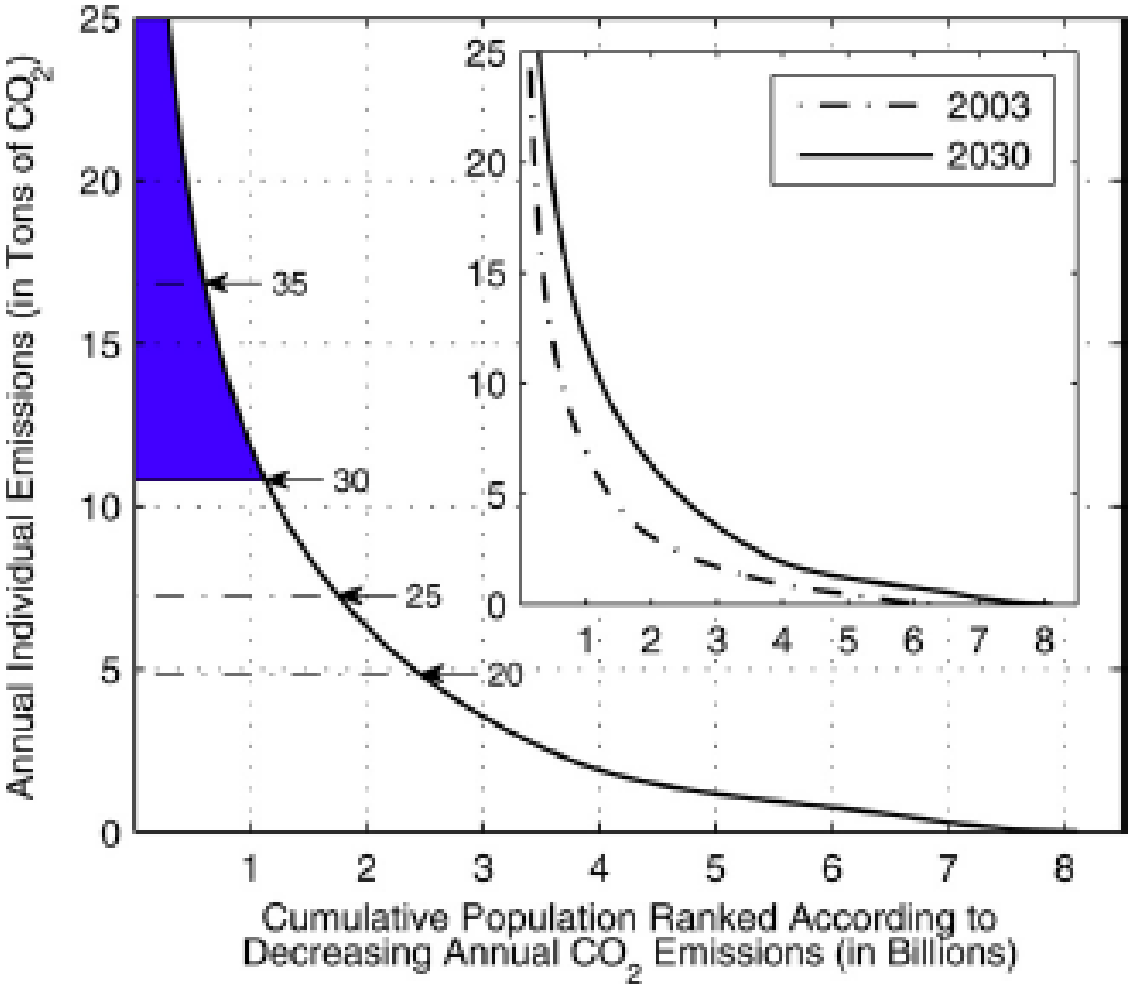
Figure 1.1 Individuals' emissions in high-income countries overwhelm those in developing countries



Sources: Emissions of greenhouse gases in 2005 from WRI 2008, augmented with land-use change emissions from Houghton 2009; population from World Bank 2009c.

