



FINANCIAL
TIMES

**Living with limits: growth, resources
and climate change** **Martin Wolf,**
Associate Editor & Chief Economics
Commentator, *Financial Times*

Grantham Institute for Climate Change Annual Lecture 2011

3rd November 2011

Imperial College of Science and Technology, London

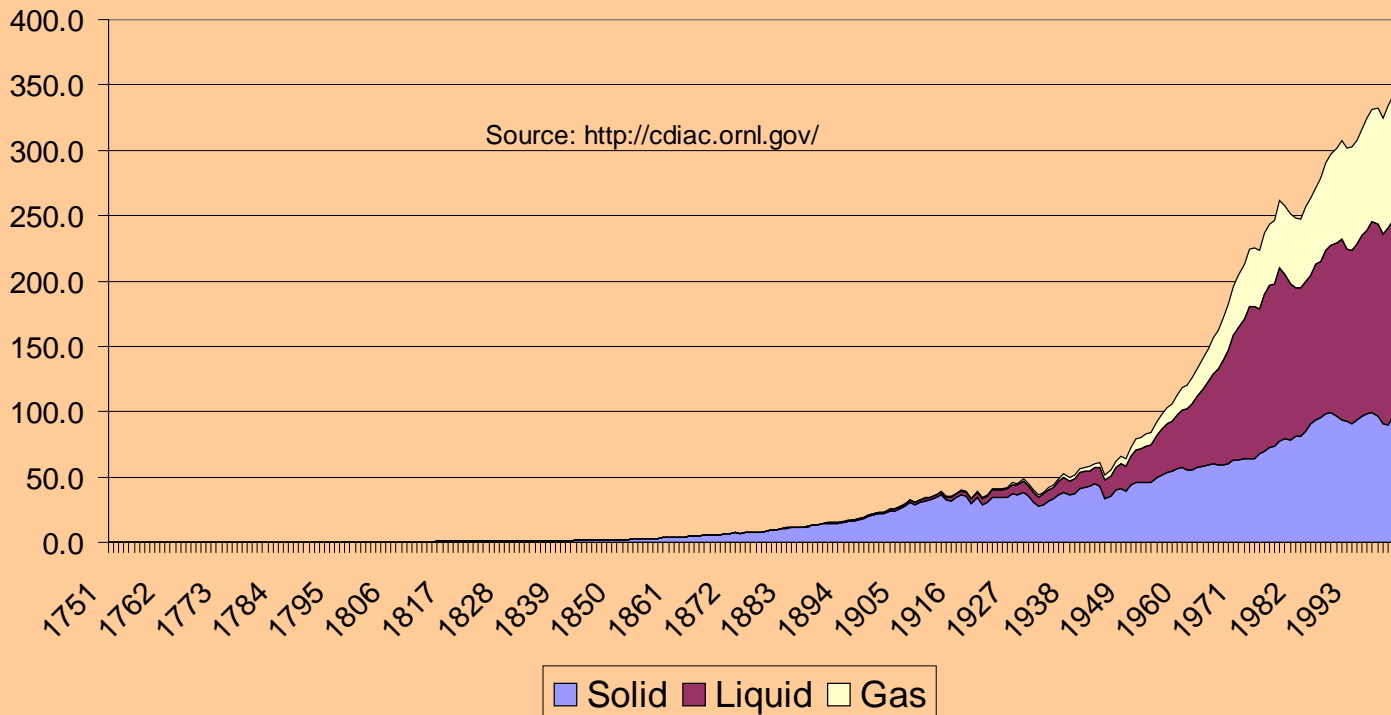
Living with limits

- From “great divergence to “great convergence”
- Affluence and the demand for resources
- The biggest collective action challenge in history
- Irresistible forces meets immoveable objects
- Nightfall for a civilisation?
- Conclusion

1. From “great divergence to “convergence”

THE ENERGY REVOLUTION

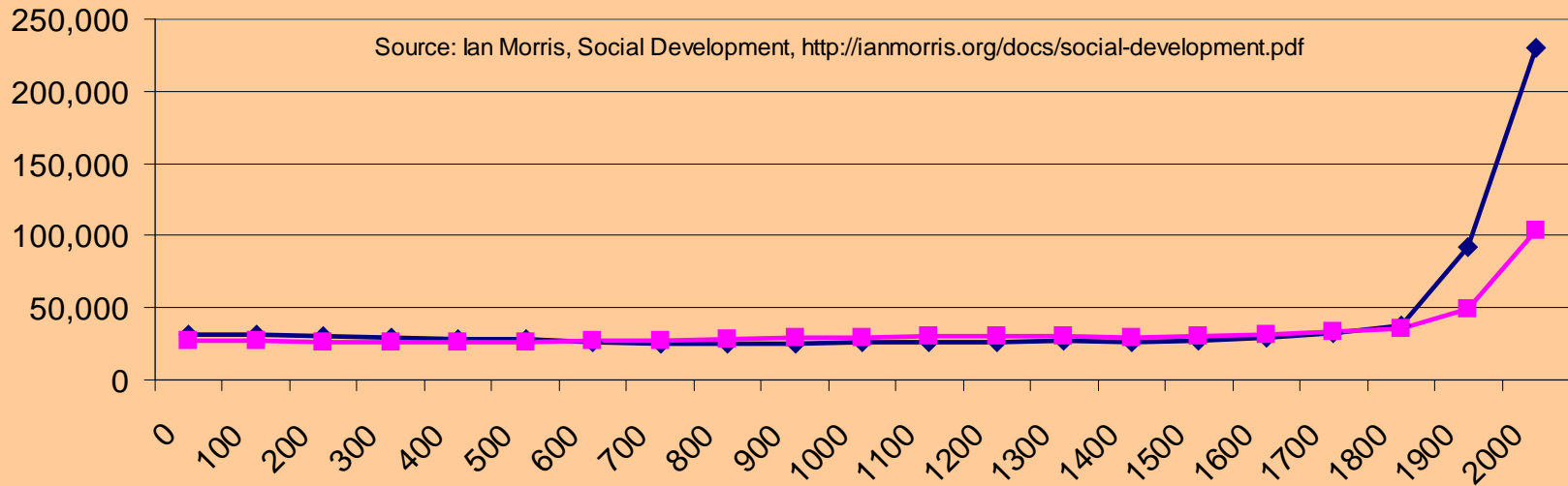
**Chart 1: GLOBAL ENERGY OUTPUT FROM FOSSIL FUELS
(exajoules)**



