Lecture 3A

Energy Resources, Economics and Environment

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Quality of Life

General well being of individuals and societies

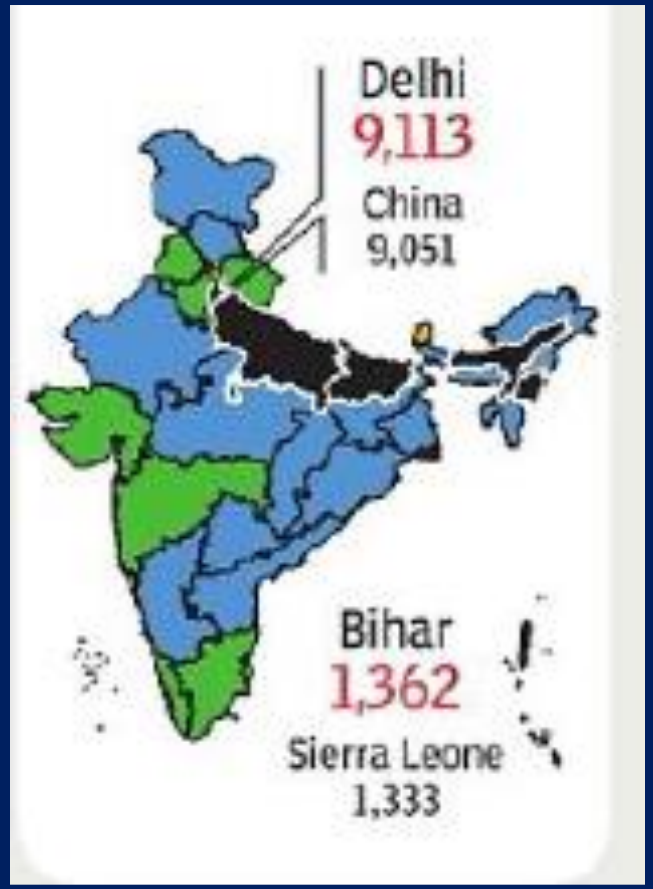
What parameters matter?

Where do you think Quality of Life would be best?

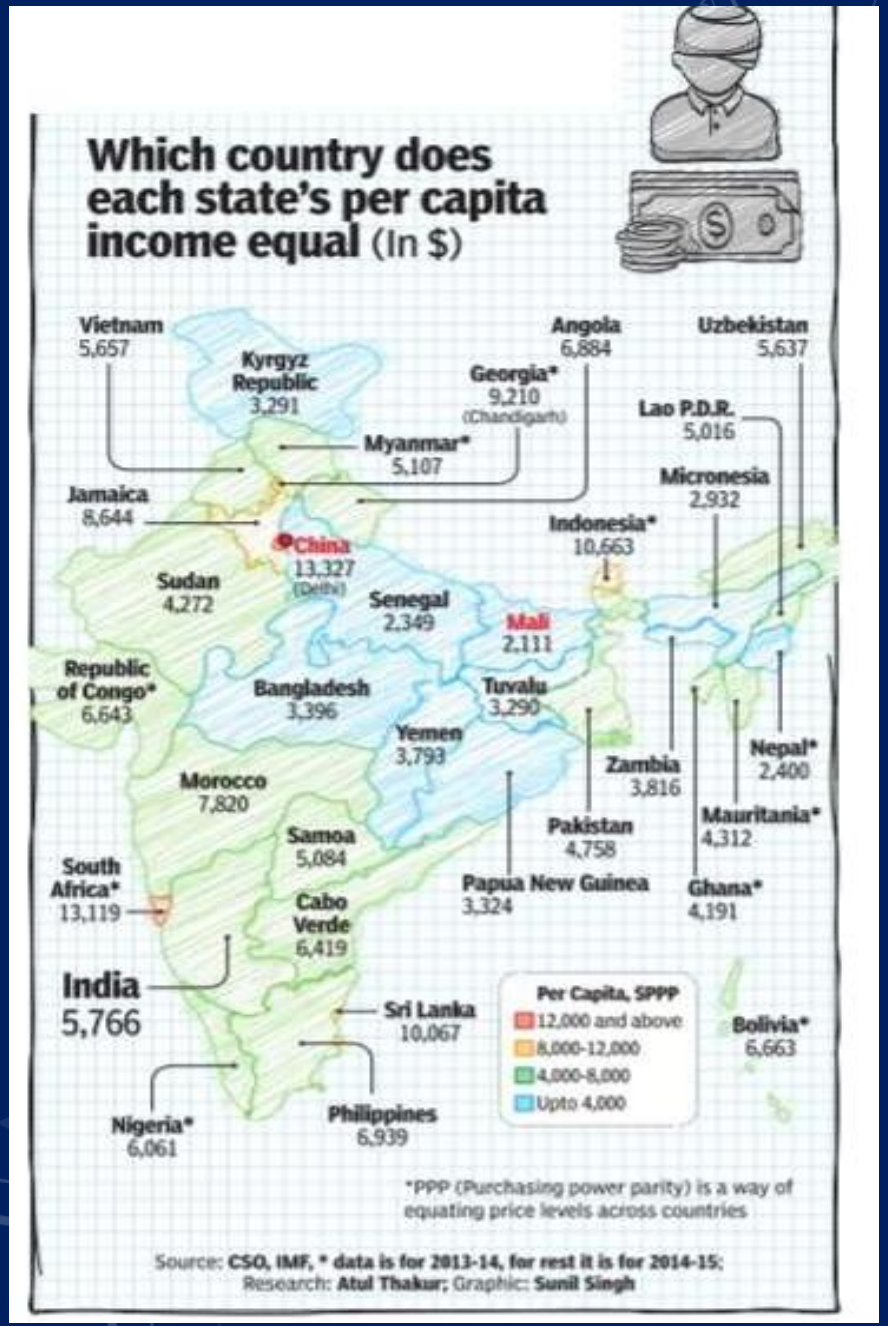
Where would you like to live? Why?

GDP/ capita (Source : Times of India)

GDP/ capita (Source : Times of India)



GDP per capita 2013-15

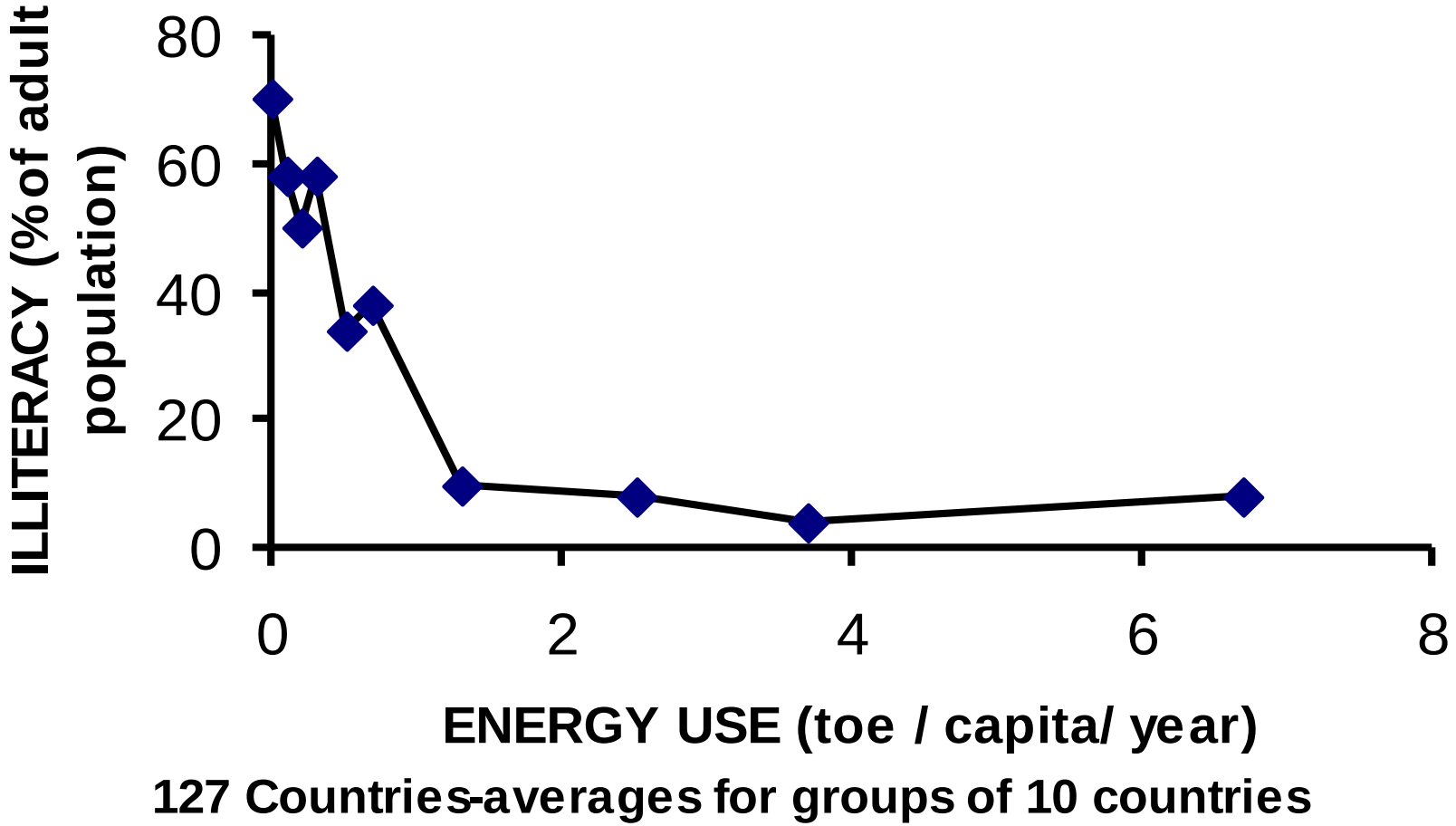


http://epaperbeta.timesofindia.com/Article.aspx?eid=31808&articlexml=STATOISTICS-DELHI-IS-CHINA-AND-BIHAR-IS-MALI-20042017009028

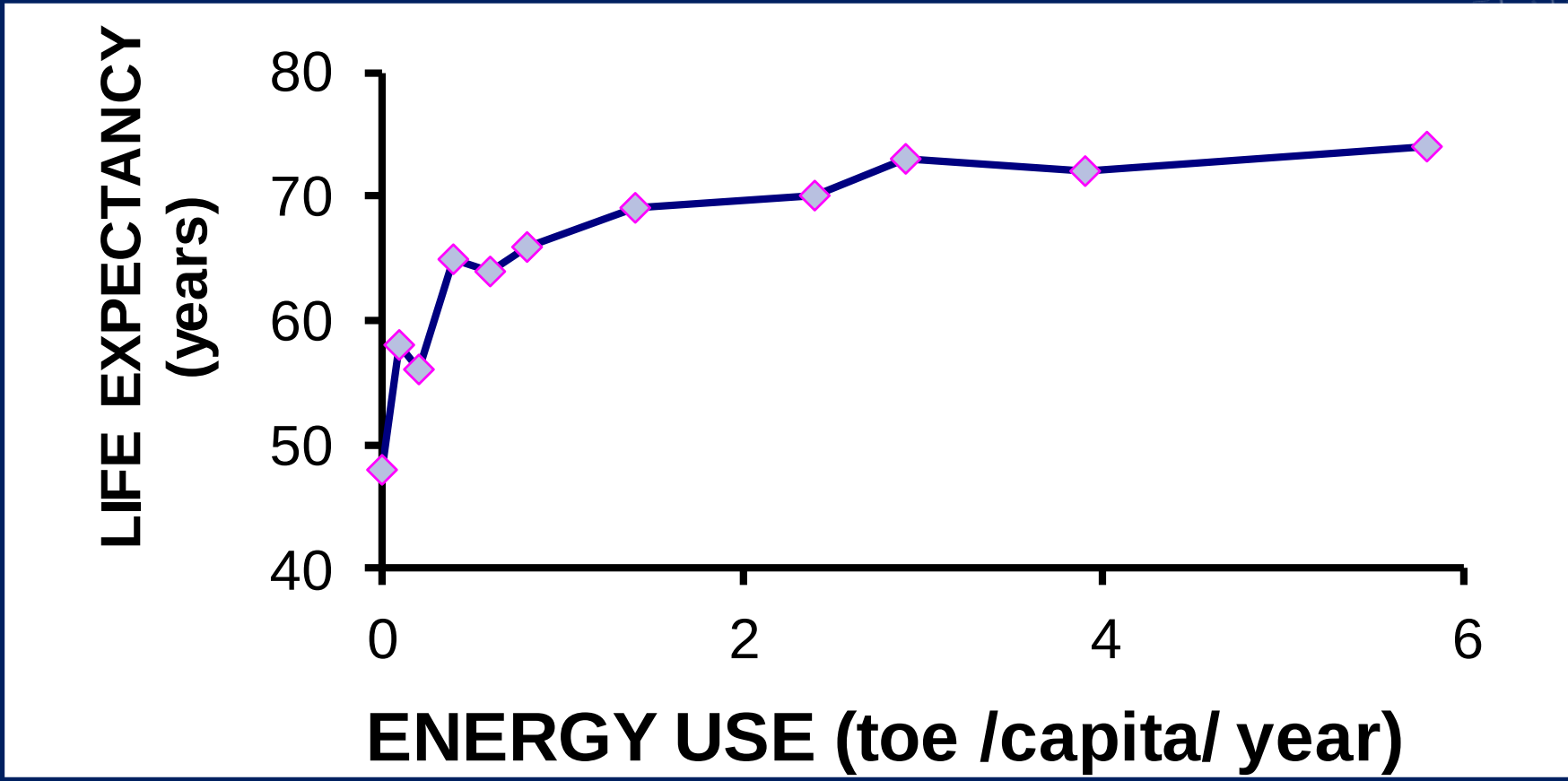
Quality of Life Indices

- Human Development Index – UNDP
- Physical Quality of Life Index – David Morris – Literacy, Infant mortality, life expectancy
- Happy Planet Index
- Popsicle Index
- Gross National Happiness (difficult to quantify)
- Livability index – for cities
- Gender related Development Index
- Multi Dimensional Poverty Index
- Gender Inequality Index

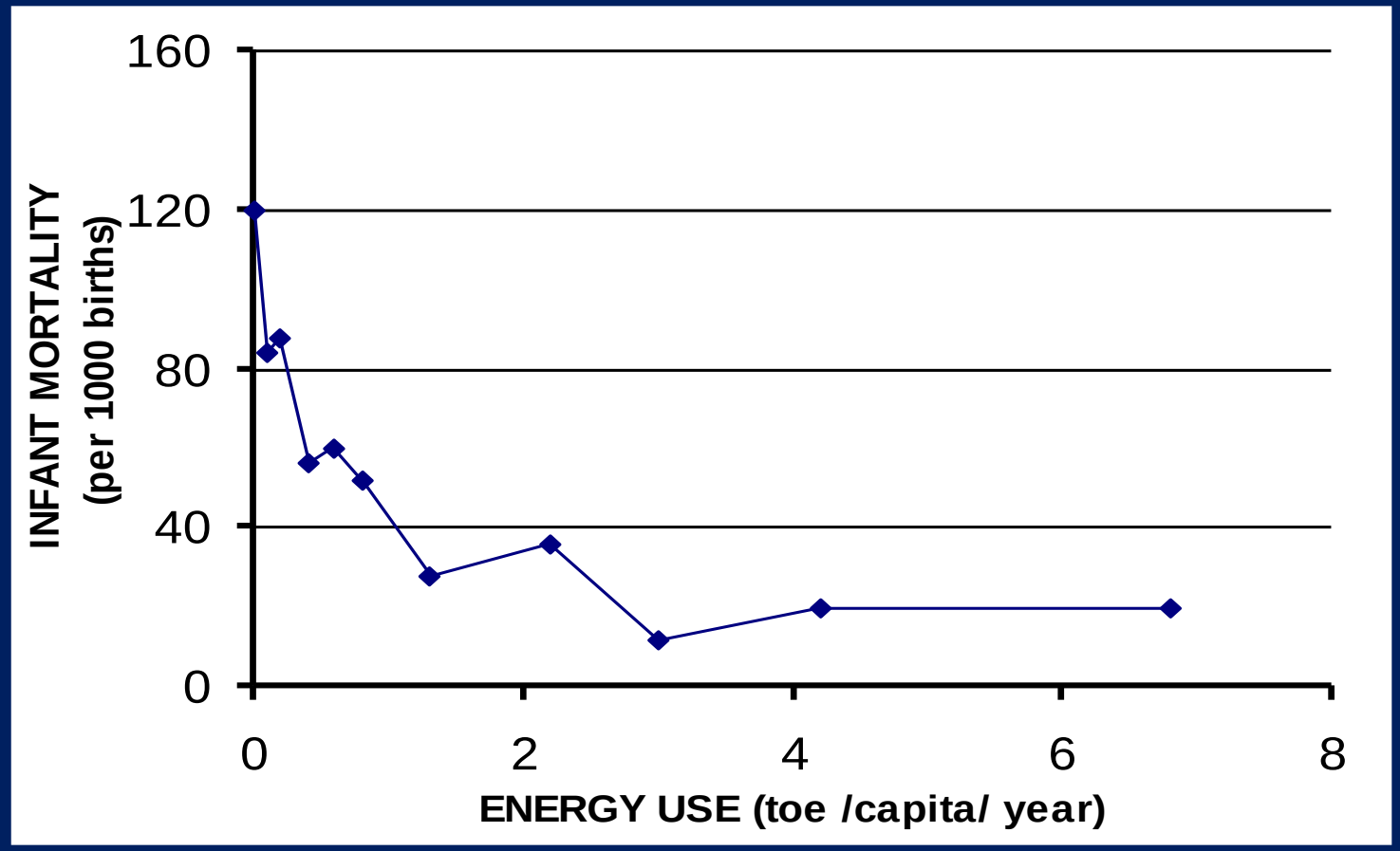
Illiteracy vs Energy Use



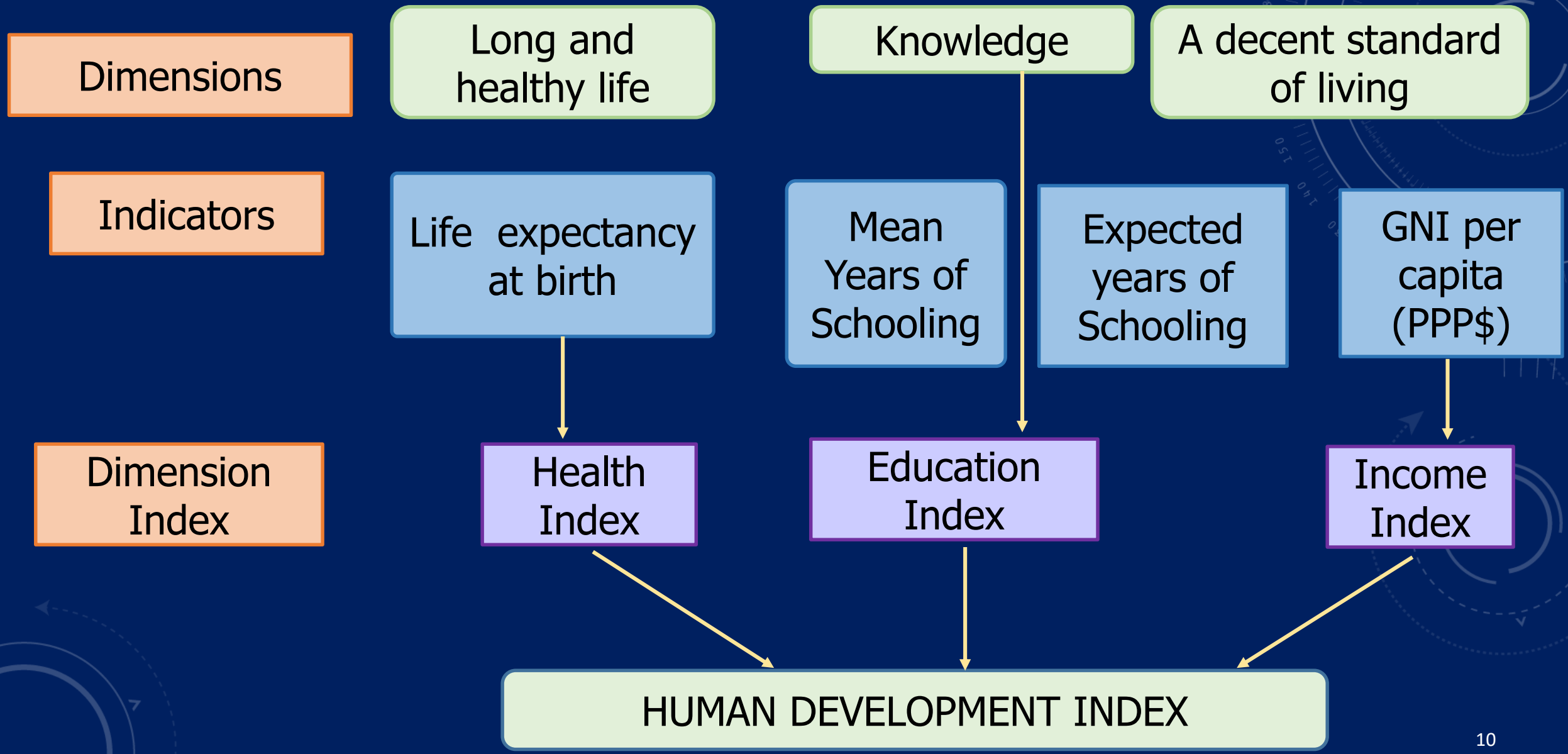
Life Expectancy vs Energy Use



Infant Mortality vs Energy Use



Human Development Index



Energy and Quality of Life

- Energy needed for development & improved quality of life
- Life Expectancy at birth
- Education/Literacy
- Infant Mortality Rate
- Income (GDP/capita)