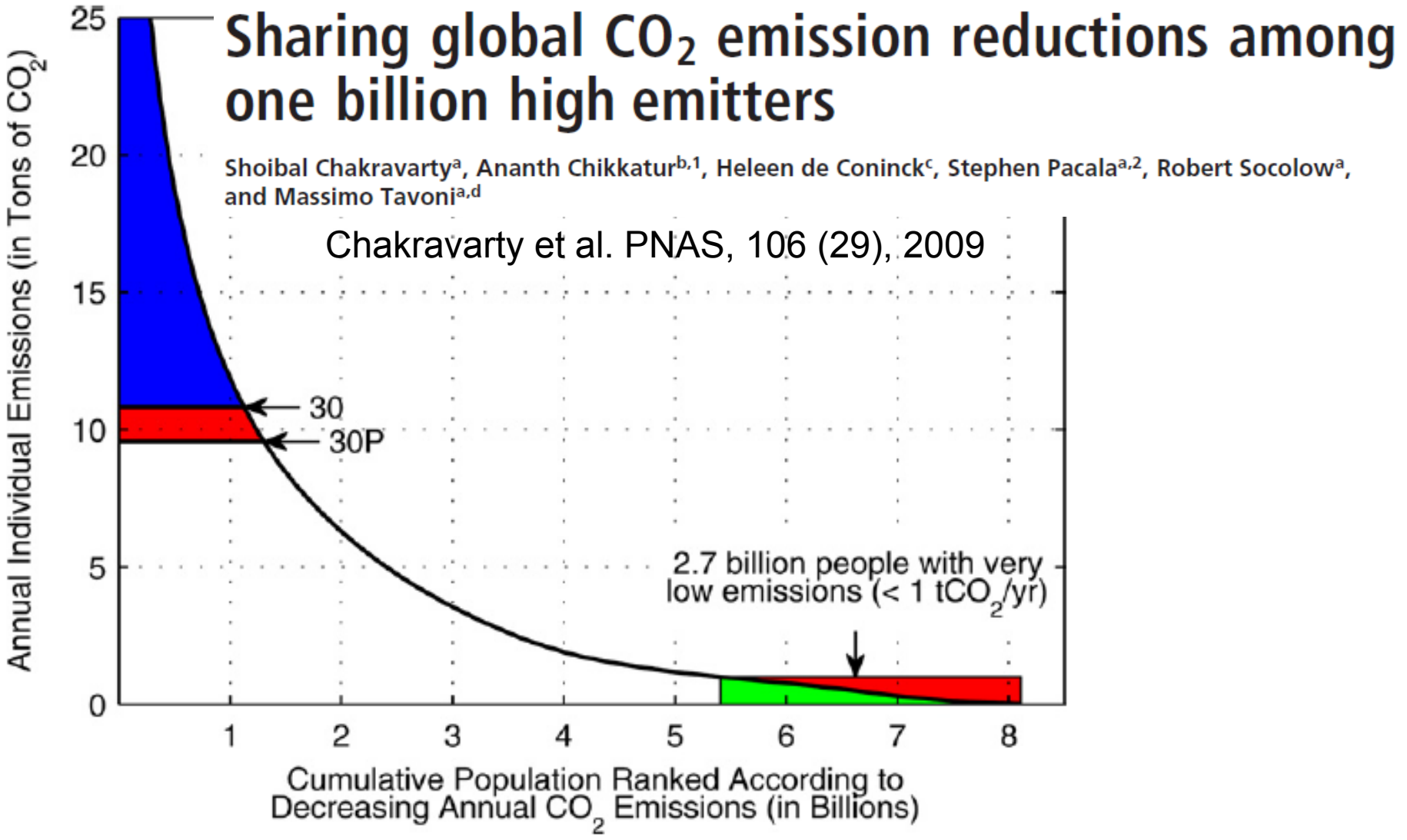
Note: The width of each column depicts population and the height depicts per capita emissions, so the area represents total emissions. Per capita emissions of Qatar (55.5 tons of carbon dioxide equivalent per capita), UAE (38.8), and Bahrain (25.4)—greater than the height of the y-axis—are not shown. Among the larger countries, Brazil, Indonesia, the Democratic Republic of Congo, and Nigeria have low energy-related emissions but significant emissions from land-use change; therefore, the share from land-use change is indicated by the hatching.

Carbon emissions – individual not national



(Chakravarty et al 2009)

Global emissions – and energy justice (2030)



Cheap gas – Romney and Obama

- Pielke's 'iron law' of climate policy
  - 'When policies focused on economic growth confront policies focused on emissions reductions, it is economic growth that will win out every time' (Pielke 2010: 46)
- Political sensitivity of gas prices, particularly in the US – need other ways than price to influence consumption (path dependence – European high energy prices).

Climate change / industrialization / development

- Agency of emissions reduction changes
  - from states to particular sources (disaggregate by income)
  - From individuals to meso-levels (Sankey diagram)
  - Situate climate change in relation to other objectives (iron law)
  - Centrality of transition in understanding emissions reductions and the role of industrializing economies
- Emerging economies (India, China, Africa) need energy to industrialize