1. From “great divergence to “convergence”

ARRIVAL OF AFFLUENCE

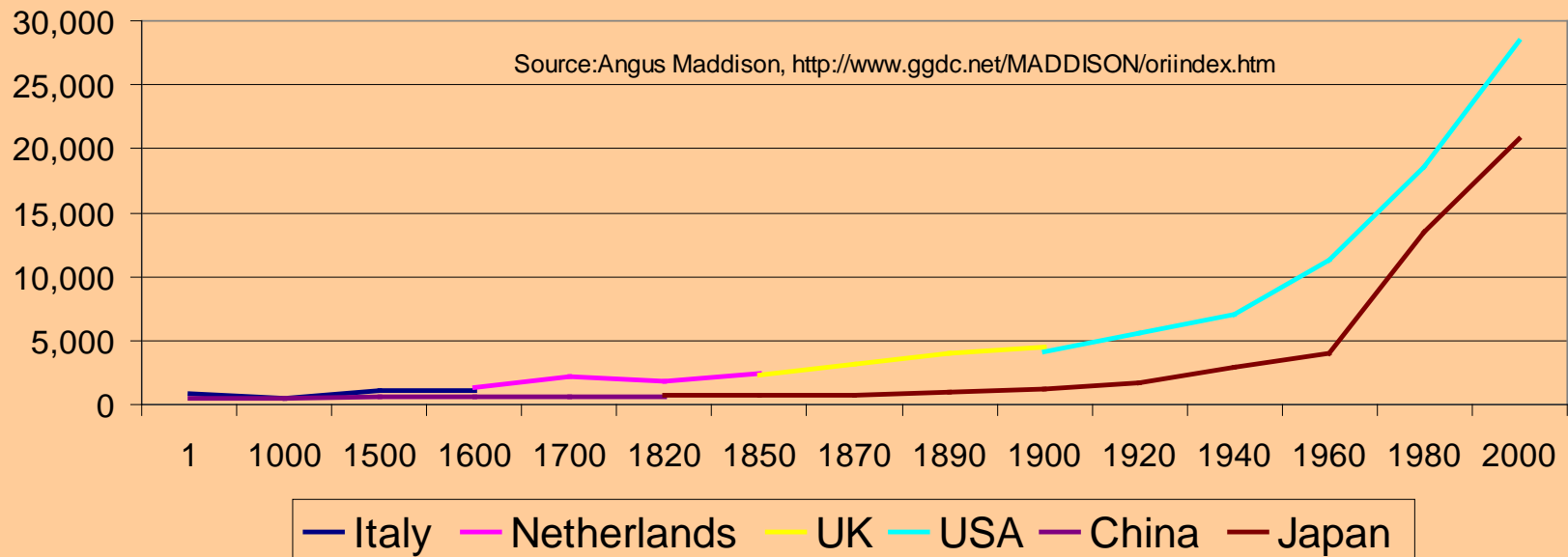
**Chart 2: ENERGY CAPTURE IN THE MOST ADVANCED WESTERN AND EASTERN ECONOMIES
(kilocalories per head)**



1. From “great divergence to “convergence”

THE TRANSFORMATION

Chart 3: GDP PER HEAD OF RICHEST WESTERN AND EASTERN COUNTRIES (1990 PPP \$s)

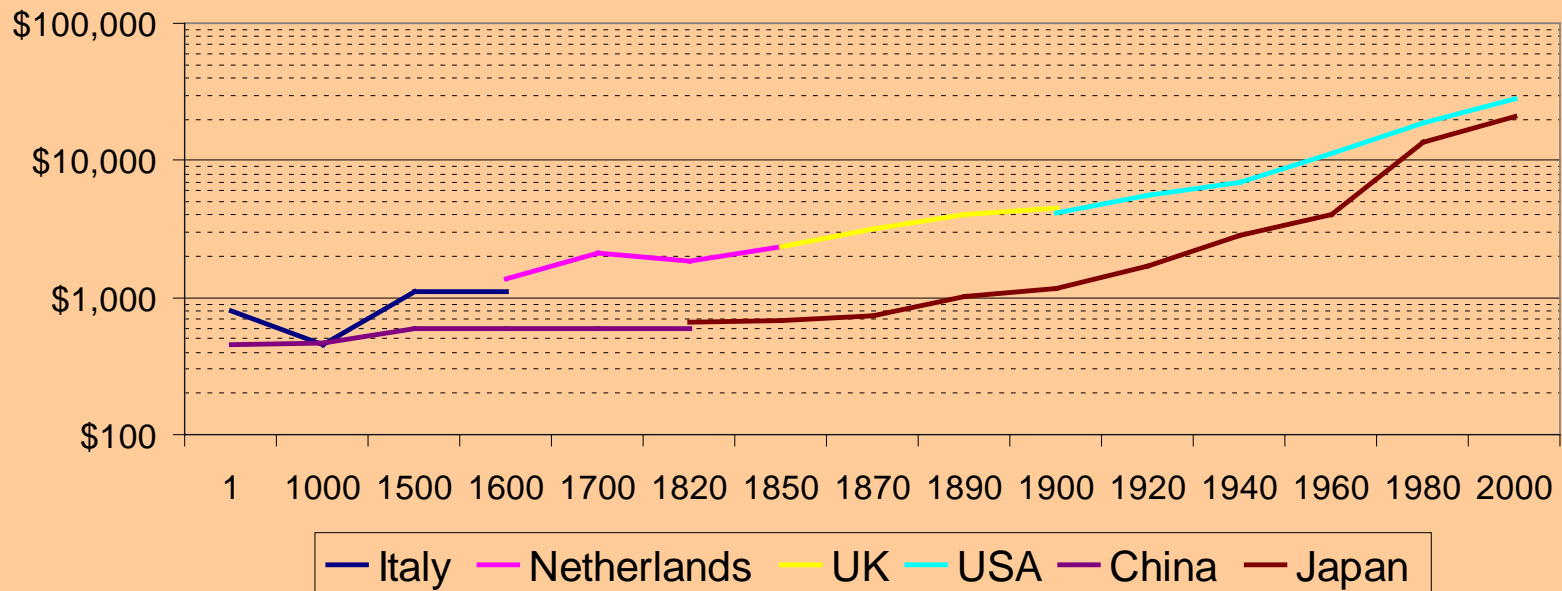


1. From “great divergence to “convergence”

THE TRANSFORMATION

Chart 4: GDP PER HEAD OF RICHEST WESTERN AND EASTERN COUNTRIES (1990 PPP \$s)