Human Development Index

Life expectancy at birth

Education – adult literacy, enrolment

Real GDP per capita (purchasing power parity)

Index = (Actual – Min)/(Max-Min)

HDI = Average of above indices

HDI - Calculation

	Life Exp Index	Education Attainm Index	Adjust GDP index	HDI =Sum/3
Germany	0.87	0.954	0.895	0.906
China	0.747	0.782	0.575	0.701

Source: Human Development Report UNDP 2000

HDI - Calculation

	Life Exp	Adult Lit	Enrolment ratio	GDP/capita PPP
Min	25 years	0%	0%	$100
Max	85 years	100%	100%	$40000
Germany	77.2	99.0	88.1	21260
China	69.8	82.9	68.9	3130

2013 HDI calculation

Goalposts for the Human Development Index in this Report

Indicator	Observed maximum	Minimum
Life expectancy (years)	83.6 (Japan, 2012)	20.0
Mean years of schooling	13.3 (United States, 2010)	0
Expected years of schooling	18.0 (capped at)	0
Combined education index	0.971 (New Zealand, 2010)	0
GNI per capita (PPP $)	87,478 (Qatar, 2012)	100

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Human Development Indicator

Rank	Country	Human Development Index (HDI) Value, 2013	Life expectancy at birth (years), 2013	Mean years of schooling (years), 2012 a	Expected years of schooling (years), 2012 a	Gross national income (GNI) per capita (2011 PPP $), 2013	Human Development Index (HDI) Value, 2012
135	India	0.586	66.4	4.4	11.7	5150	0.583

HDI calculation

$$(I_{\text{Life}}^{1/3} \cdot I_{\text{Education}}^{1/3} \cdot I_{\text{Income}}^{1/3})$$

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Example – 2013 Ghana

Indicator	Value
Life expectancy at birth (years)	64.6
Mean years of schooling	7.0
Expected years of schooling	11.4
GNI per capita (PPP $)	1,684
Note: Values are rounded	

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2013 HDI calculation

Goalposts for the Human Development Index in this Report

Indicator	Observed Maximum	Minimum
Life expectancy (years)	83.6 (Japan, 2012)	20.0
Mean years of schooling	13.3 (United States, 2010)	0
Expected years of schooling	18.0 (capped)	0
Combined education index	0.971 (New Zealand, 2010)	0
GNI per capita (PPP$)	87,478 (Qatar, 2012)	100

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Example – HDI calculation

$$\text{Life expectancy index} = \frac{64.6 - 20}{83.6 - 20} = 0.701$$

$$\text{Mean years of schooling index} = \frac{7.0 - 0}{13.3 - 0} = 0.527$$

$$\text{Expected years of schooling index} = \frac{11.4 - 0}{18.0 - 0} = 0.634$$

$$\text{Education index} = \frac{\sqrt{0.527 \cdot 0.634} - 0}{0.971 - 0} = 0.596$$

$$\text{Income index} = \frac{\ln(1{,}684) - \ln(100)}{\ln(87{,}478) - \ln(100)} = 0.417$$

$$\text{Human Development Index} = \sqrt[3]{0.701 \cdot 0.596 \cdot 0.417} = 0.558$$

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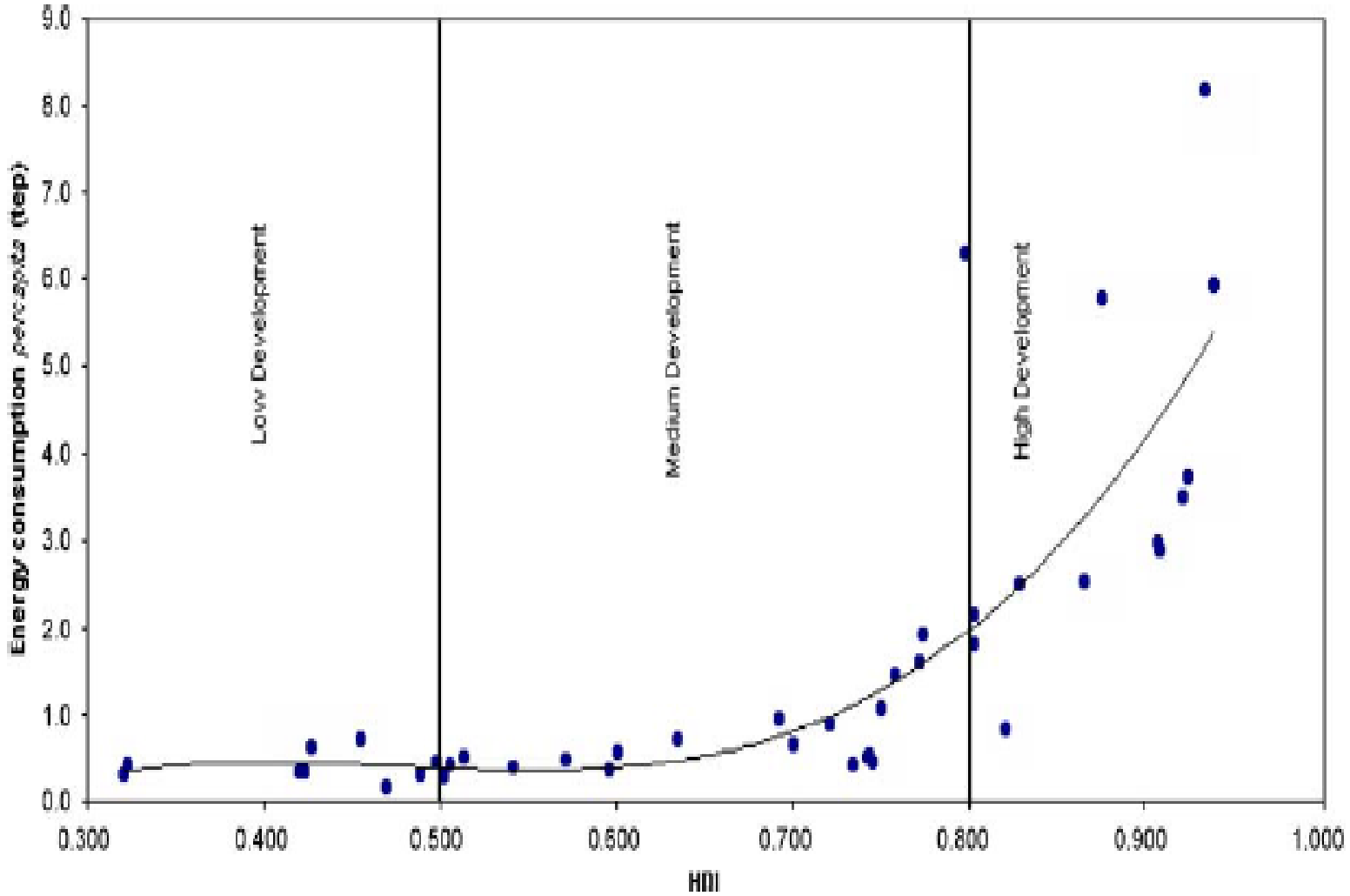
Energy consumption vs HDI



Dias et al, 2006

	Table 1. Human Development Index and its components							
			SDG 3		SDG 4.3		SDG 4.6	
HDI rank	Country	Human Development Index (HDI) Value	Life expectancy at birth (years)		Expected years of schooling (years)		Mean years of schooling (years)	
		2017	2017		2017	[a]	2017	
	VERY HIGH HUMAN DEVELOPMENT							
1	Norway	0.953	82.3		17.9		12.6	
2	Switzerland	0.944	83.5		16.2		13.4	
3	Australia	0.939	83.1		22.9	[b]	12.9	
4	Ireland	0.938	81.6		19.6	[b]	12.5	
5	Germany	0.936	81.2		17.0		14.1	
6	Iceland	0.935	82.9		19.3	[b]	12.4	
7	Hong Kong, China (SAR)	0.933	84.1		16.3		12.0	
7	Sweden	0.933	82.6		17.6		12.4	
9	Singapore	0.932	83.2		16.2	[d]	11.5	
10	Netherlands	0.931	82.0		18.0		12.2	
11	Denmark	0.929	80.9		19.1	[b]	12.6	
12	Canada	0.926	82.5		16.4	[c]	13.3	
13	United States	0.924	79.5		16.5		13.4	
14	United Kingdom	0.922	81.7		17.4		12.9	
15	Finland	0.920	81.5		17.6		12.4	
16	New Zealand	0.917	82.0		18.9	[b]	12.5	
17	Belgium	0.916	81.3		19.8	[b]	11.8	
17	Liechtenstein	0.916	80.4	[g]	14.7		12.5	
19	Japan	0.909	83.9		15.2		12.8	

http://hdr.undp.org/en/composite/HDI

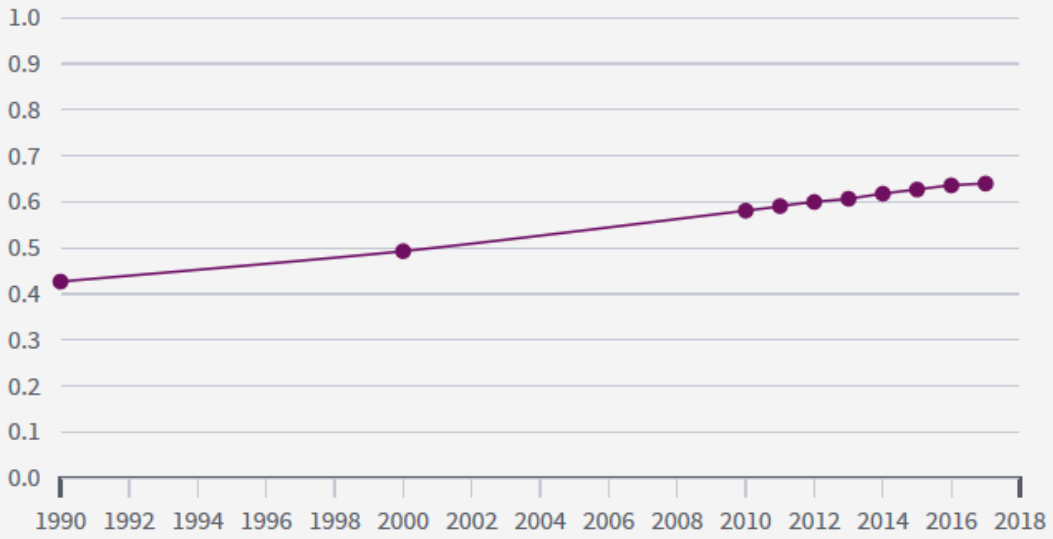
India

Download Data | Download Country Explanatory Note | Embed

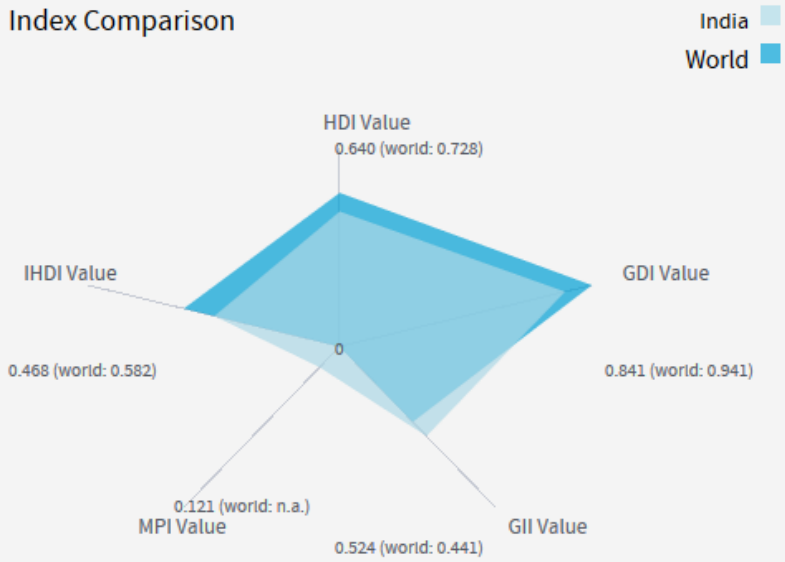
Human Development Indicators

Human Development Index	Index	Rank
	0.640	130

Trends 1990 - Present



Index Comparison



Expand All

http://hdr.undp.org/en/countries/profiles/IND

Region and HDI group	HDI	Life expectancy at birth (years)	Mean years of schooling (years)	Expected years of schooling (years)	Gross national income per capita (2005 PPP $)
Region					
Arab States	0.652	71.0	6.0	10.6	8,317
East Asia and the Pacific	0.683	72.7	7.2	11.8	6,874
Europe and Central Asia	0.771	71.5	10.4	13.7	12,243
Latin America and the Caribbean	0.741	74.7	7.8	13.7	10,300
South Asia	0.558	66.2	4.7	10.2	3,343
Sub-Saharan Africa	0.475	54.9	4.7	9.3	2,010
HDI group					
Very high human development	0.905	80.1	11.5	16.3	33,391
High human development	0.758	73.4	8.8	13.9	11,501
Medium human development	0.640	69.9	6.3	11.4	5,428
Low human development	0.466	59.1	4.2	8.5	1,633
World	0.694	70.1	7.5	11.6	10,184

Note: Data are weighted by population and calculated based on HDI values for 187 countries. PPP is purchasing power parity.
Source: HDRO calculations. See statistical table 1 for detailed data sources.

Human Development Report 2013

HDI – Indian states

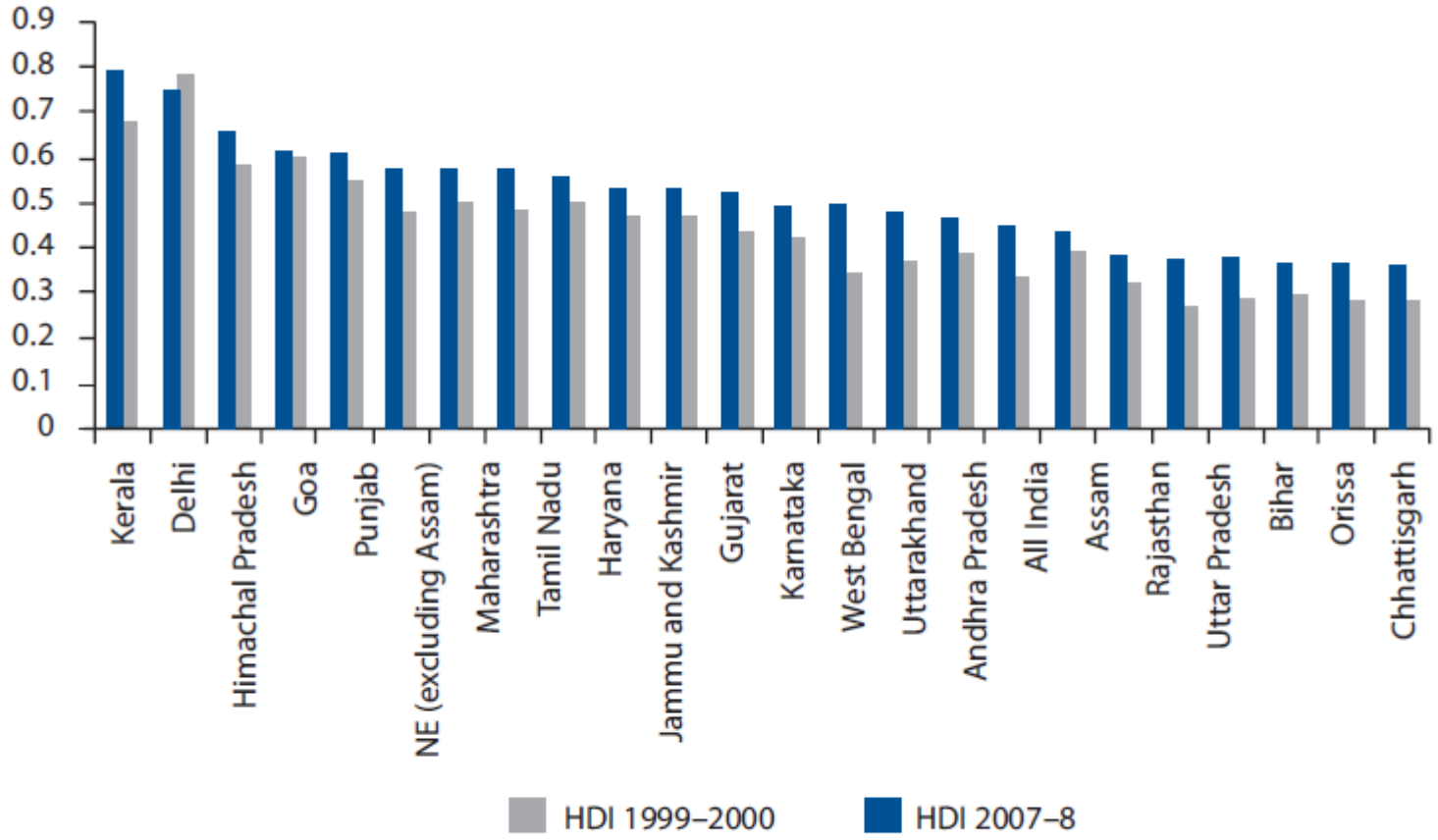


Figure 1.2 HDI across States, 1999–2000 and 2007–8

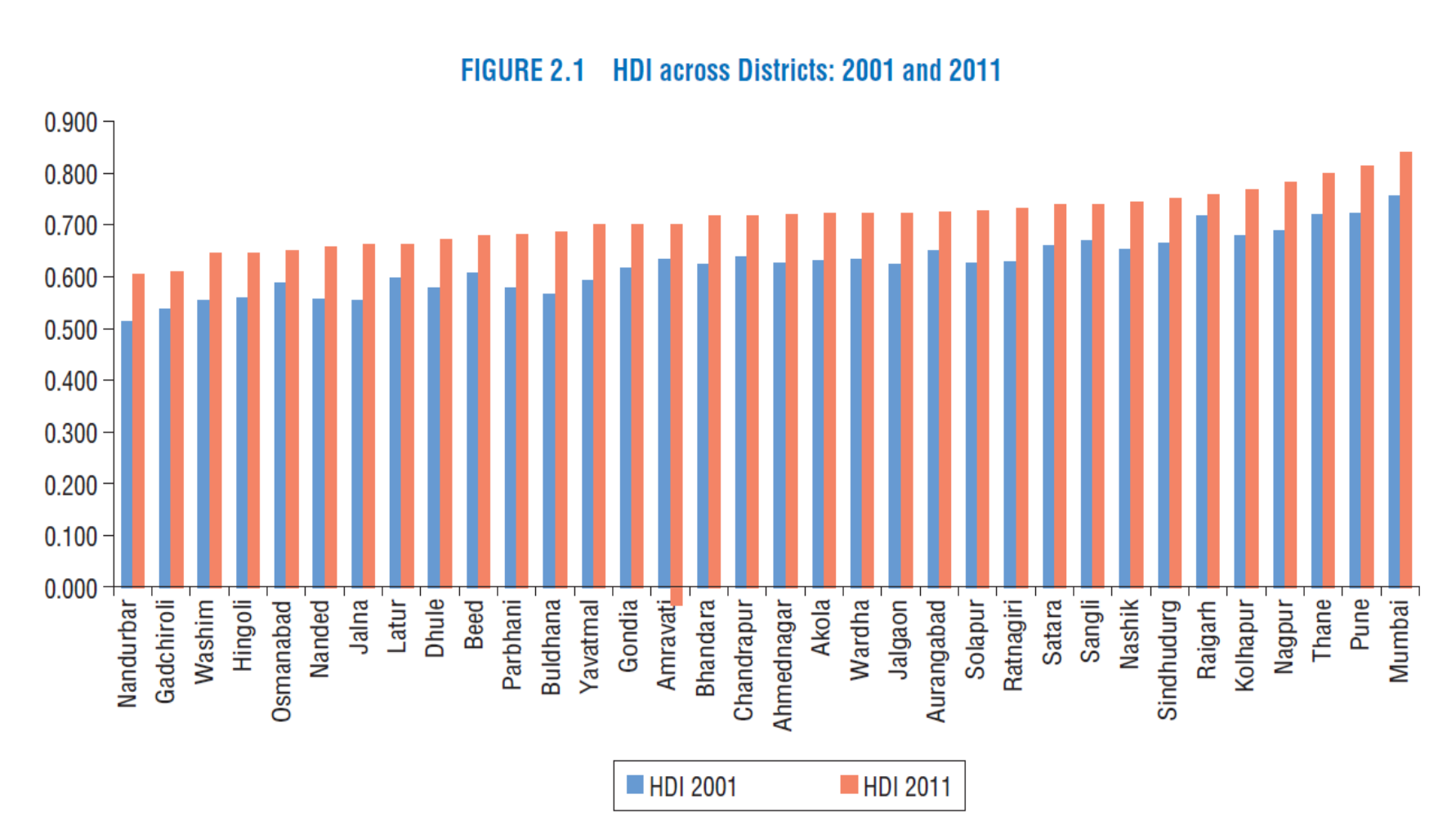
India - Human Development Report 2011

Table 4.8 Hunger Index of Selected Indian States, 2008

States	*Prevalence of Calorie Under Nourishment (per cent)*	*Proportion of Underweight Children Less than 5 years of Age (per cent)*	*Under Five Mortality Rate (Per 100)*	*Hunger Index (HI)*	*Rank as Per HI*
Punjab	11.1	24.6	5.2	13.63	1
Kerala	28.6	22.7	1.6	17.63	2
Andhra Pradesh	19.6	32.7	6.3	19.53	3
Assam	14.6	36.4	8.5	19.83	4
Haryana	15.1	39.7	5.2	20.00	5
Tamil Nadu	29.1	30.0	3.5	20.87	6
Rajasthan	14.0	40.4	8.5	20.97	7
West Bengal	18.5	38.5	5.9	20.97	8
Uttar Pradesh	14.5	42.3	9.6	22.13	9
Maharashtra	27.0	36.7	4.7	22.80	10
Karnataka	28.1	37.6	5.5	23.73	11
Orissa	21.4	40.9	9.1	23.80	12
Gujarat	23.3	44.7	6.1	24.70	13
Chhattisgarh	23.3	47.6	9.0	26.63	14
Bihar	17.3	56.1	8.5	27.30	15
Jharkhand	19.6	57.1	9.3	28.67	16
Madhya Pradesh	23.4	59.8	9.4	30.87	17
India	20.0	42.5	7.4	23.30	

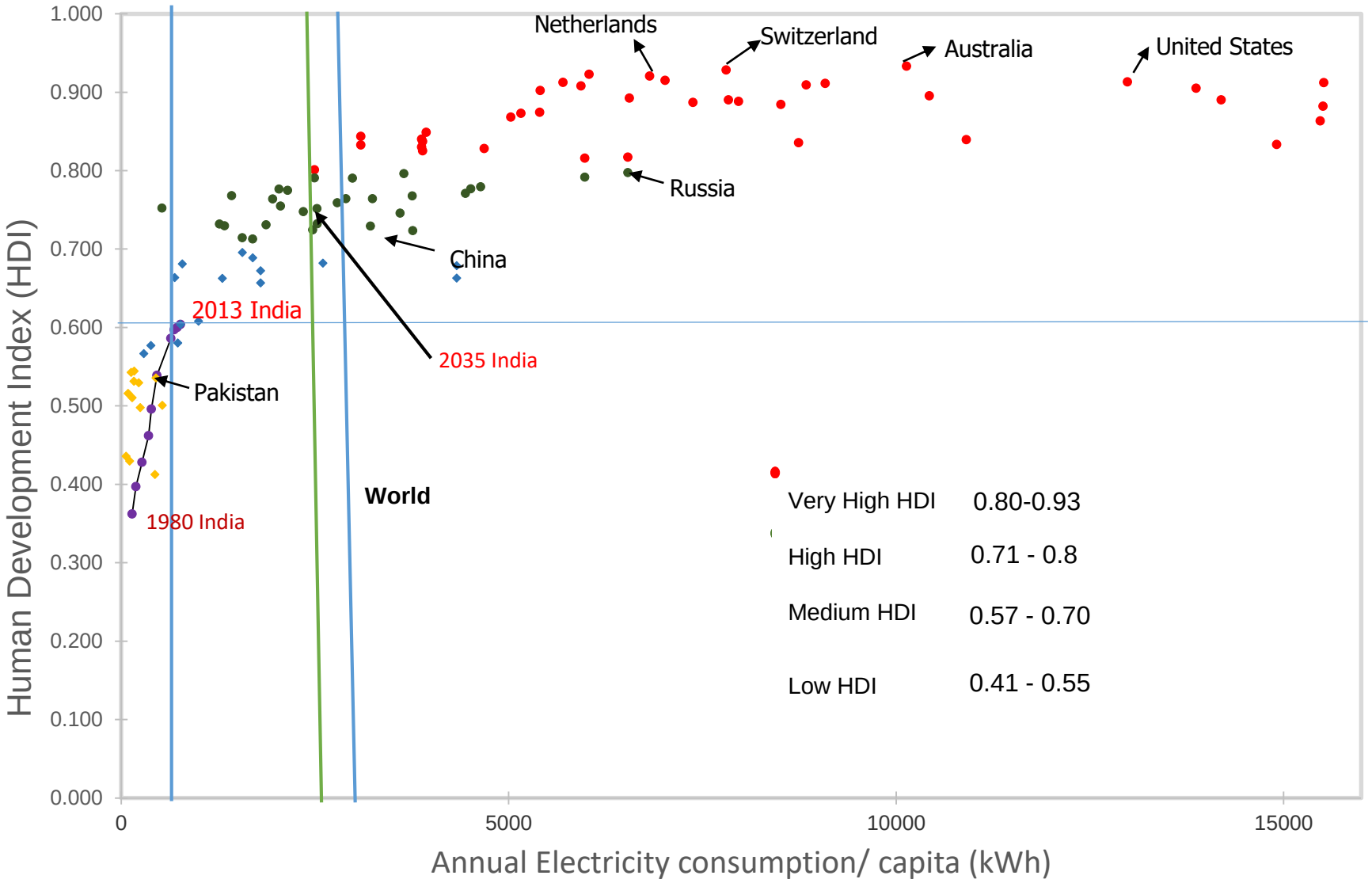
India - Human Development Report 2011

Maharashtra Districts HDI

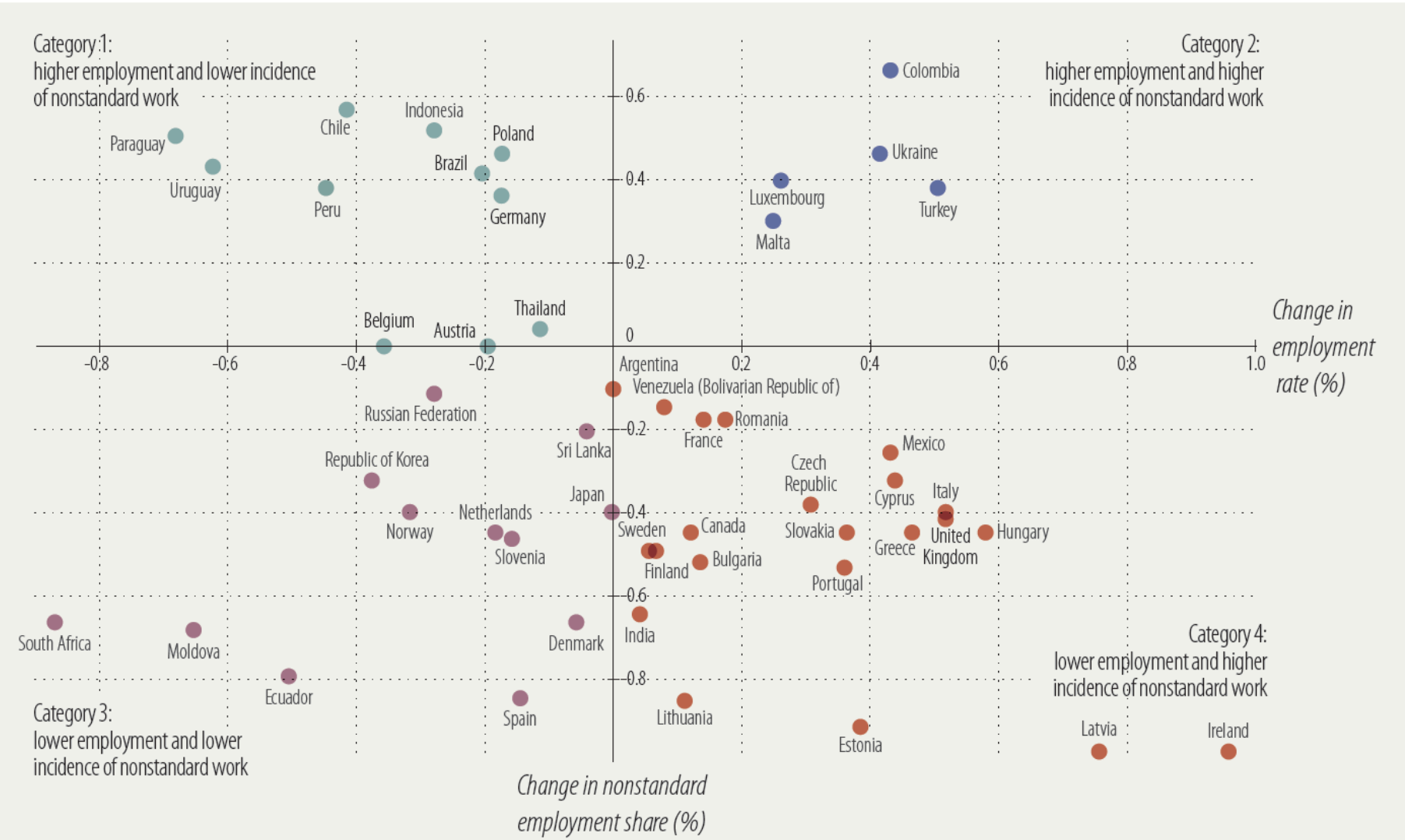


http://www.in.undp.org/content/dam/india/docs/human-development/MHDR%20English-2012.pdf

HDI and Electricity consumption (2013)

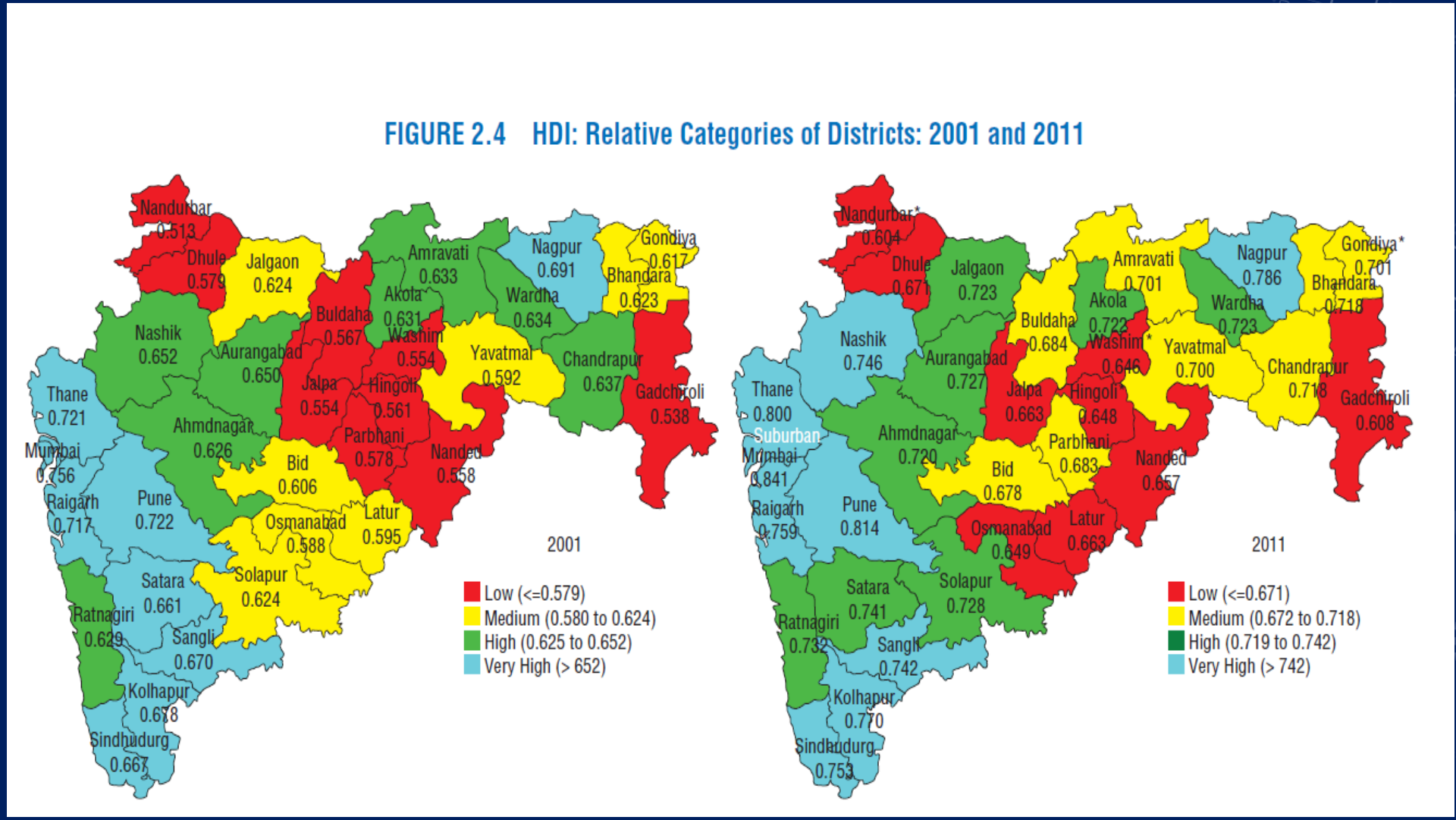


Employment (2007-10)



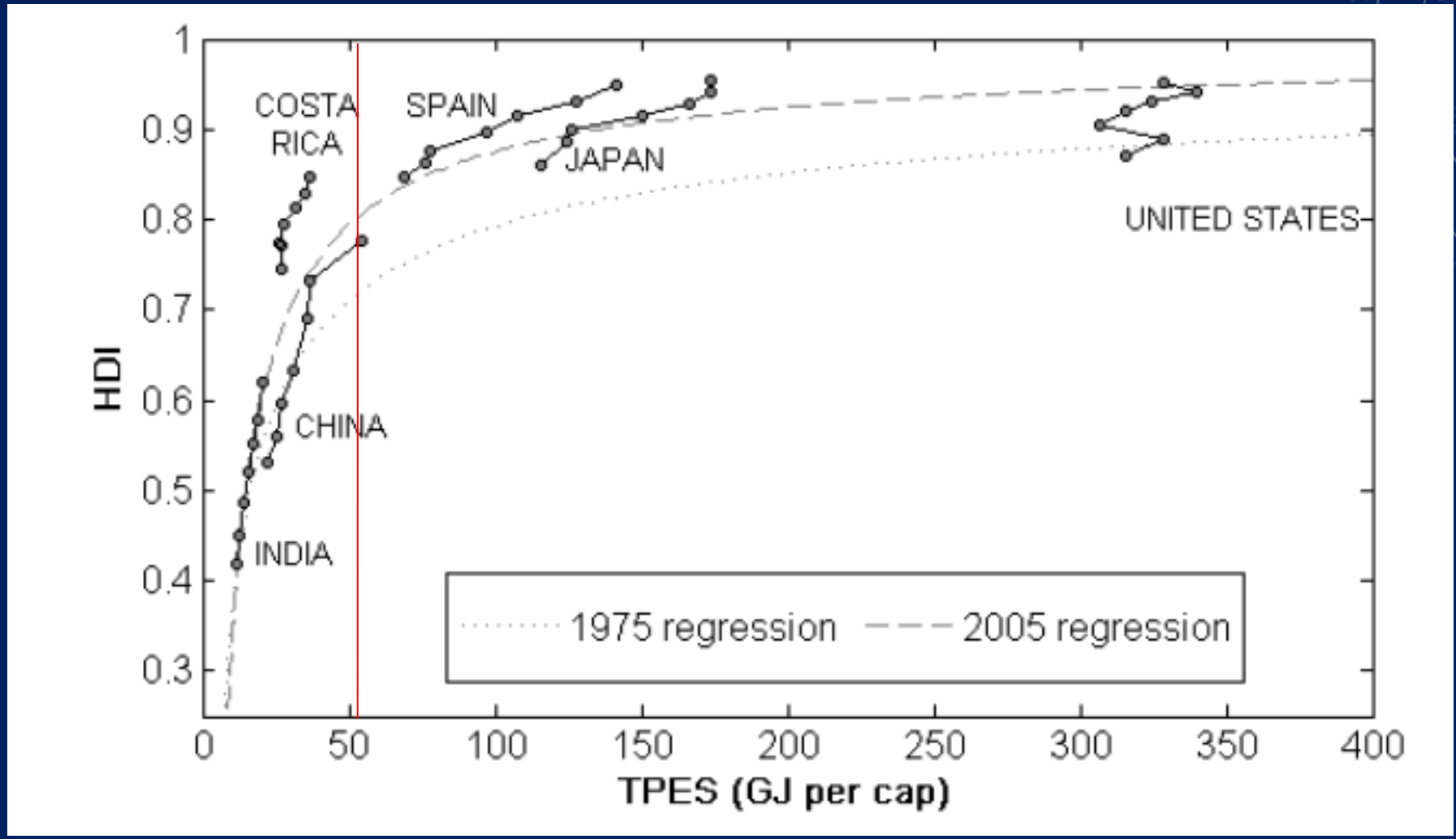
http://hdr.undp.org/sites/default/files/hdr14-report-en-1.pdf