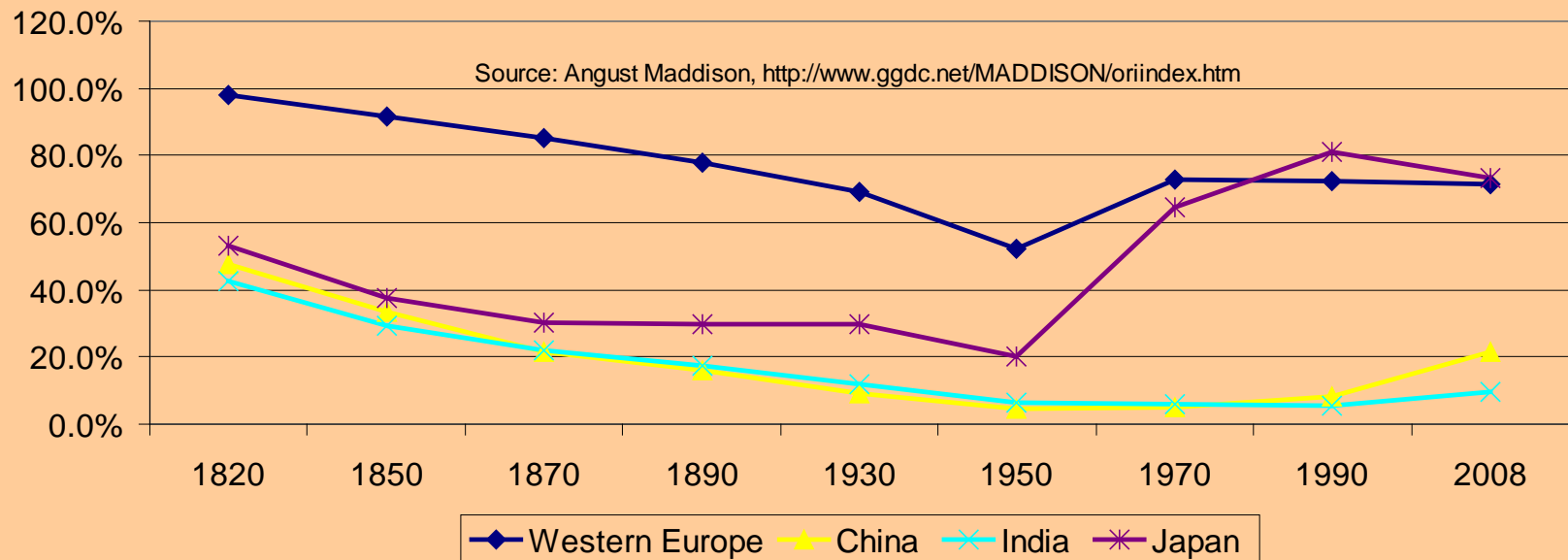
Source: Angus Maddison, <http://www.ggd.net/MADDISON/oriindex.htm>



1. From “great divergence to “convergence”

THE DECLINE AND RISE OF THE EAST

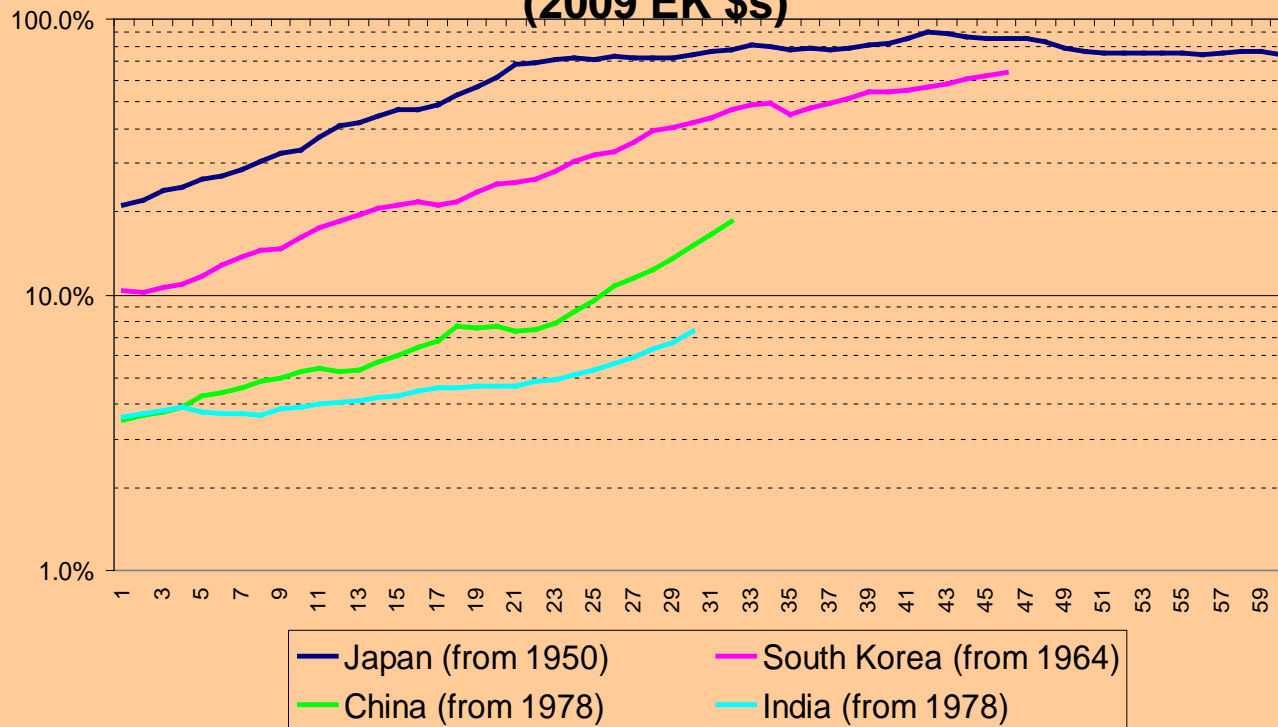
**Chart 5: GDP PER HEAD RELATIVE TO THE US
(1990 PPP \$s)**



1. From “great divergence to “convergence”

PATTERNS OF CATCH-UP GROWTH

**Chart 6: GDP PER HEAD RELATIVE TO US
(2009 EK \$s)**

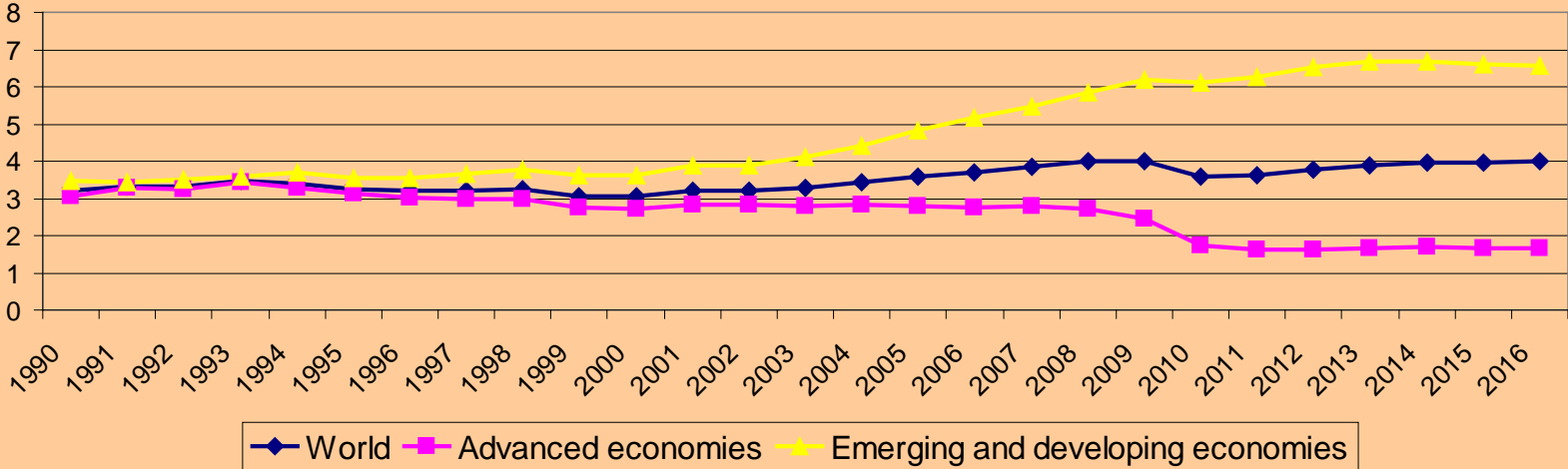


2. Affluence and the demand for resources

EMERGING COUNTRIES OUTPERFORM HUGELY

**Chart 7: GDP GROWTH RATE IN THE WORLD ECONOMY
(10-year moving average, end year)**

Source: IMF WEO, September 2011

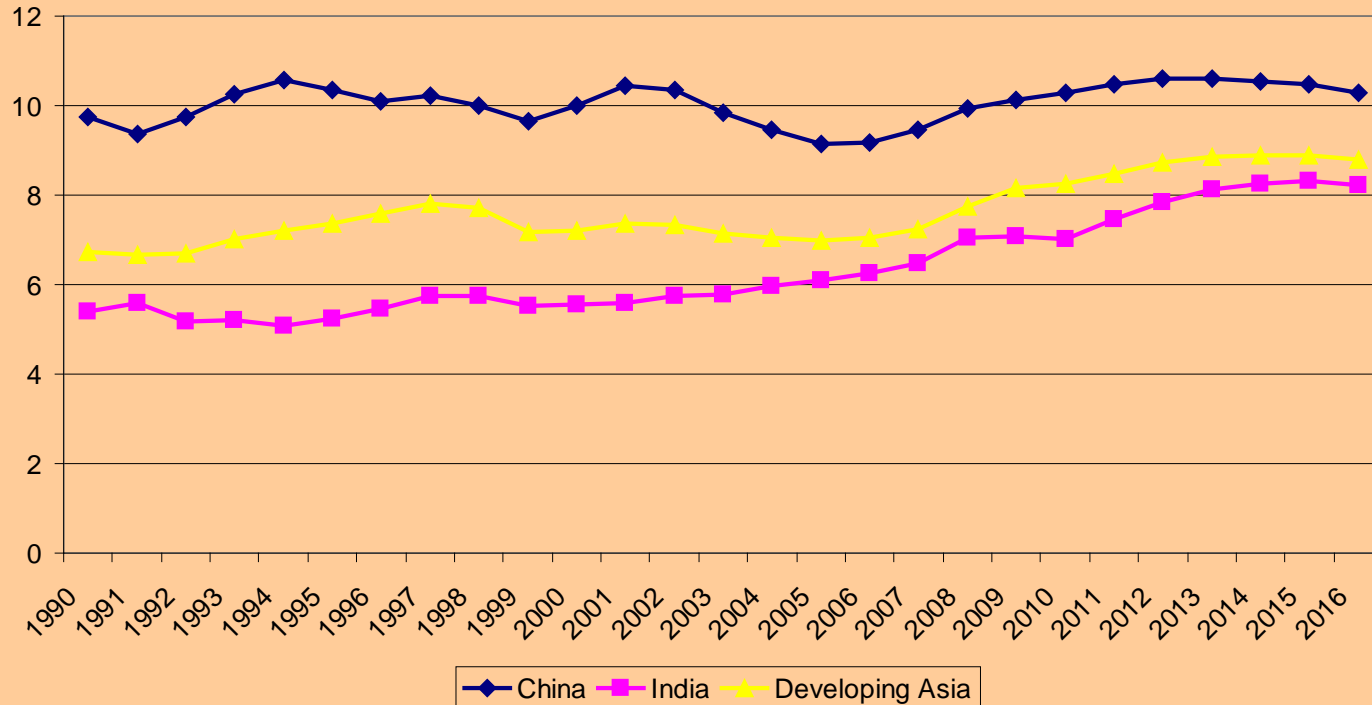


2. Affluence and the demand for resources

CHINA LEADS, BUT INDIA CATCHES UP

Chart 8: GDP GROWTH IN ASIA
(10-year moving average, end year)

Source: IMF, WEO Database, September 2011

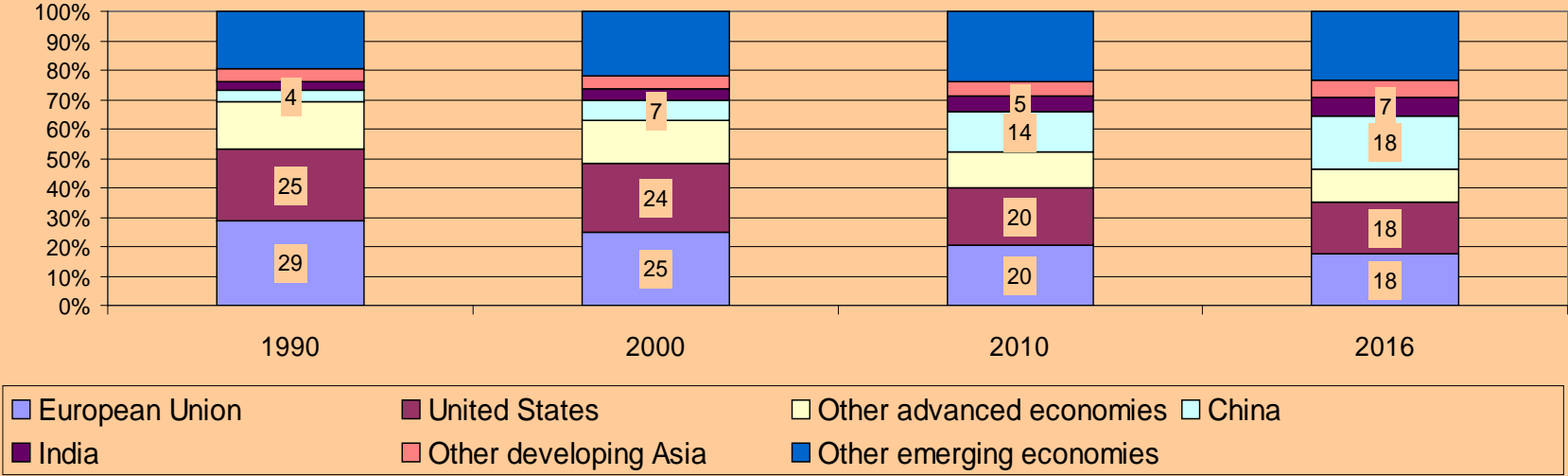


2. Affluence and the demand for resources

ADVANCED COUNTRIES FALL, ASIA RISES

Chart 9: SHARES IN WORLD OUTPUT
(at PPP, per cent)