HDI of districts



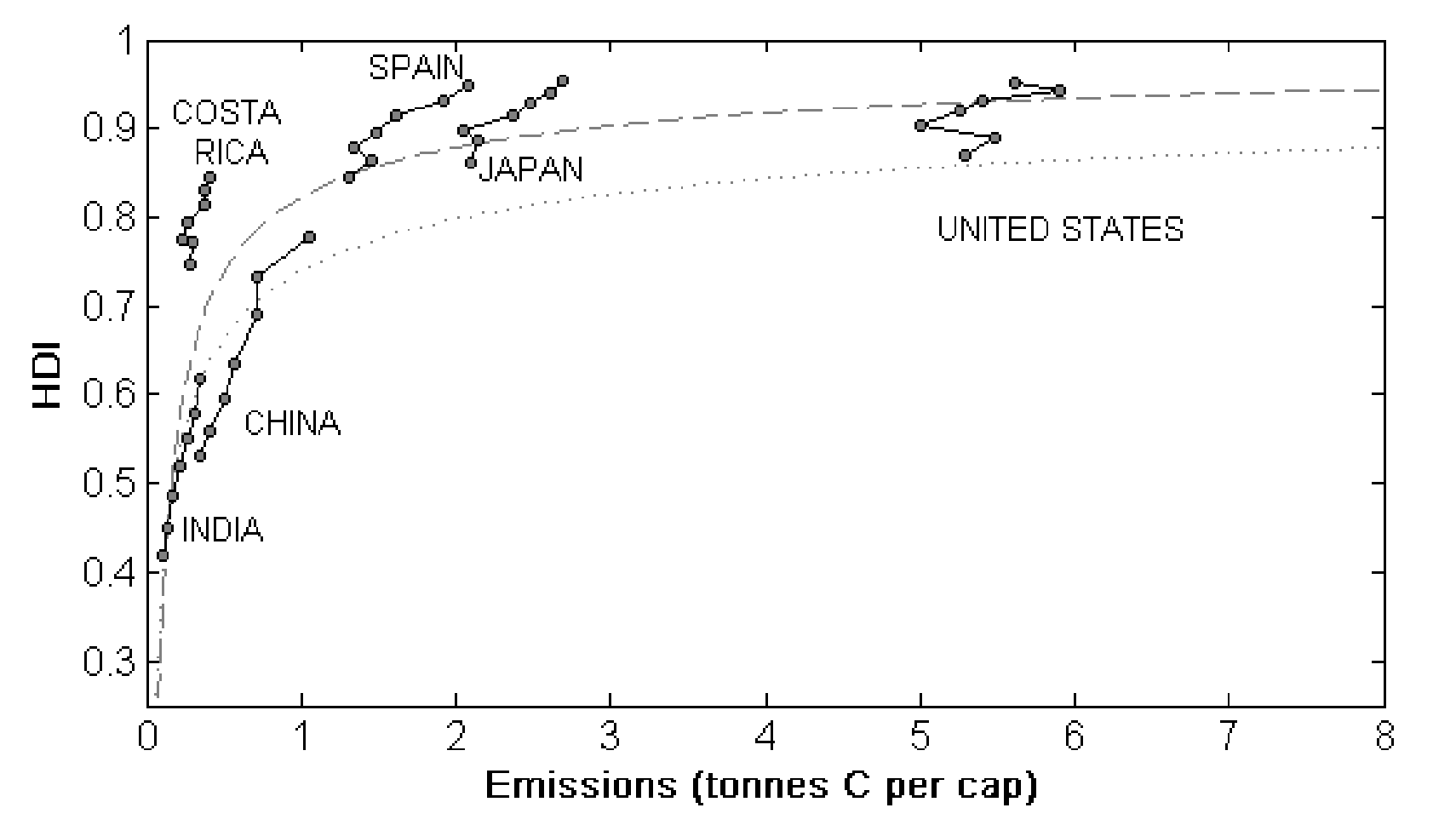
http://www.in.undp.org/content/dam/india/docs/human-development/MHDR%20English-2012.pdf

HDI vs Primary Energy supply



Steinberger, Roberts, 2009

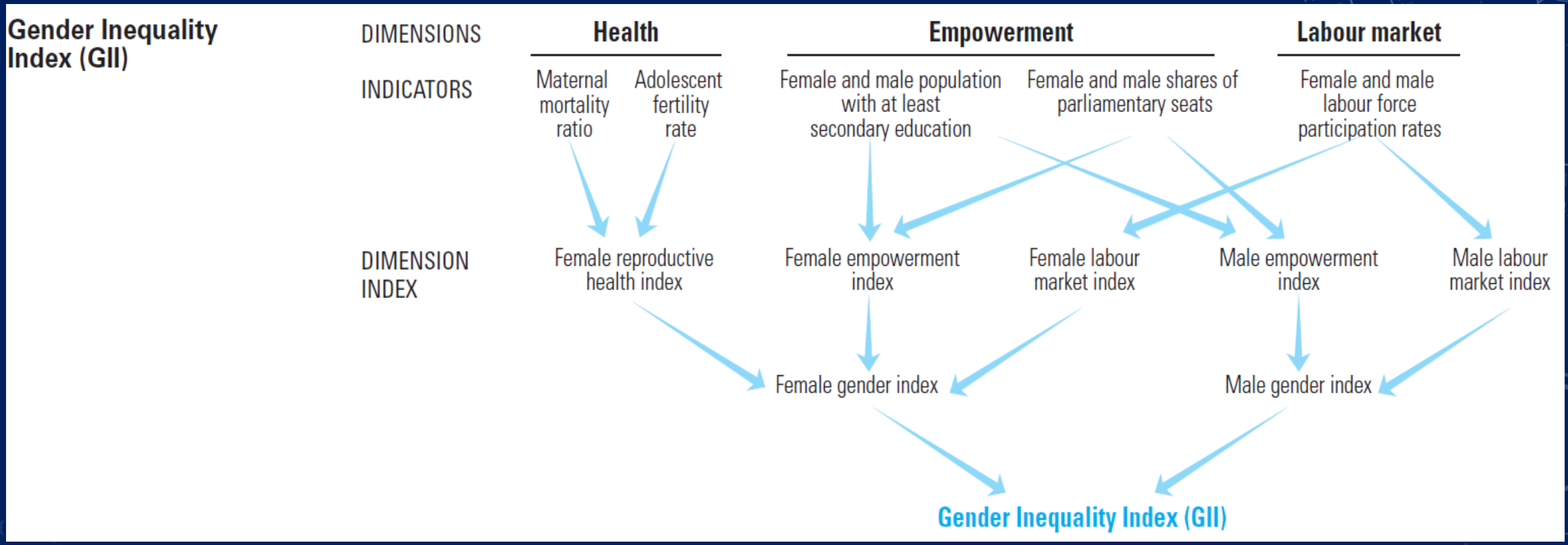
HDI vs Per capita Carbon emissions



Steinberger, Roberts, 2009

HDI Improvement 1990-2012

Gender Inequality Index



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Gender Gap Index

Subindex	Variable
Economic Participation and Opportunity	Ratio: female labour force participation over male value
	Wage equality between women and men for similar work (survey data, normalized on a 0-to-1 scale)
	Ratio: female estimated earned income over male value
	Ratio: female legislators, senior officials and managers over male value
	Ratio: female professional and technical workers over male value
Educational Attainment	Ratio: female literacy rate over male value
	Ratio: female net primary enrolment rate over male value
	Ratio: female net secondary enrolment rate over male value
	Ratio: female gross tertiary enrolment ratio over male value
Health and Survival	Sex ratio at birth (converted to female-over-male ratio)
	Ratio: female healthy life expectancy over male value
Political Empowerment	Ratio: females with seats in parliament over male value
	Ratio: females at ministerial level over male value
	Ratio: number of years with a female head of state (last 50 years) over male value

http://www3.weforum.org/docs/WEF_GGGR_2018.pdf

Gender Gap Index- India 2018

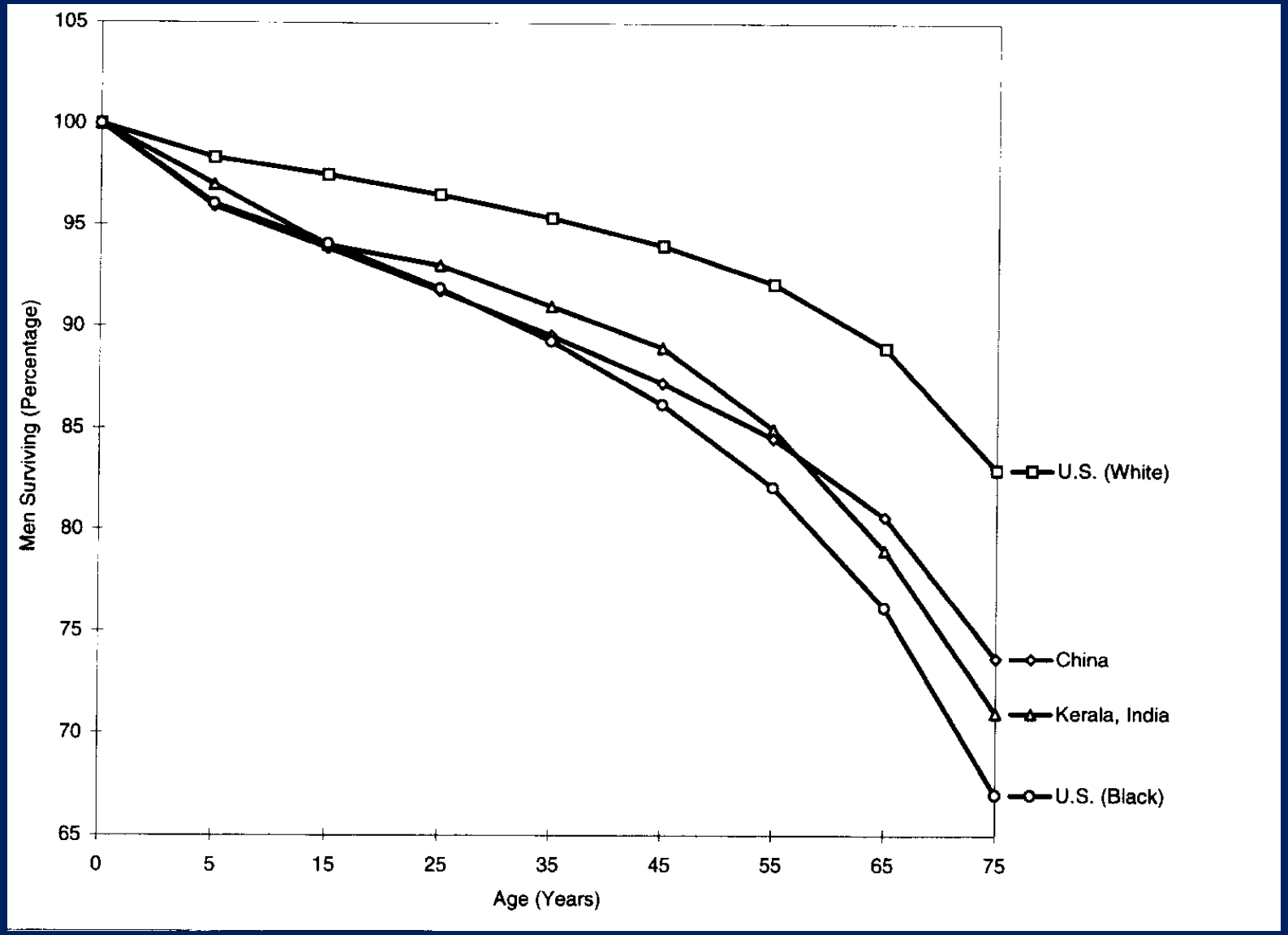
	2006		2018	
	rank	score	rank	score
Global Gender Gap score	**98**	**0.601**	**108**	**0.665**
Economic participation and opportunity	110	0.397	142	0.385
Educational attainment	102	0.819	114	0.953
Health and survival	103	0.962	147	0.940
Political empowerment	20	0.227	19	0.382
rank out of	115		149	

http://www3.weforum.org/docs/WEF_GGGR_2018.pdf

Gender Gap Index- Iceland

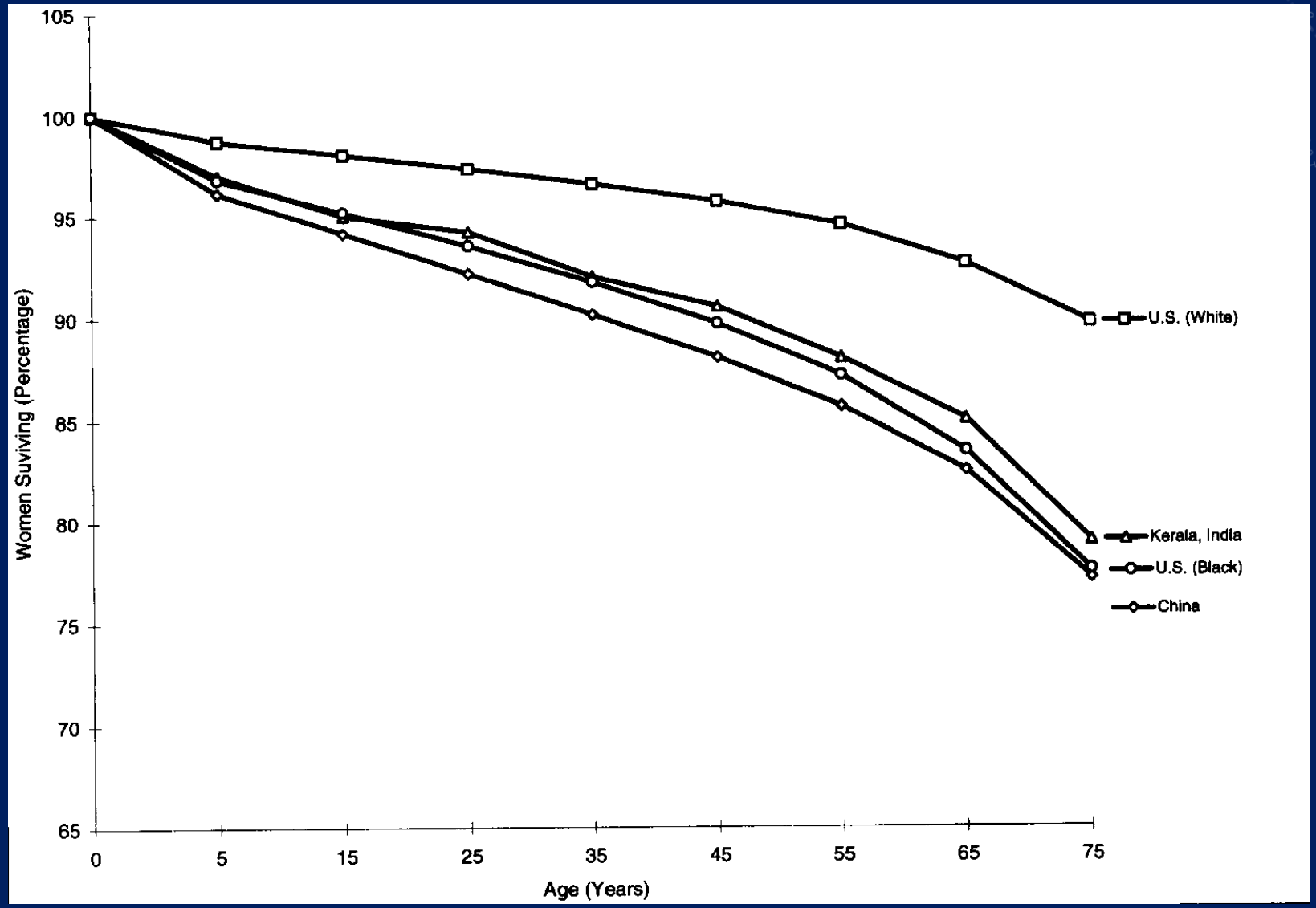
	2006		2018	
	rank	score	rank	score
Global Gender Gap score	**4**	**0.781**	**1**	**0.858**
Economic participation and opportunity	17	0.711	16	0.793
Educational attainment	50	0.991	39	0.999
Health and survival	92	0.968	121	0.968
Political empowerment	4	0.456	1	0.674
rank out of	115		149	

Variations in Male Survival rate by region



Sen, 1997

Variations in Female Survival rate by region



Sen, 1997

References

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Lecture – 3B

Energy Resources, Economics and Environment

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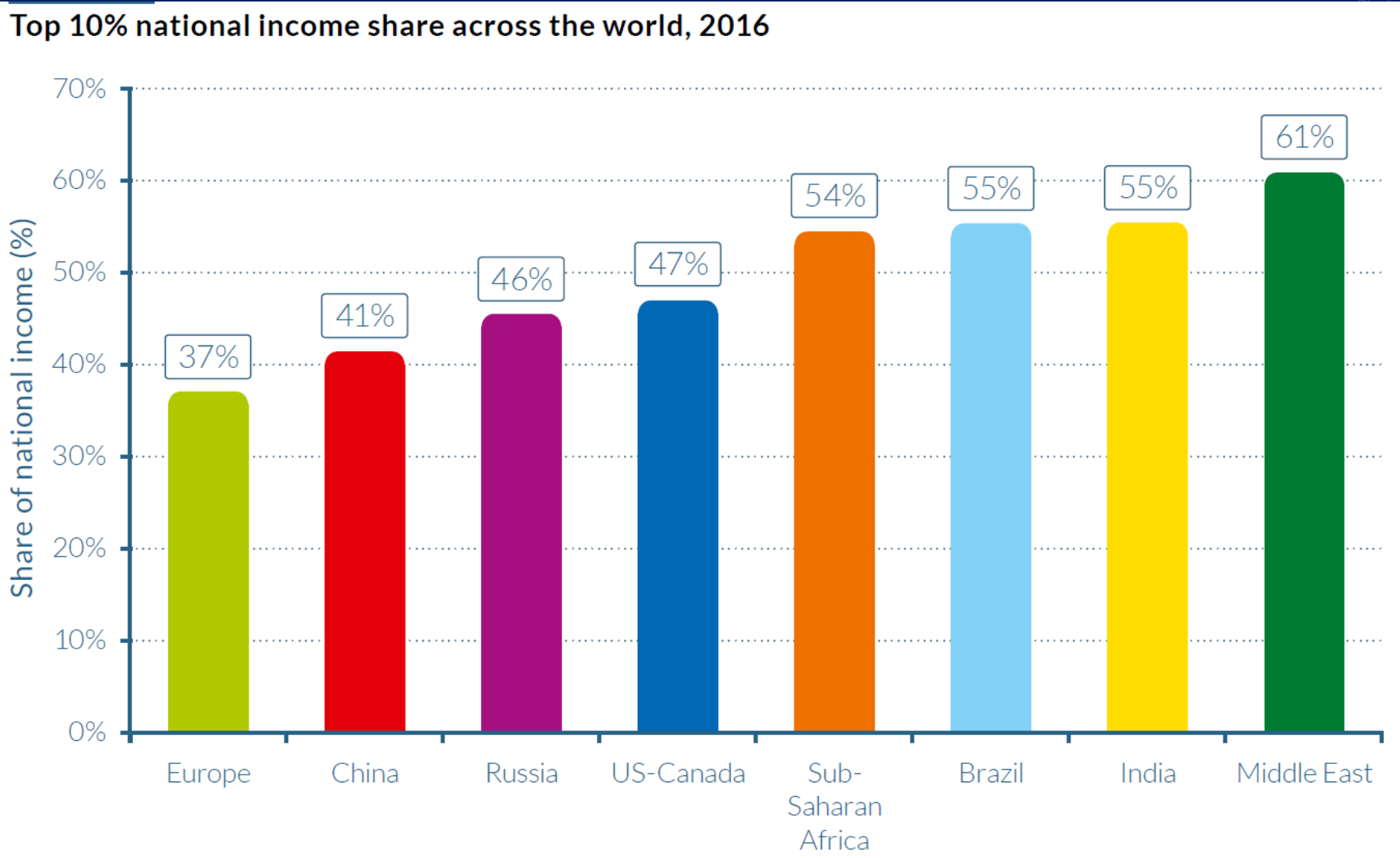
Energy Inequality

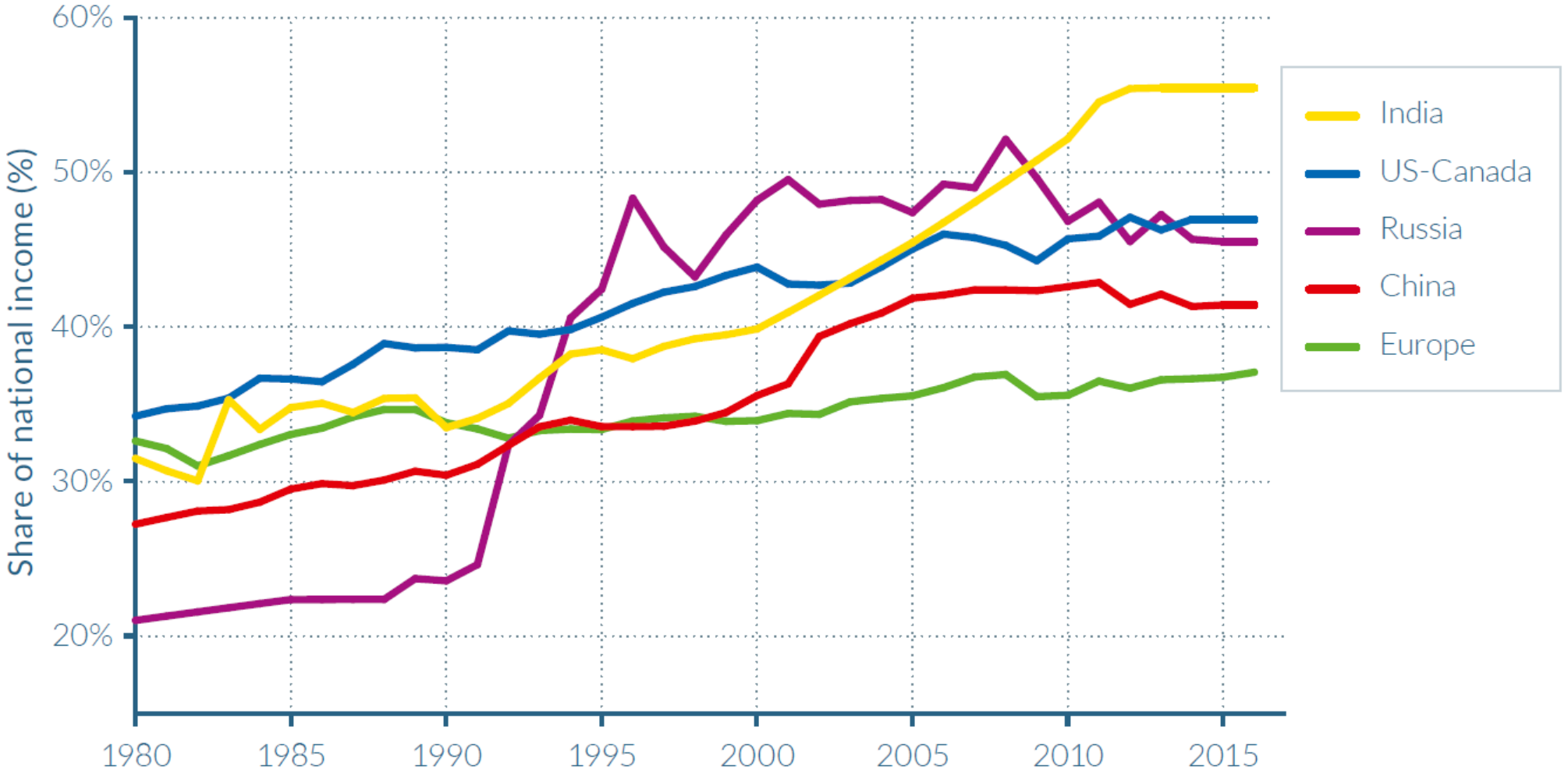
How do we measure inequality? Why is it important?

Top 10% Income share



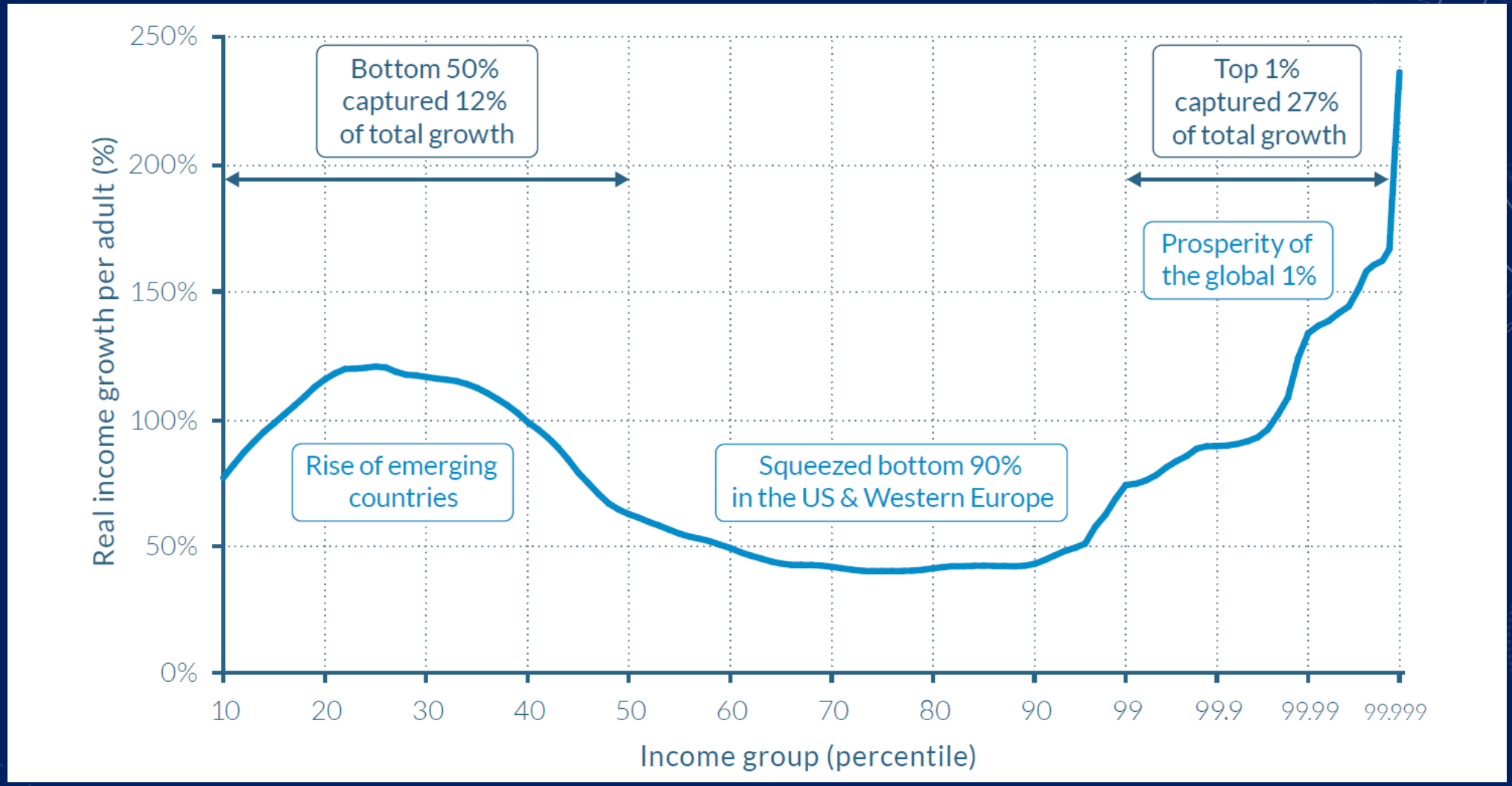
https://wir2018.wid.world/files/download/wir2018-full-report-english.pdf

Share of top 10% Income share



https://wir2018.wid.world/files/download/wir2018-full-report-english.pdf

Global Inequality and growth 1980-2016



https://wir2018.wid.world/files/download/wir2018-full-report-english.pdf

Lorentz Curve

- L(x) – Proportion of income earned by the lowest x proportion of population
- L(0) = 0 L(1) =1, L increasing function
- Extreme Cases

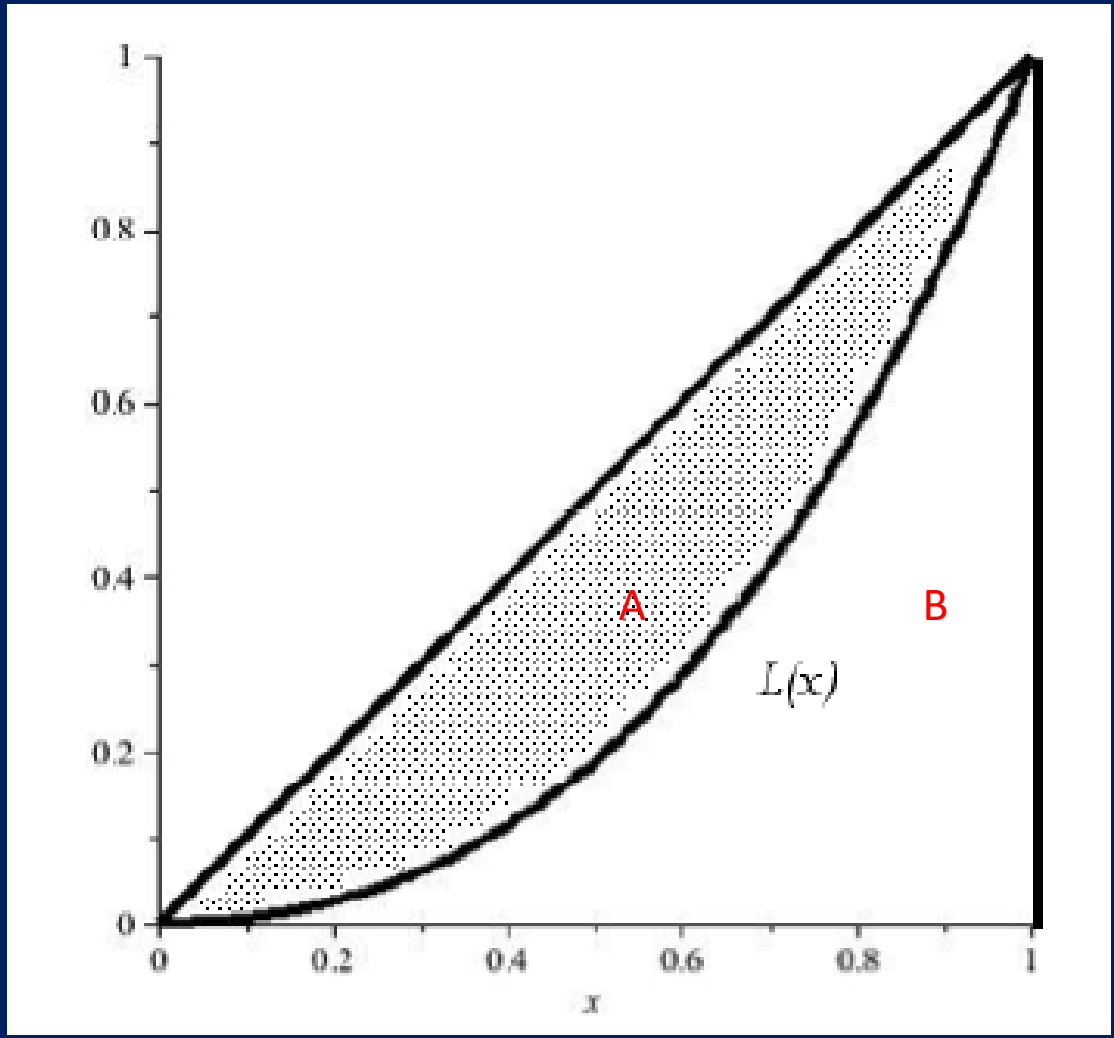
  L(x) = x 45% line Absolute equality – all earn the same

  Absolute Inequality

  L(x) = 0 $0 \leq x < 1$, L(1) =1

Nobody earns any income except one person

Lorentz Curve - Inequality



Gini Co-efficient

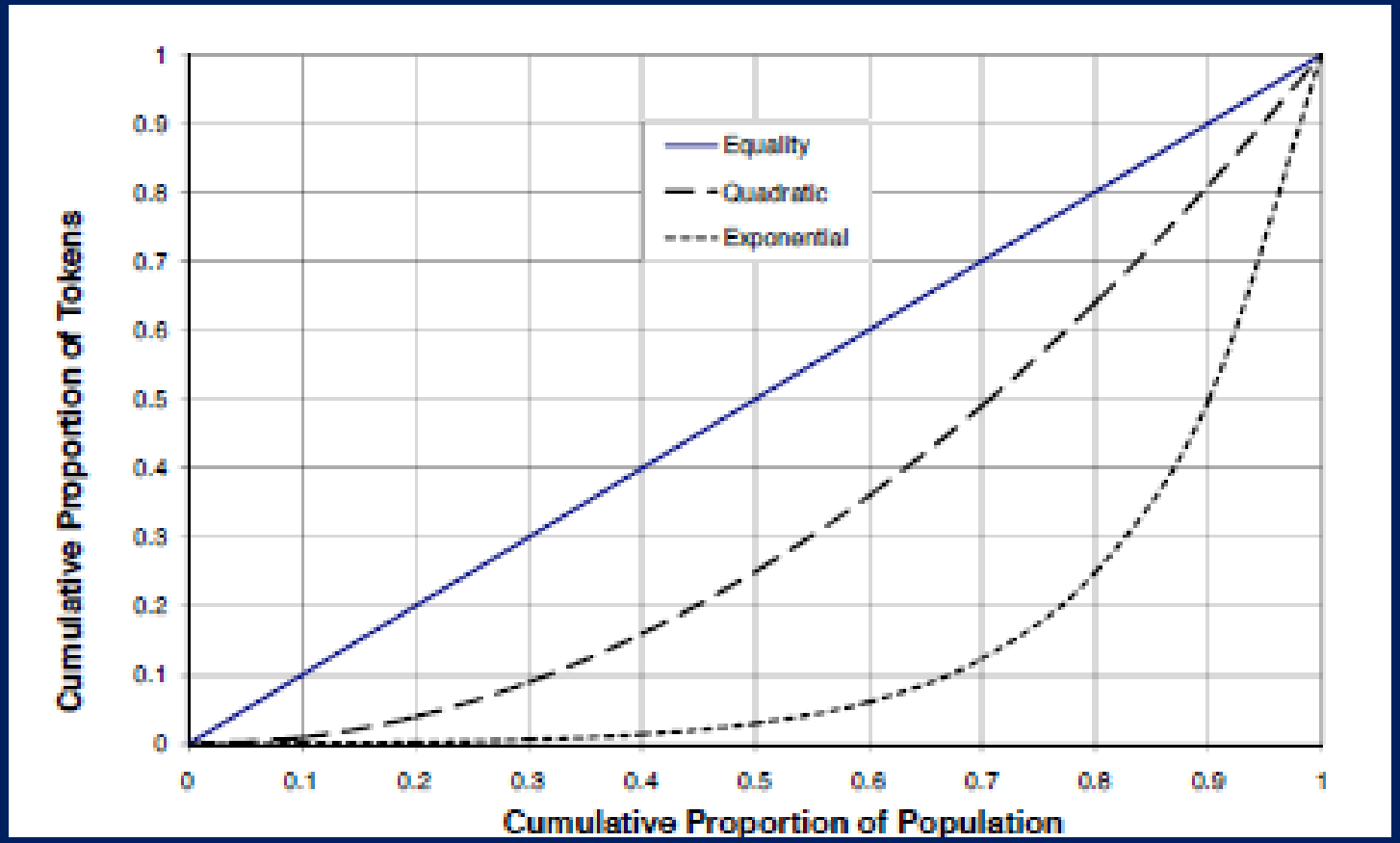
- Gini coefficient = A/ (A+B)
- A+ B = 0.5
- Gini coefficient = 2 A