Source: IMF WEO database, October 2011

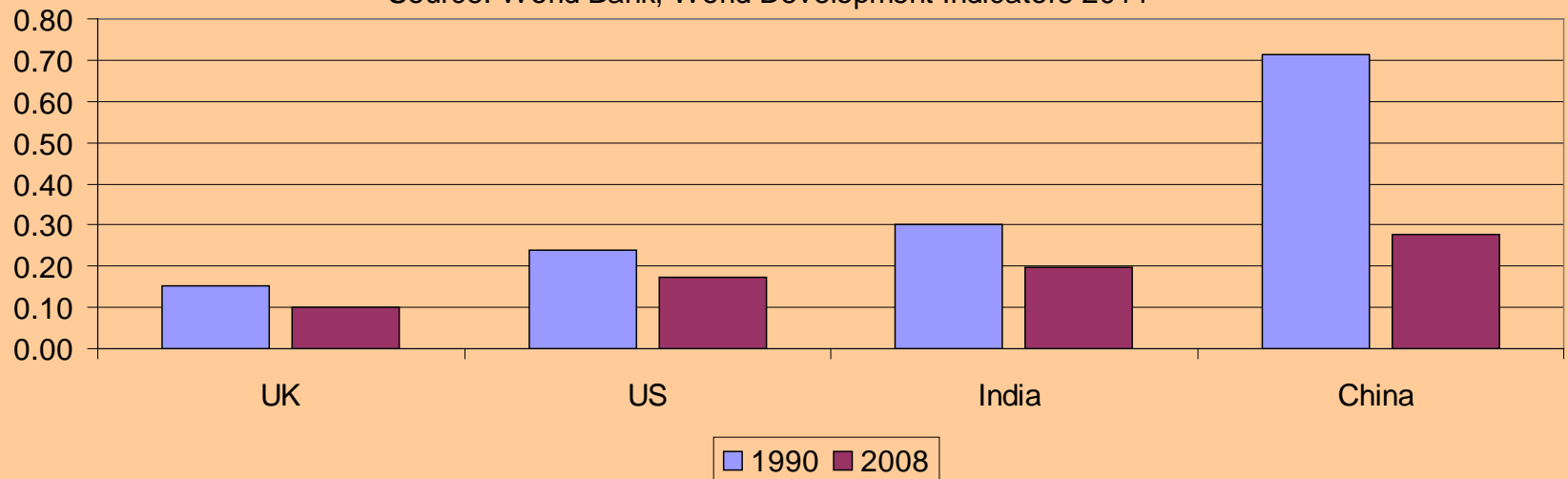


2. Affluence and the demand for resources

ENERGY EFFICIENCY IMPROVES WITH WEALTH

**Chart 10: ENERGY INPUT PER UNIT OF GDP
(kilograms of oil equivalent and GDP at 2005 \$s)**

Source: World Bank, World Development Indicators 2011

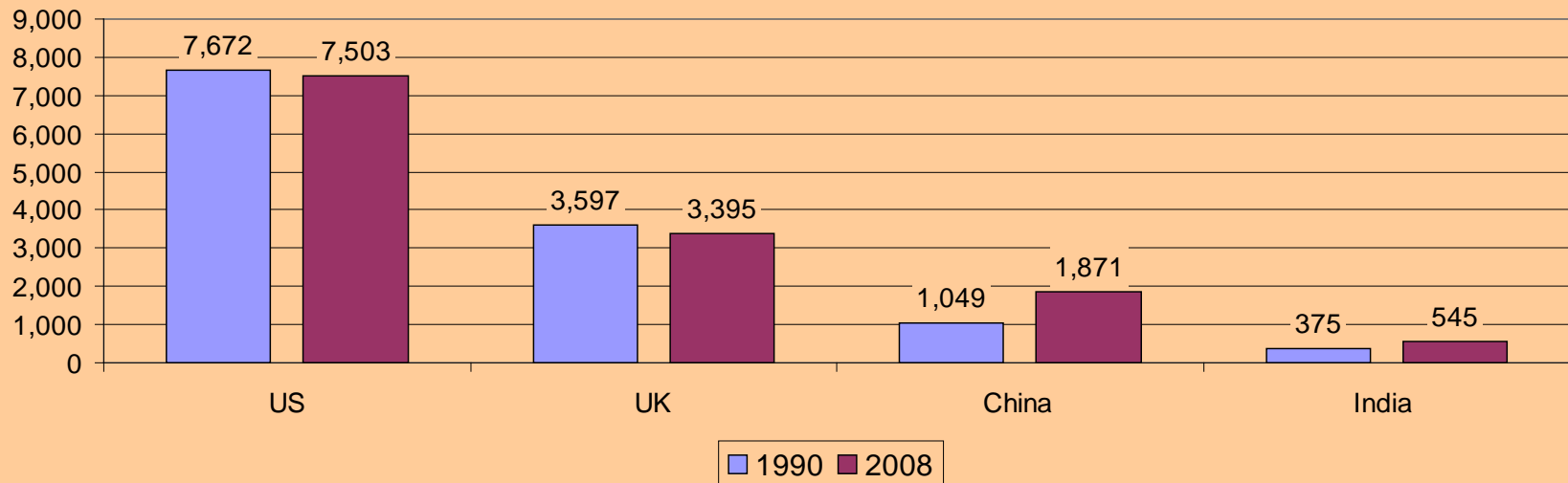


2. Affluence and the demand for resources

BUT ENERGY USE STILL RISES RAPIDLY

**Chart 11: ENERGY USE PER HEAD
(kilogram of oil equivalent)**

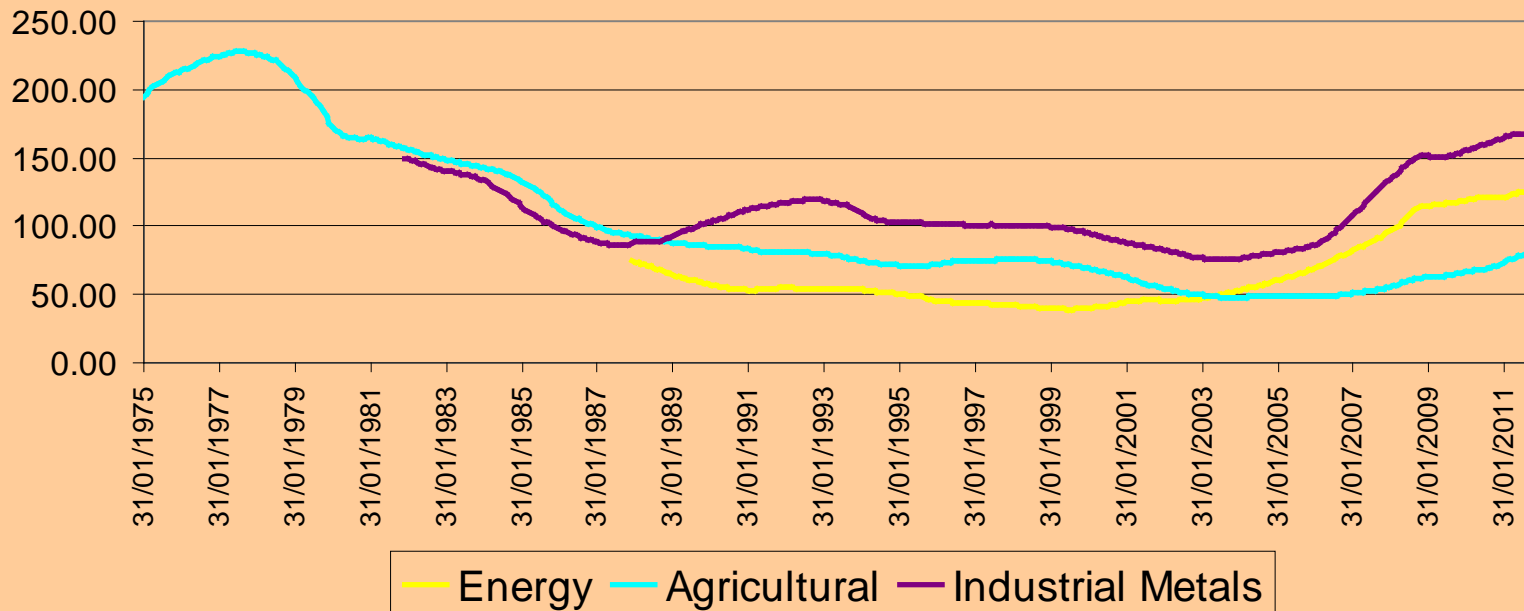
Source: World Bank, World Development Indicators 2011