$$= 2\int (x - L(x))dx$$

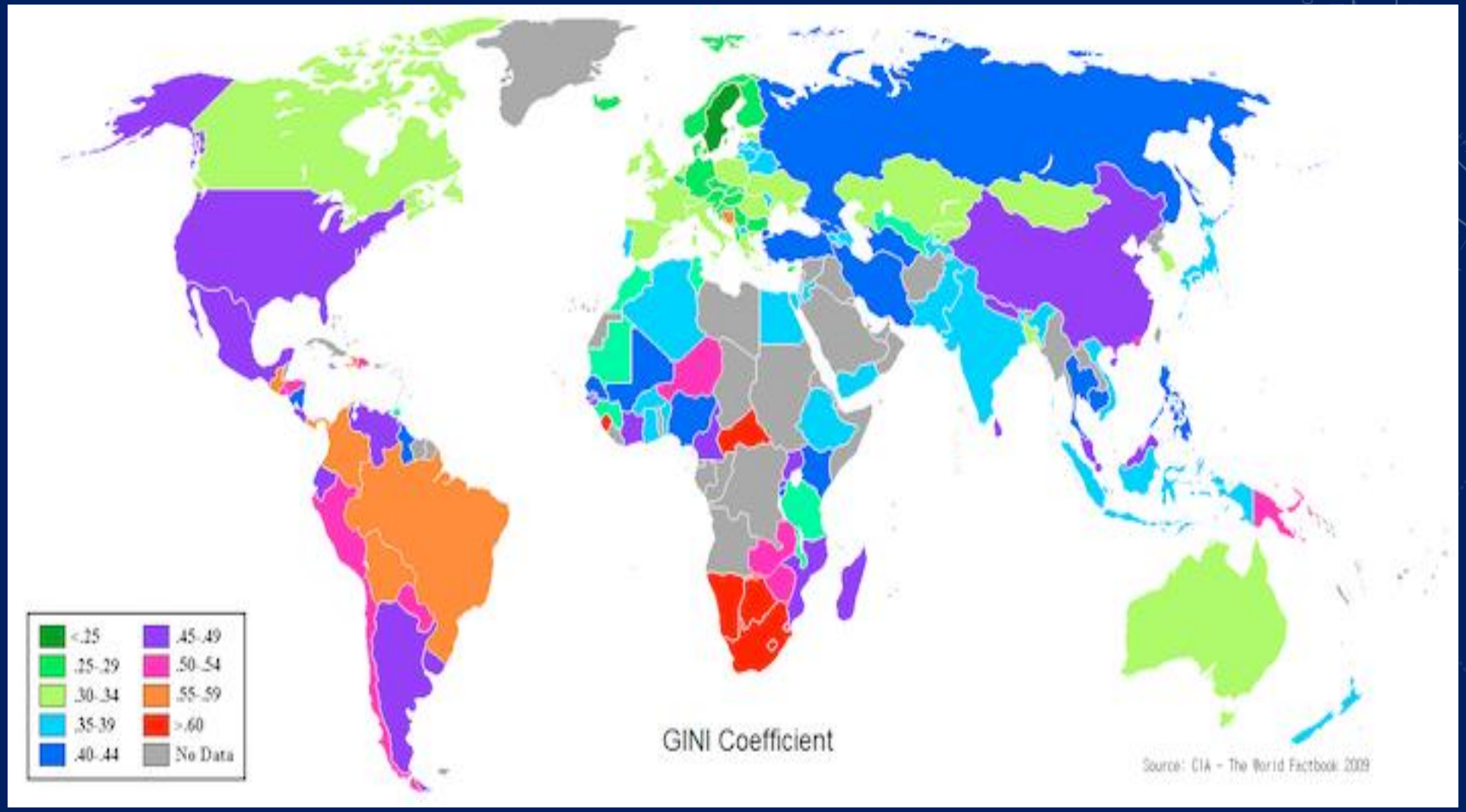
$$= 1\text{-}2B = 1 - 2\int L(x)dx$$

$$G_c = 1 - \sum_i (Y_{i+1} + Y_i)(X_{i+1} - X_i)$$

Lorenz Curves



Gini Coefficient - 2009

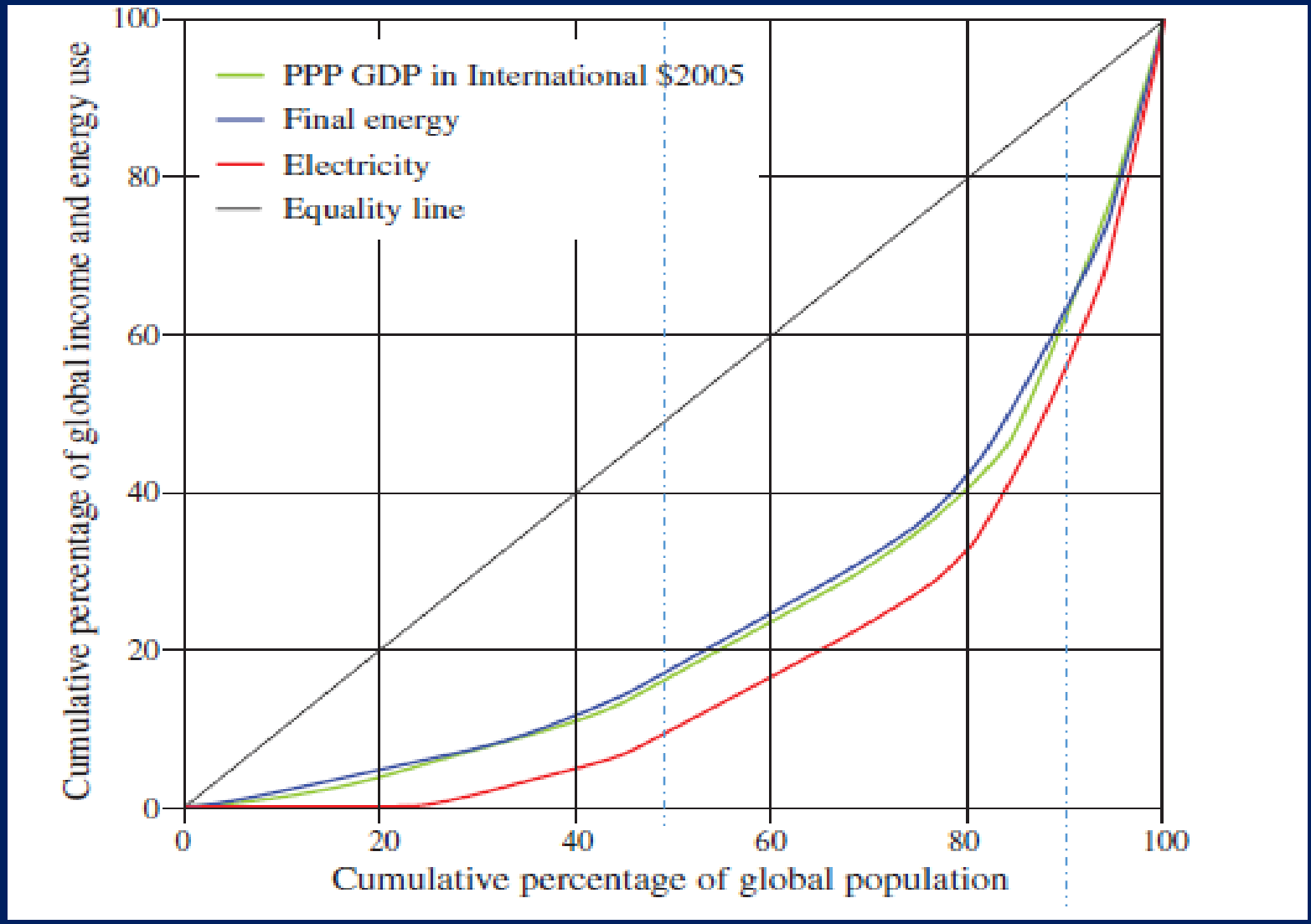


Data set : US Household Electricity consumption

Table 1: Deciles of U.S. Household Electricity Consumption

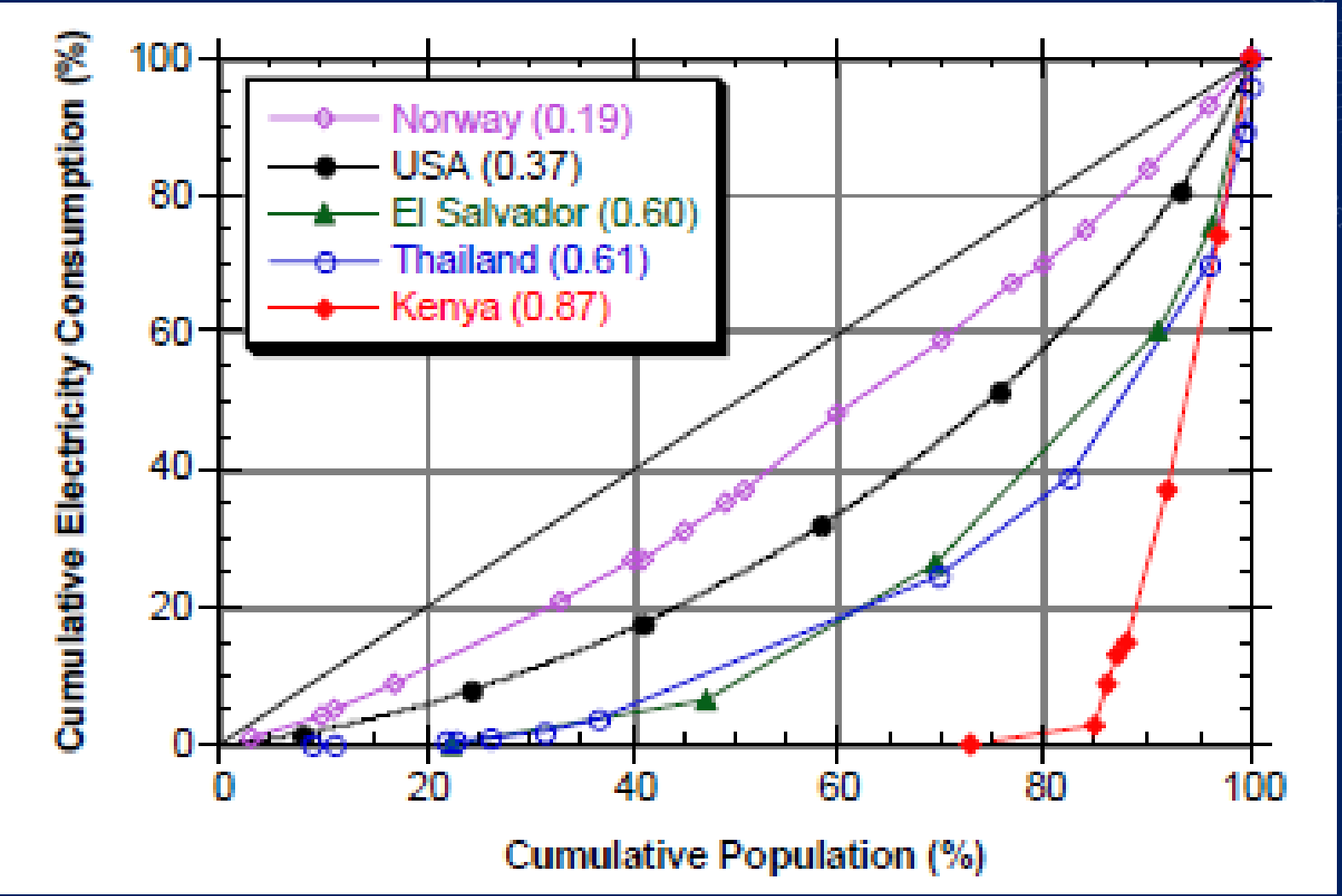
Proportion of Population	Cumulative Proportion of Electricity Consumption
0.0	0.000
0.1	0.023
0.2	0.060
0.3	0.110
0.4	0.175
0.5	0.254
0.6	0.345
0.7	0.459
0.8	0.588
0.9	0.754
1.0	1.000

Energy and Equity



Source: GEA, 2012

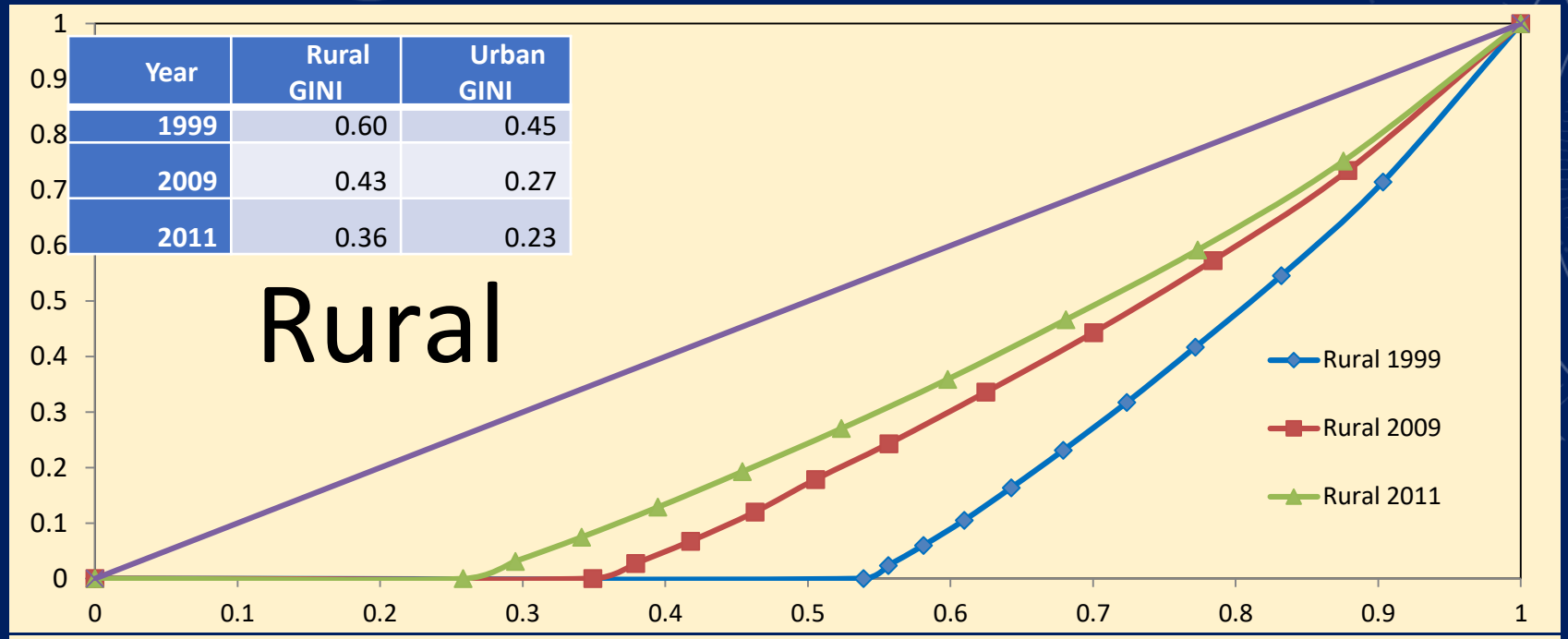
Residential Electricity Gini (Select countries)

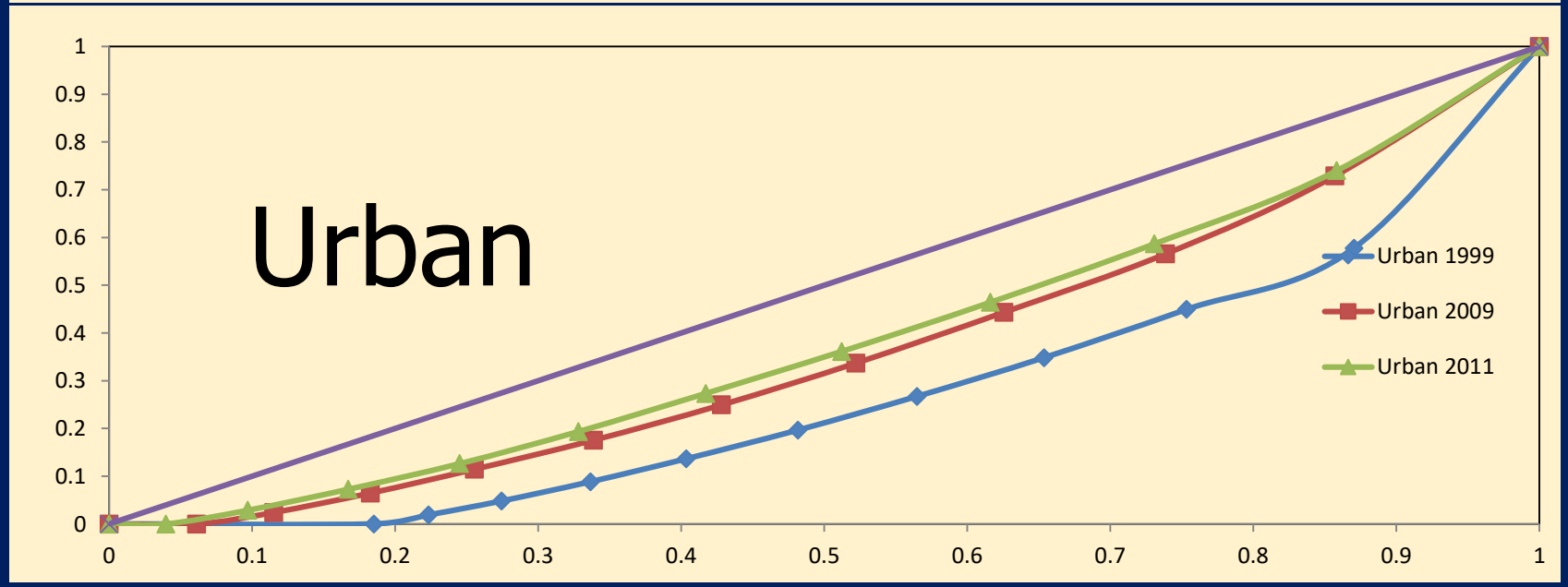


Source: Jacobsen, Energy Policy , 2005

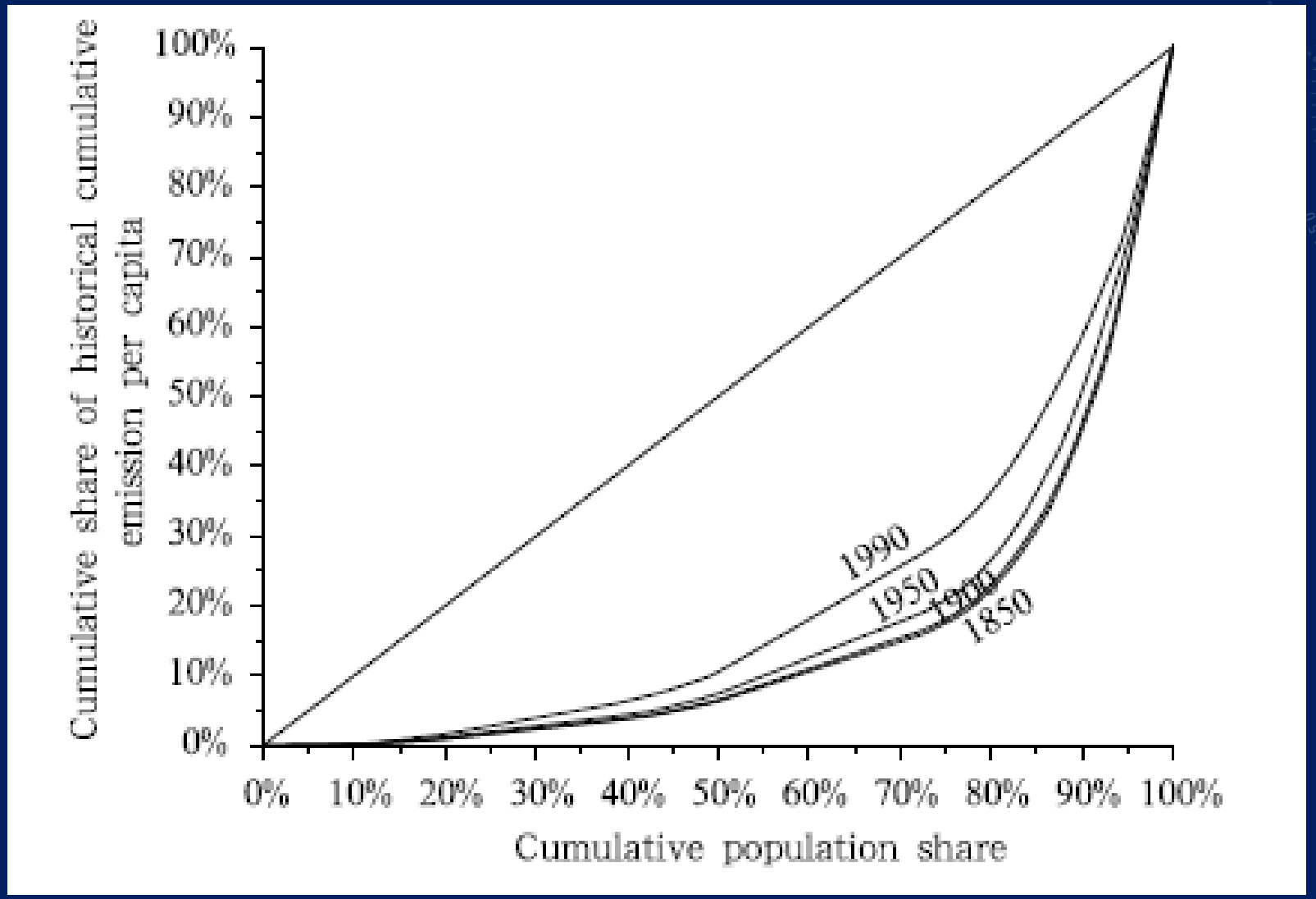
Electricity Lorenz Curves India

Year	Rural GINI	Urban GINI
1999	0.60	0.45
2009	0.43	0.27
2011	0.36	0.23



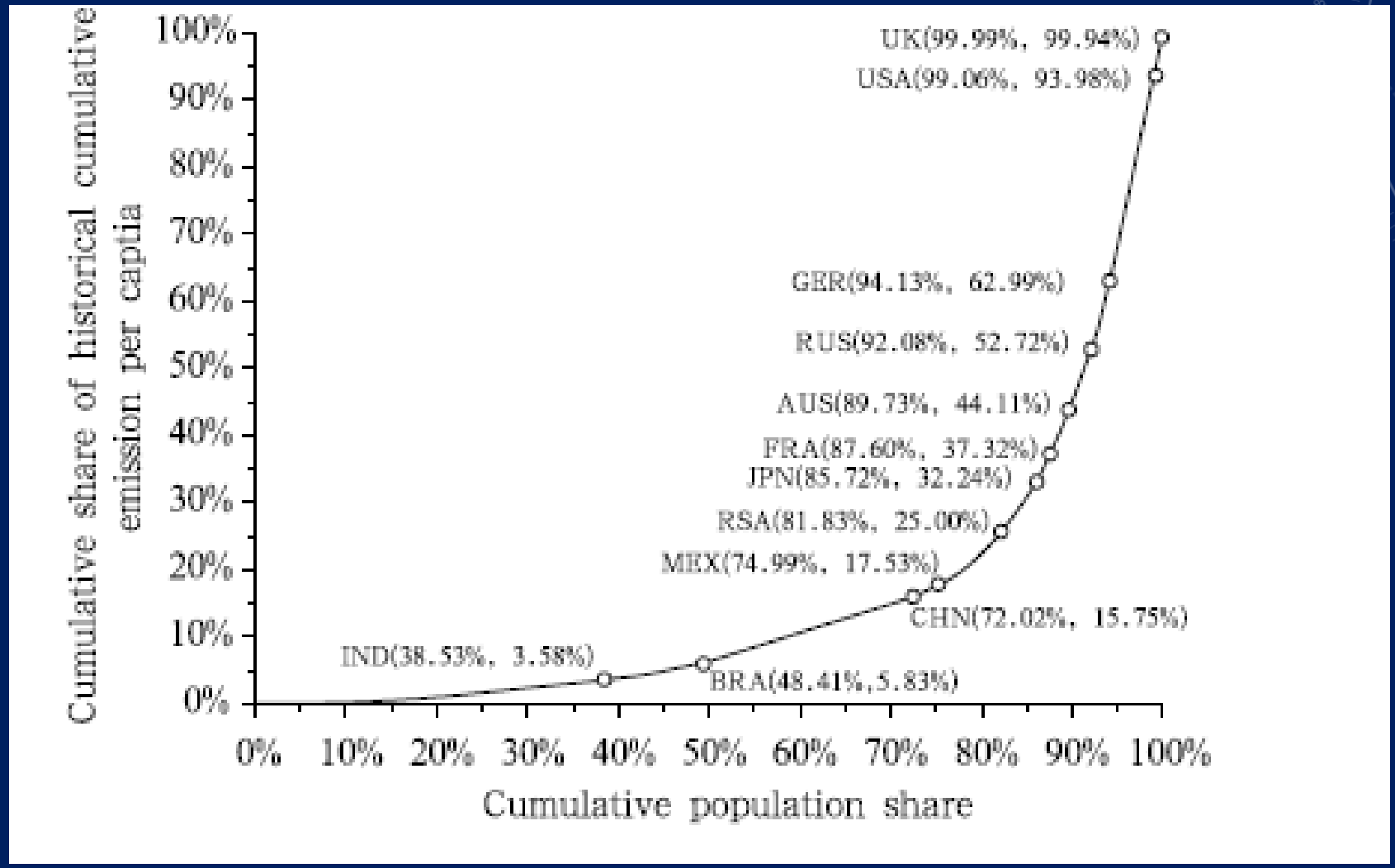


Carbon Gini



Teng et al, 2011

Carbon Gini



Teng et al, 2011

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Lecture – 3C

Energy Resources, Economics and Environment

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Department of Energy Science and Engineering

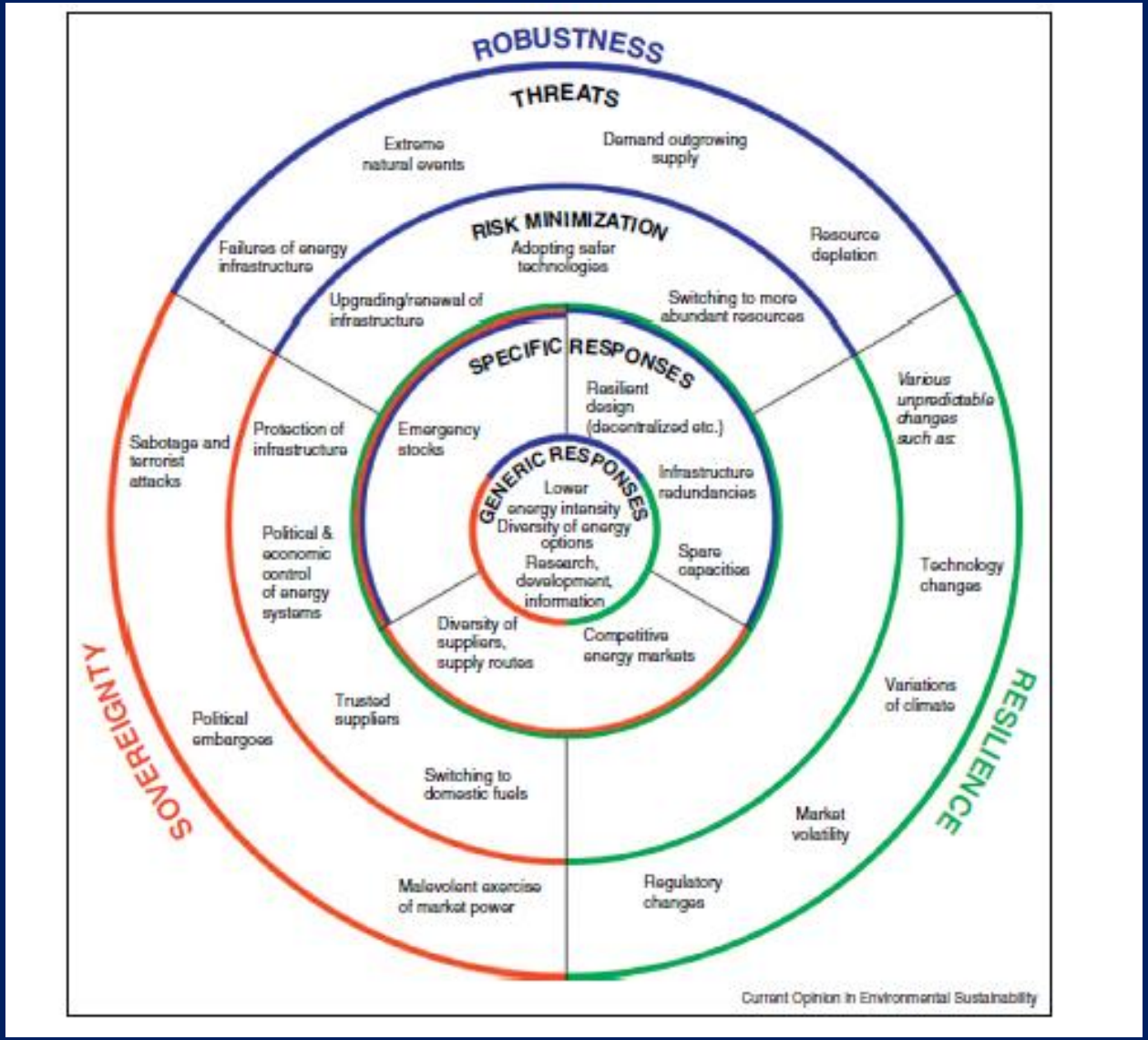
IIT Bombay

Energy Security

Energy Security

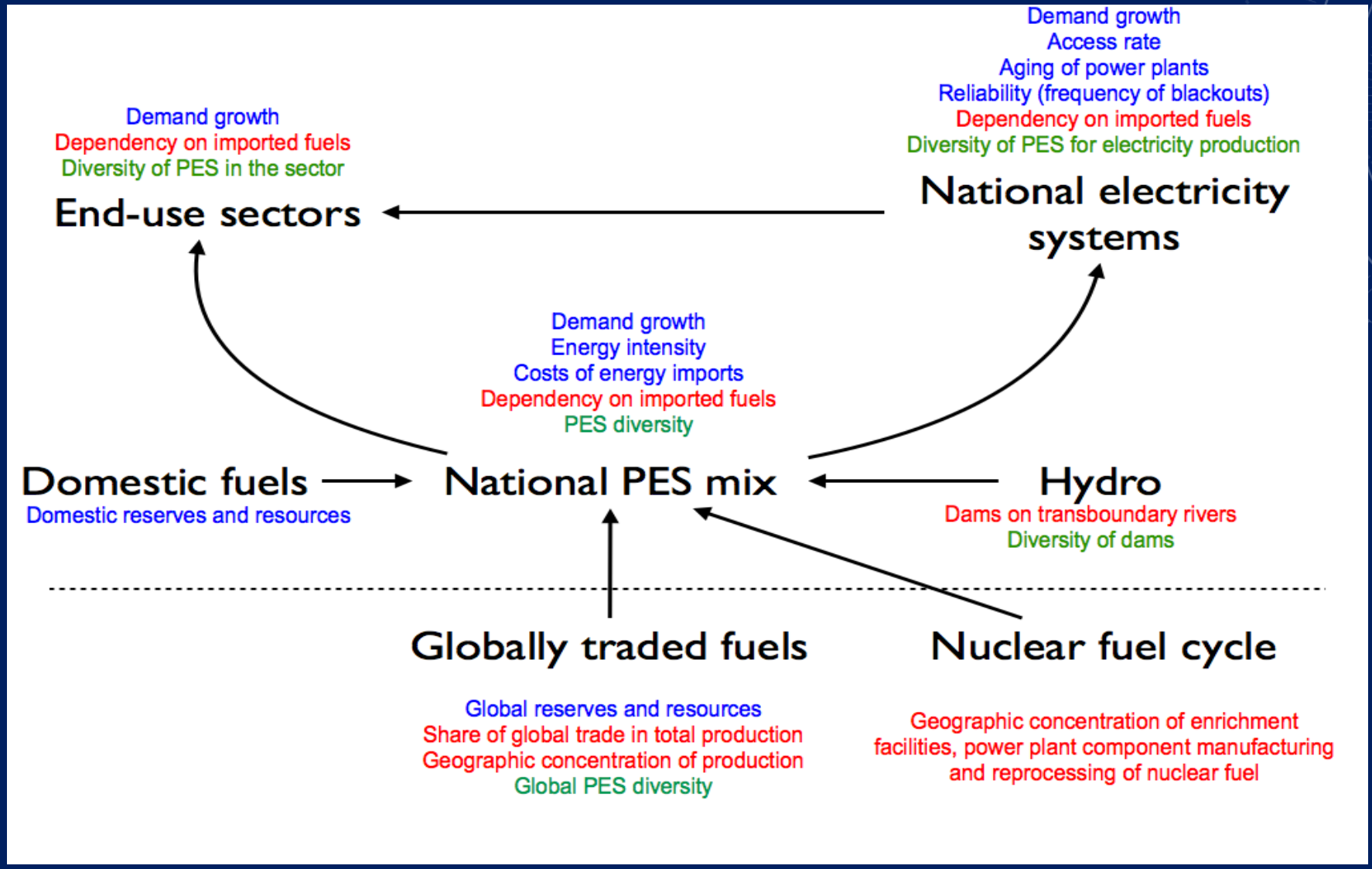
- What is Energy Security?
- What are the parameters that affect Energy Security?
- What are the options to enhance energy security?

Perspectives On Energy Security



Source: Cherp and Jewell, 2011

Energy Security - Parameters



Source: Cherp and Jewell, 2011

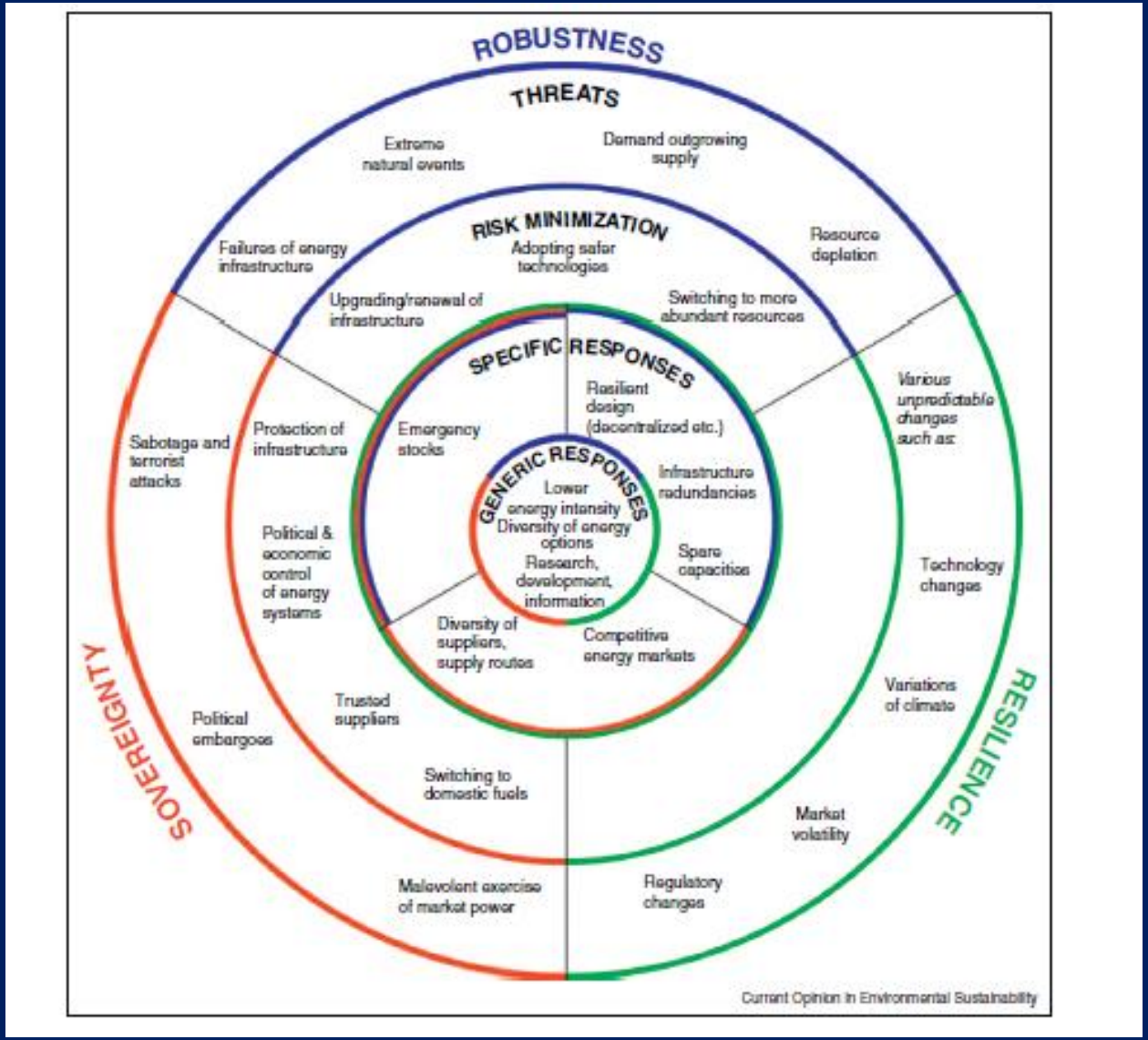
Energy Security Definition

- Energy Security – Uninterrupted provision of vital energy services - priority for every country
- Robustness
- Sovereignty
- Resilience

Energy Security Definition

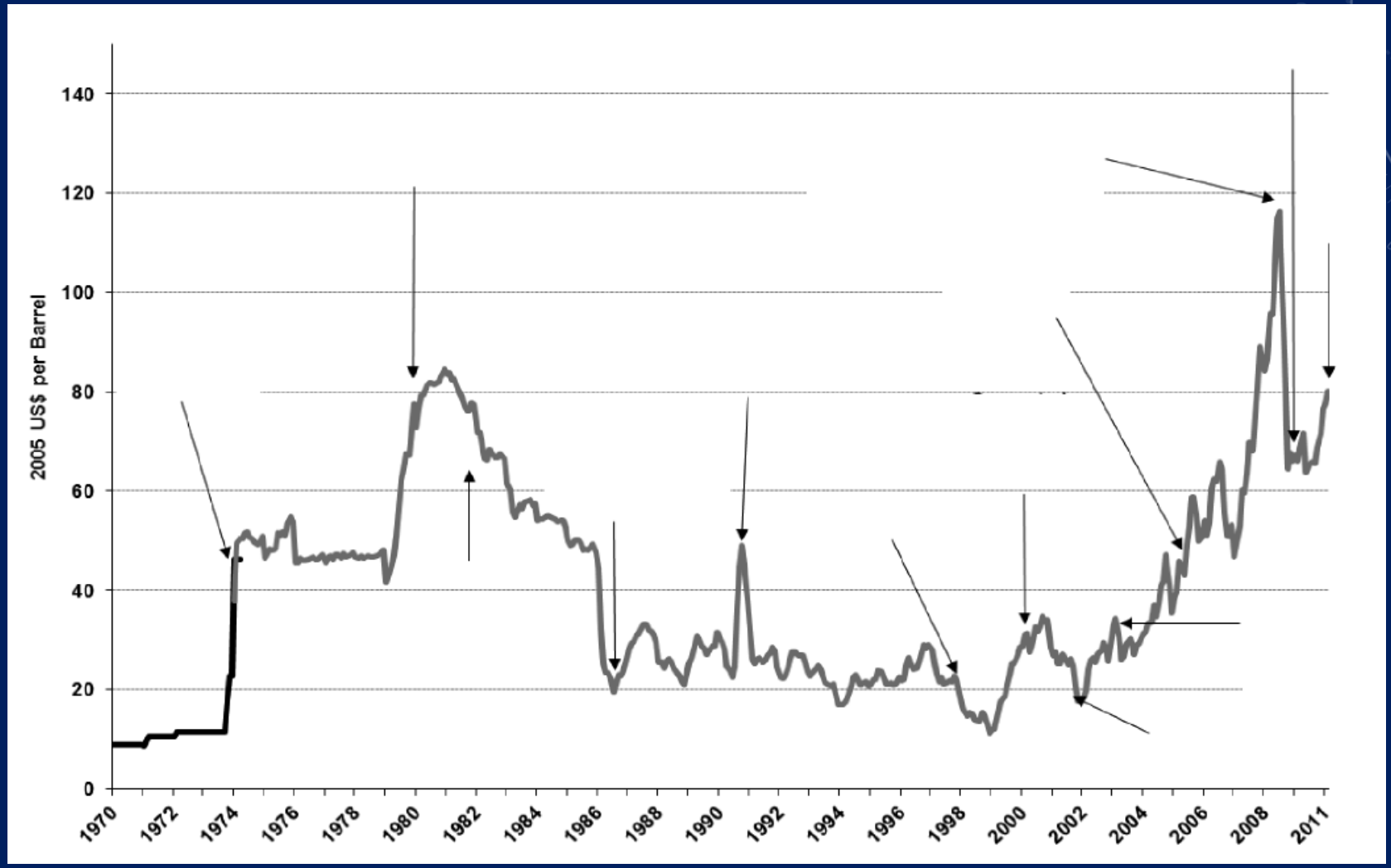
- Energy Security – Uninterrupted provision of vital energy services - priority for every country
- Robustness – Sufficiency of resources, Reliability of infrastructure, Stable and Affordable prices
- Sovereignty- Protection from potential threats from external agents
- Resilience – Ability to withstand diverse disruptions