2. Affluence and the demand for resources

AND REAL PRICES OF RESOURCES ROSE

**Chart 12: MOVING AVERAGE OF REAL COMMODITY PRICES
(previous five years)**

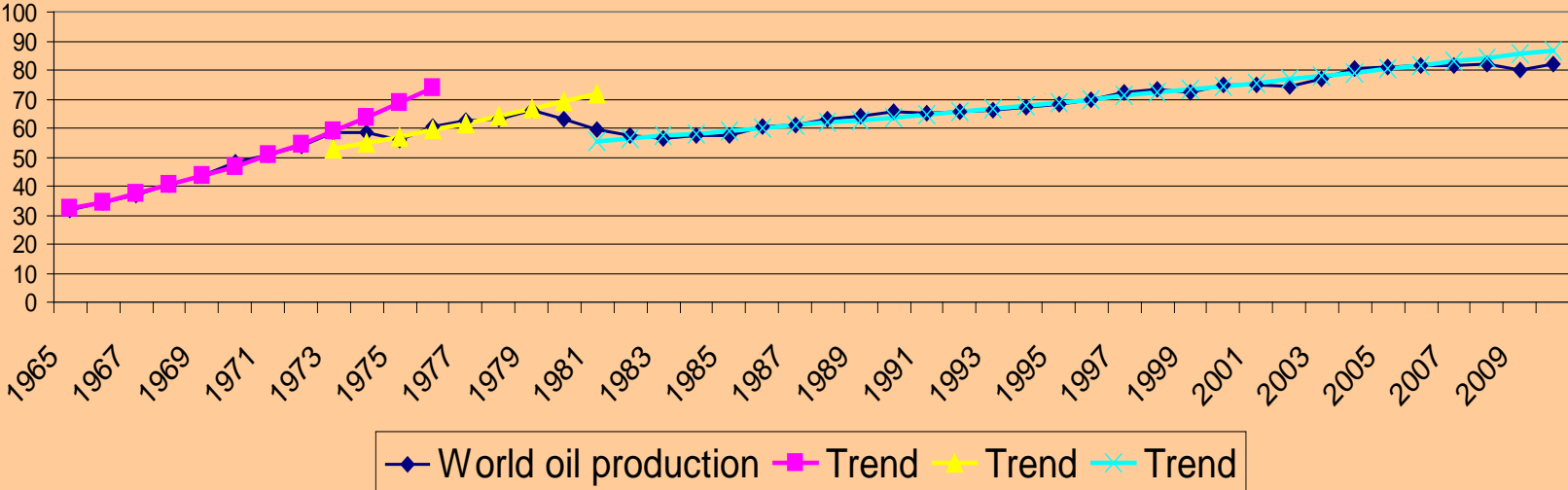


2. Affluence and the demand for resources

BUT STAGNATION HITS OIL PRODUCTION

Chart 13: WORLD OIL PRODUCTION
(millions of barrels a day)

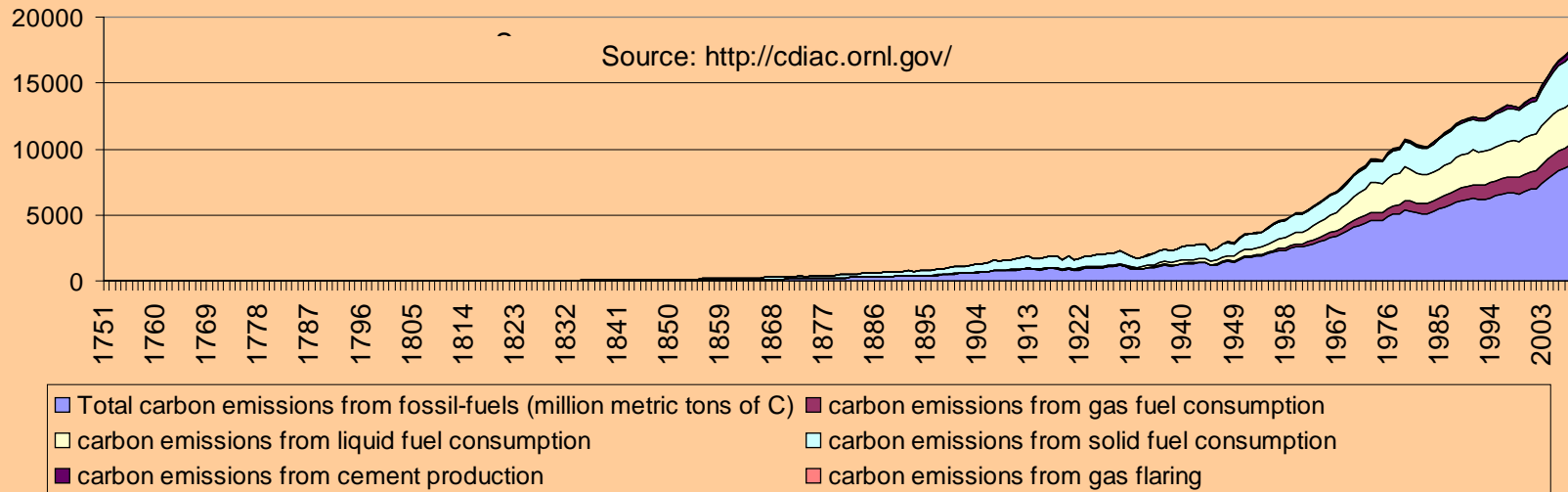
Source: IMF WEO April 2011



3. Biggest collective action challenge

EMISSIONS AND THE FOSSIL FUEL REVOLUTION

Chart 14: HISTORY OF CARBON DIOXIDE EMISSIONS
(million tonnes of carbon)

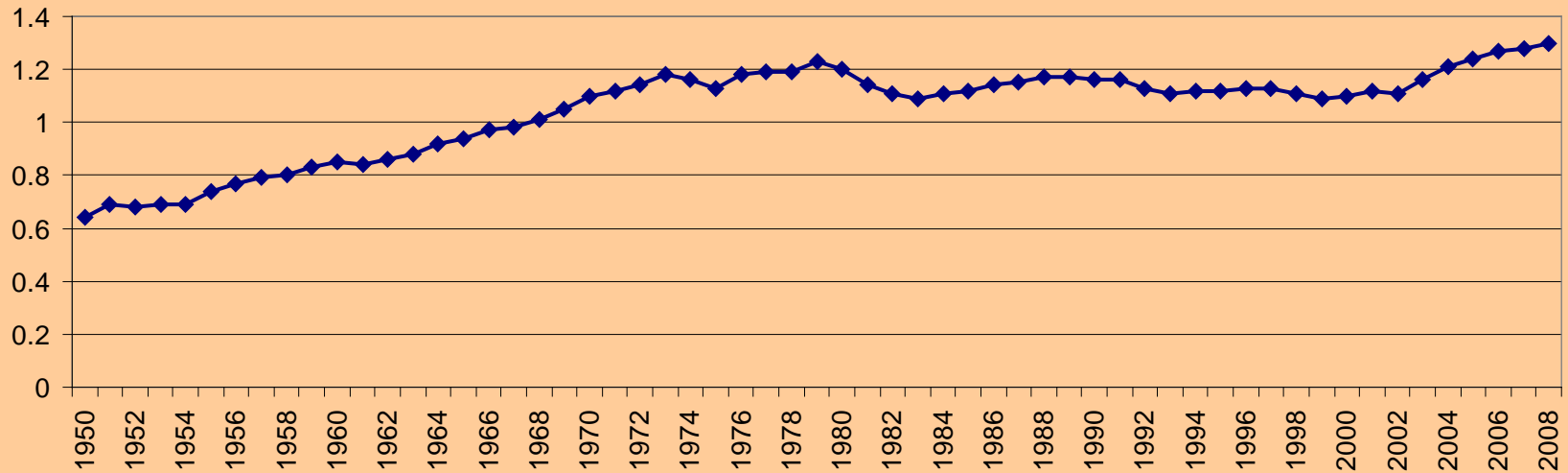


3. Biggest collective action challenge

HIGH PRICES HELP BUT NOT ENOUGH

**Chart 15: CARBON EMISSIONS PER HEAD
(tonnes of carbon)**

Source: <http://cdiac.ornl.gov/>

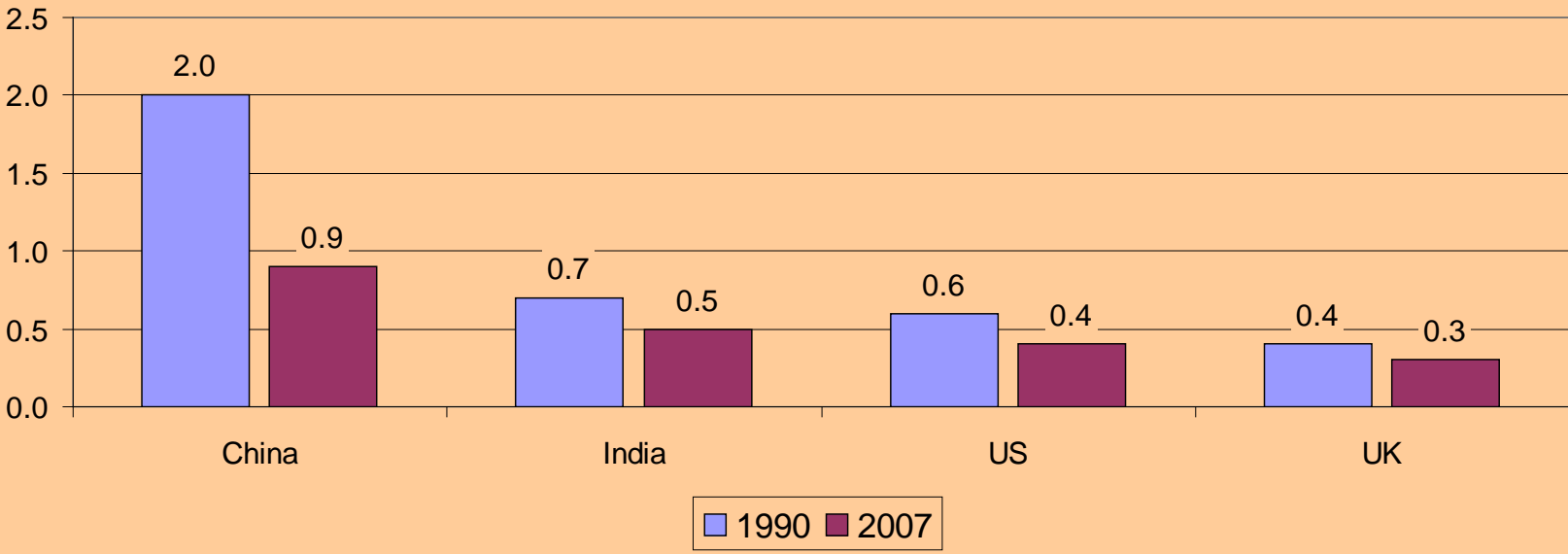


3. Biggest collective action challenge

DESPITE RISING EFFICIENCY

**Chart 16: CARBON DIXOIDE EMISSIONS PER UNIT OF GDP
(kg and 2005 PPP \$s)**

Source: World Bank, World Development Indicators 2011

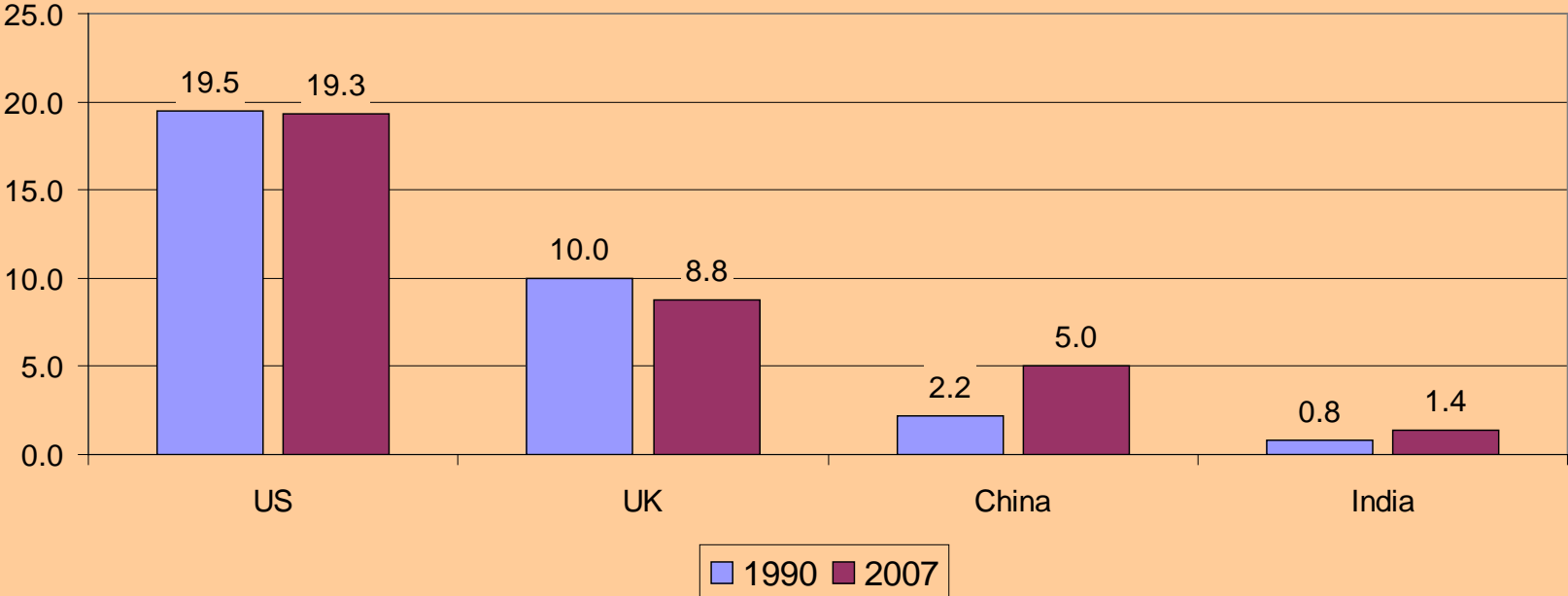


3. Biggest collective action challenge

EMISSIONS PER HEAD RISE IN POOR COUNTRIES

Chart 17: CARBON DIOXIDE EMISSIONS PER HEAD (tonnes)

Source: World Bank, World Development Indicators 2011

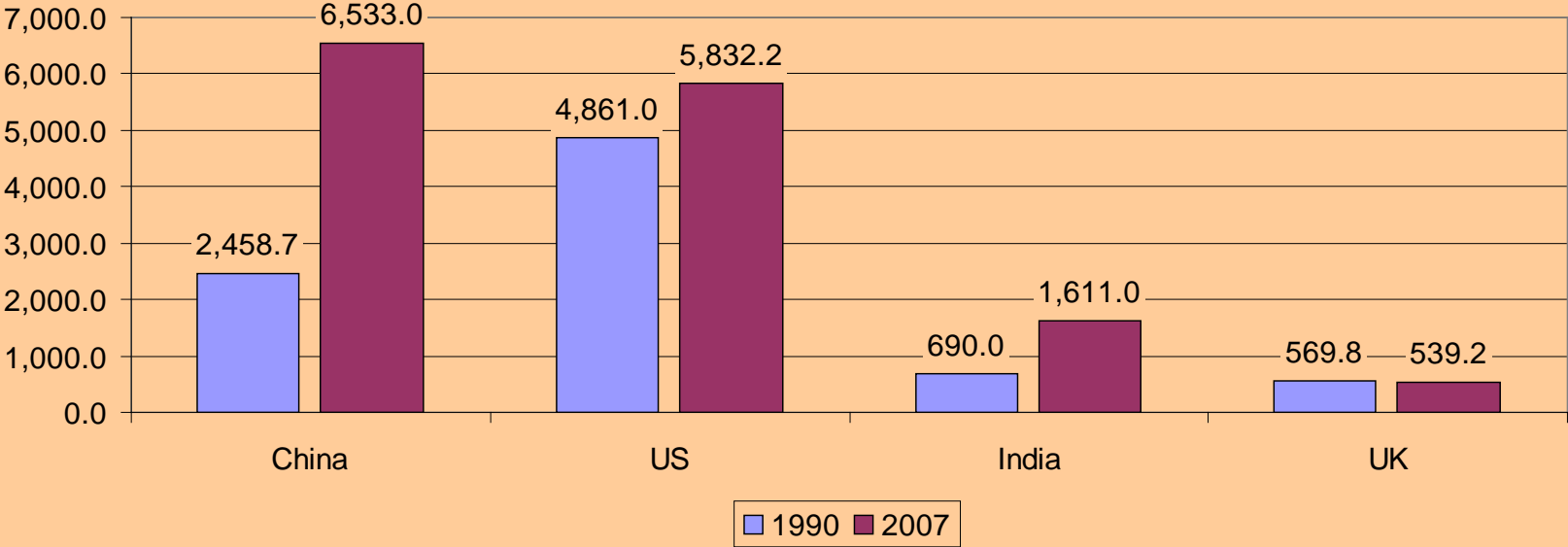


3. Biggest collective action challenge

TOTAL EMISSIONS EXPLODE IN CHINA

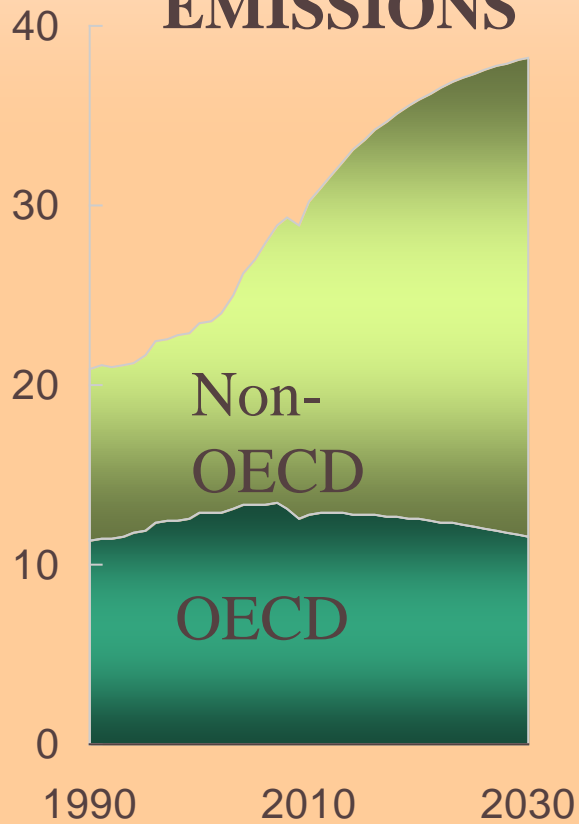
**Chart 18: TOTAL EMISSIONS
(m tonnes)**

Source: World Bank, World Development Indicators 2011



3. Biggest collective action challenge

Chart 19: CO2 EMISSIONS



Source:BP

Chart 20: vs GDP & ENERGY