Perspectives On Energy Security

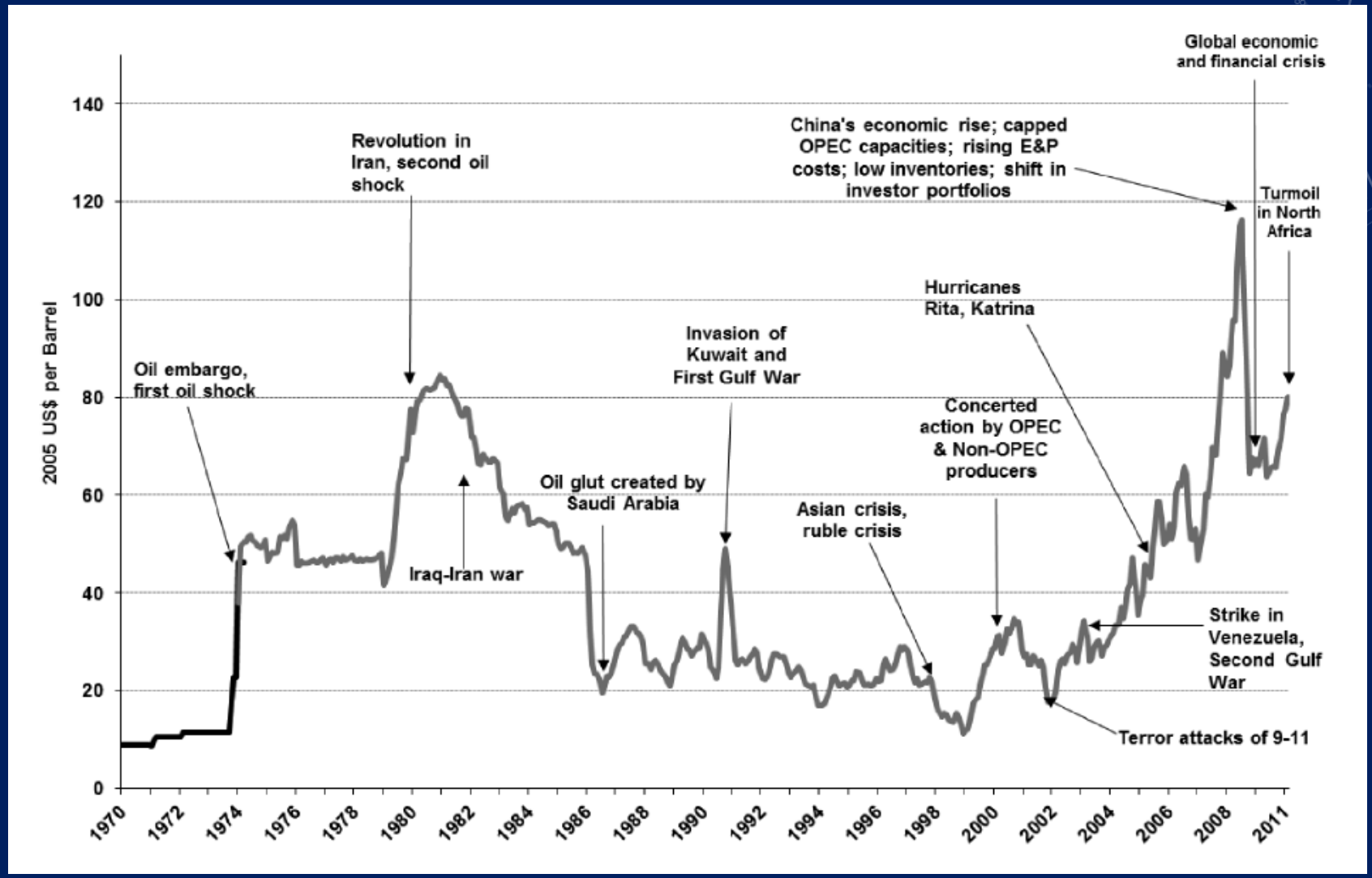


Source: Cherp and Jewell, 2011

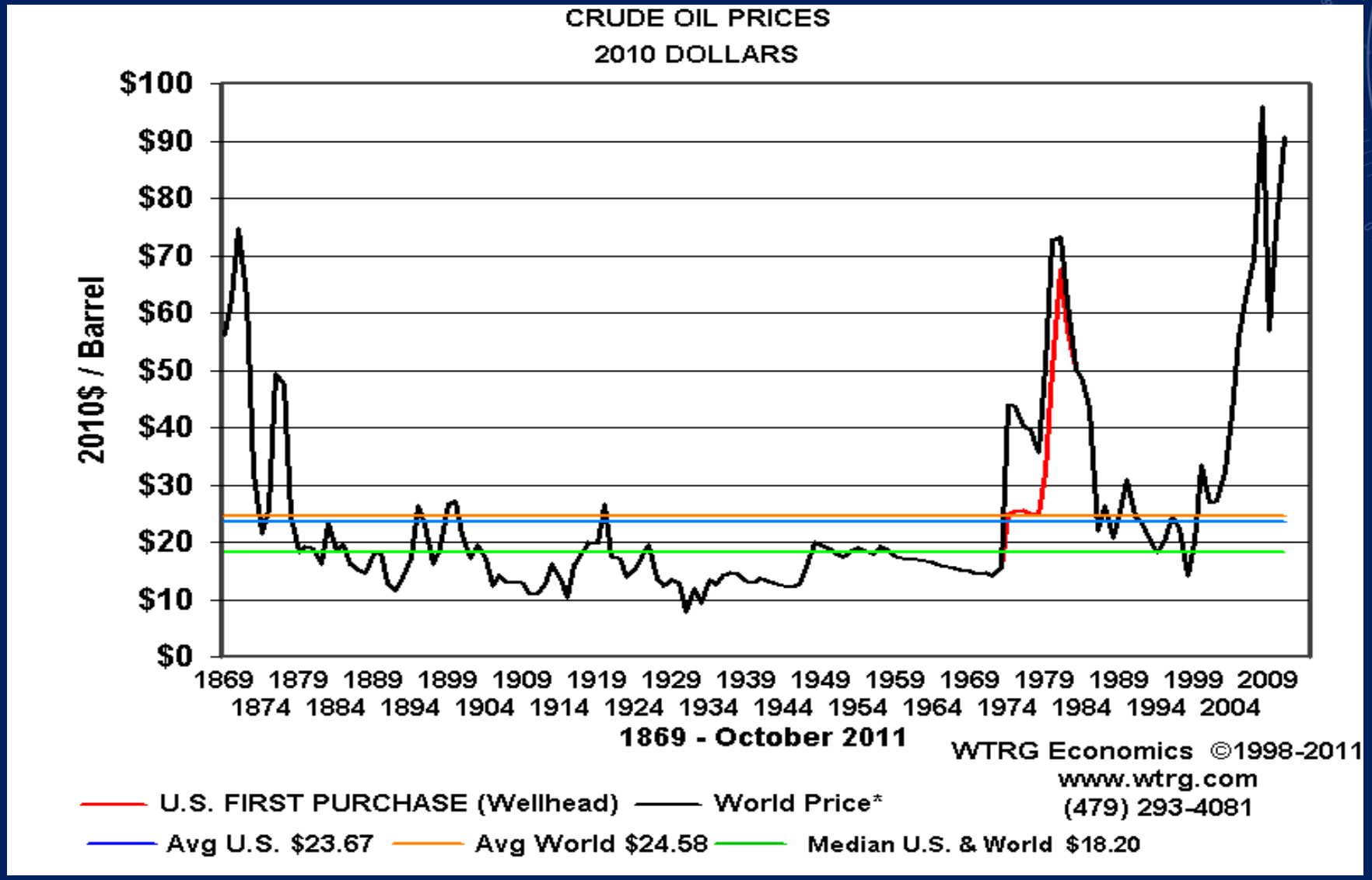
Oil Prices 1970-2011



Energy Prices and World Events

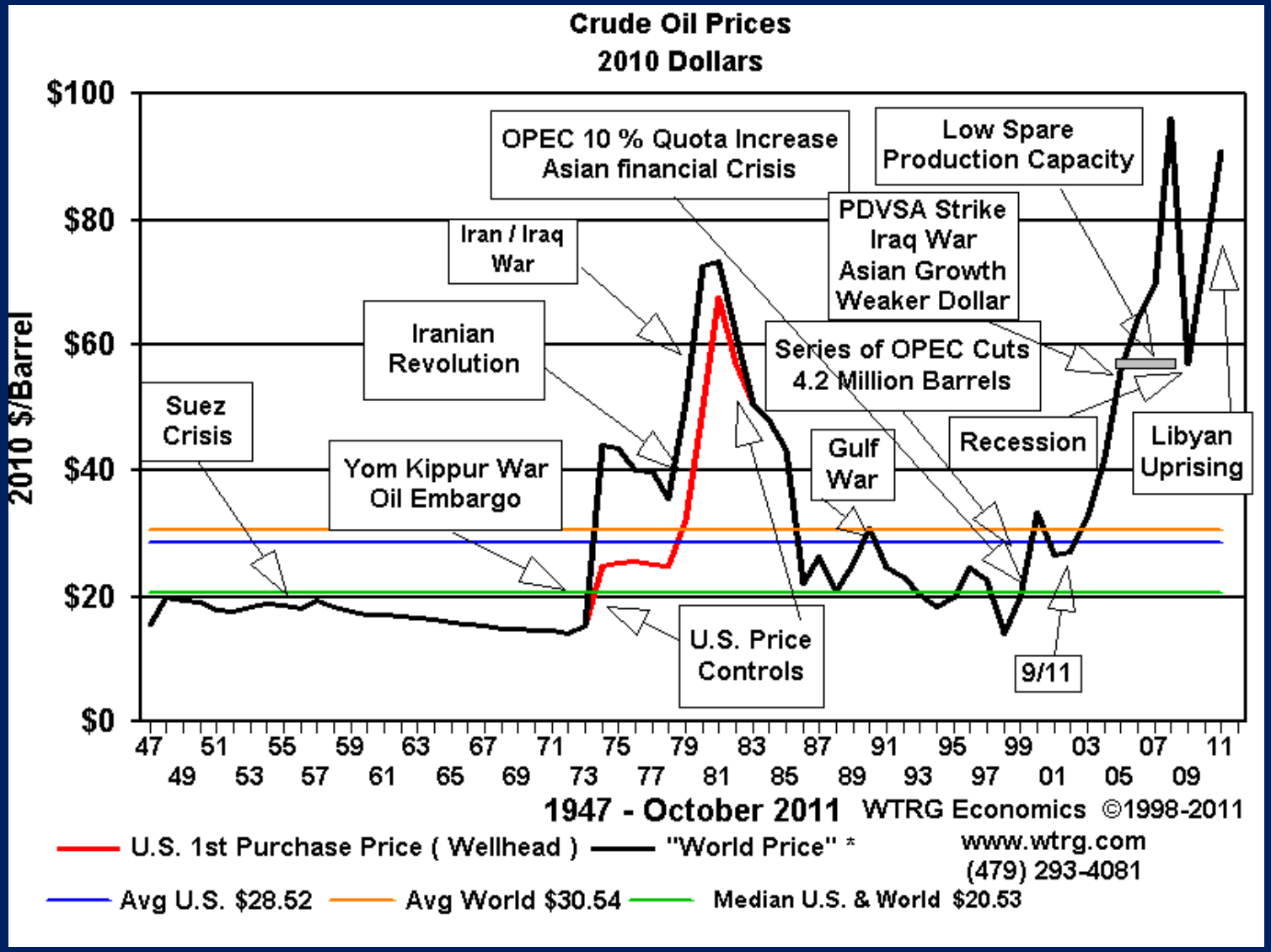


Oil Price variation 1869-2011



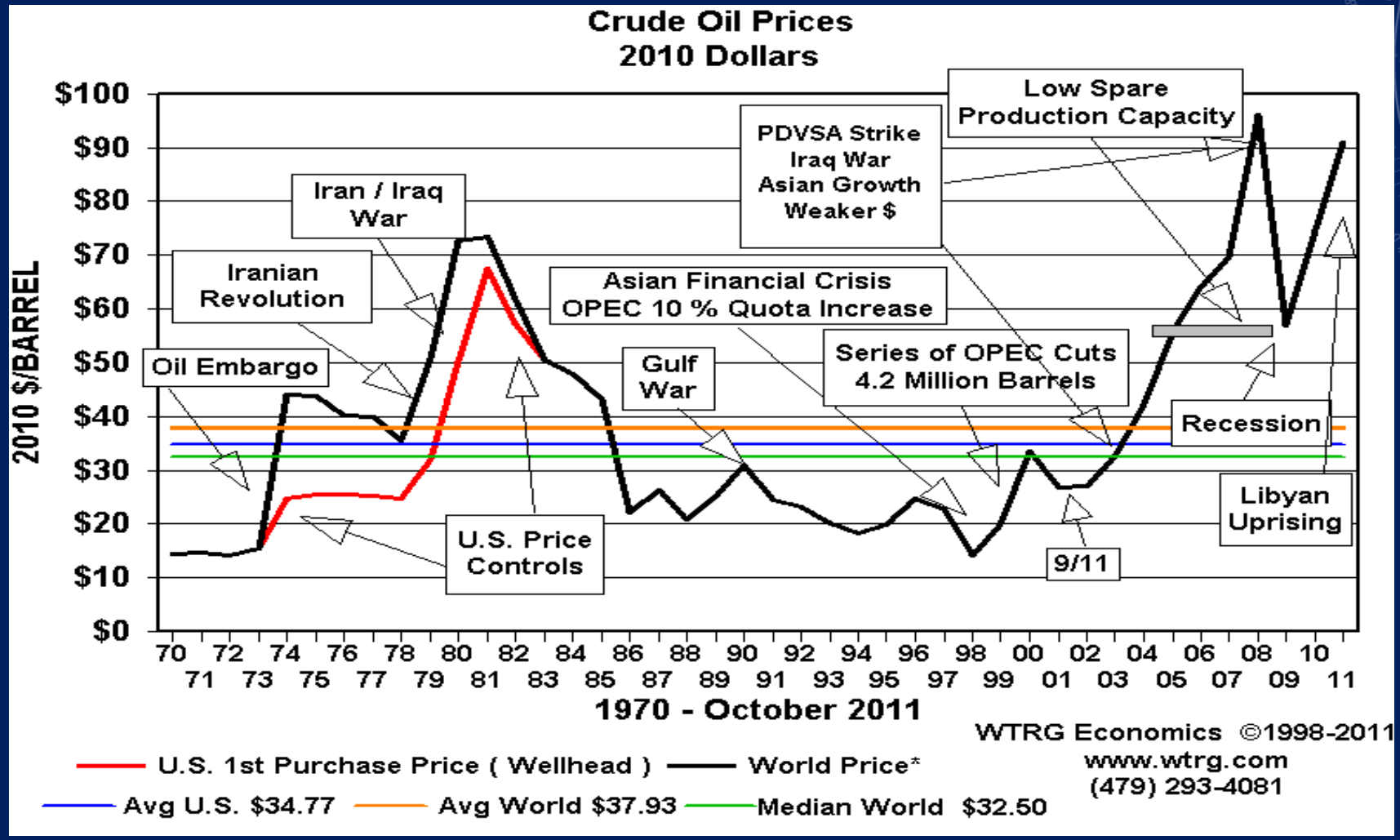
http://www.wtrg.com/prices.htm

Oil Price Variation and Events (1947-2011)



http://www.wtrg.com/prices.htm

Oil Price Variation and Events (1970-2011)

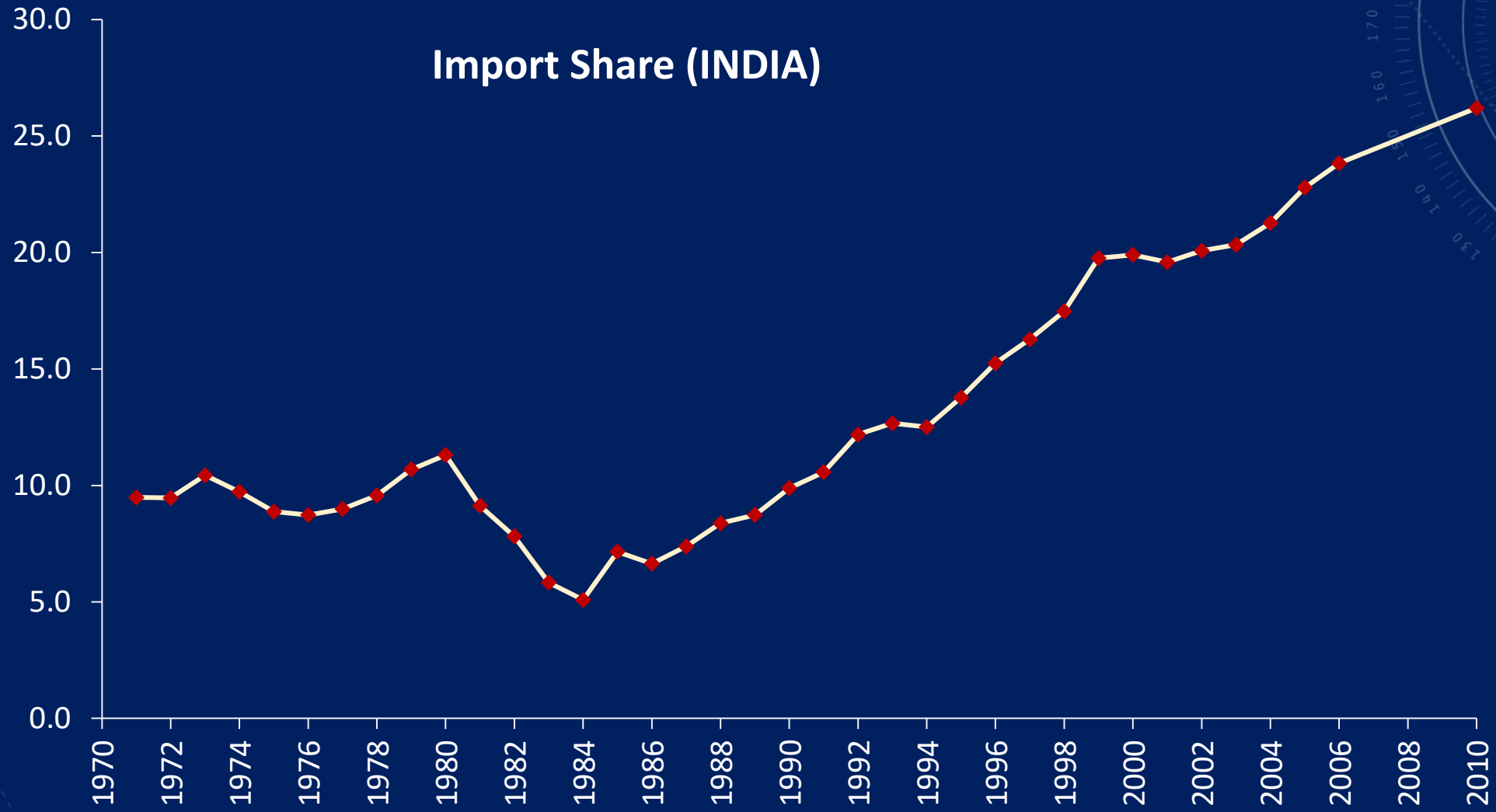


http://www.wtrg.com/oil_graphs/oilprice1970.gif

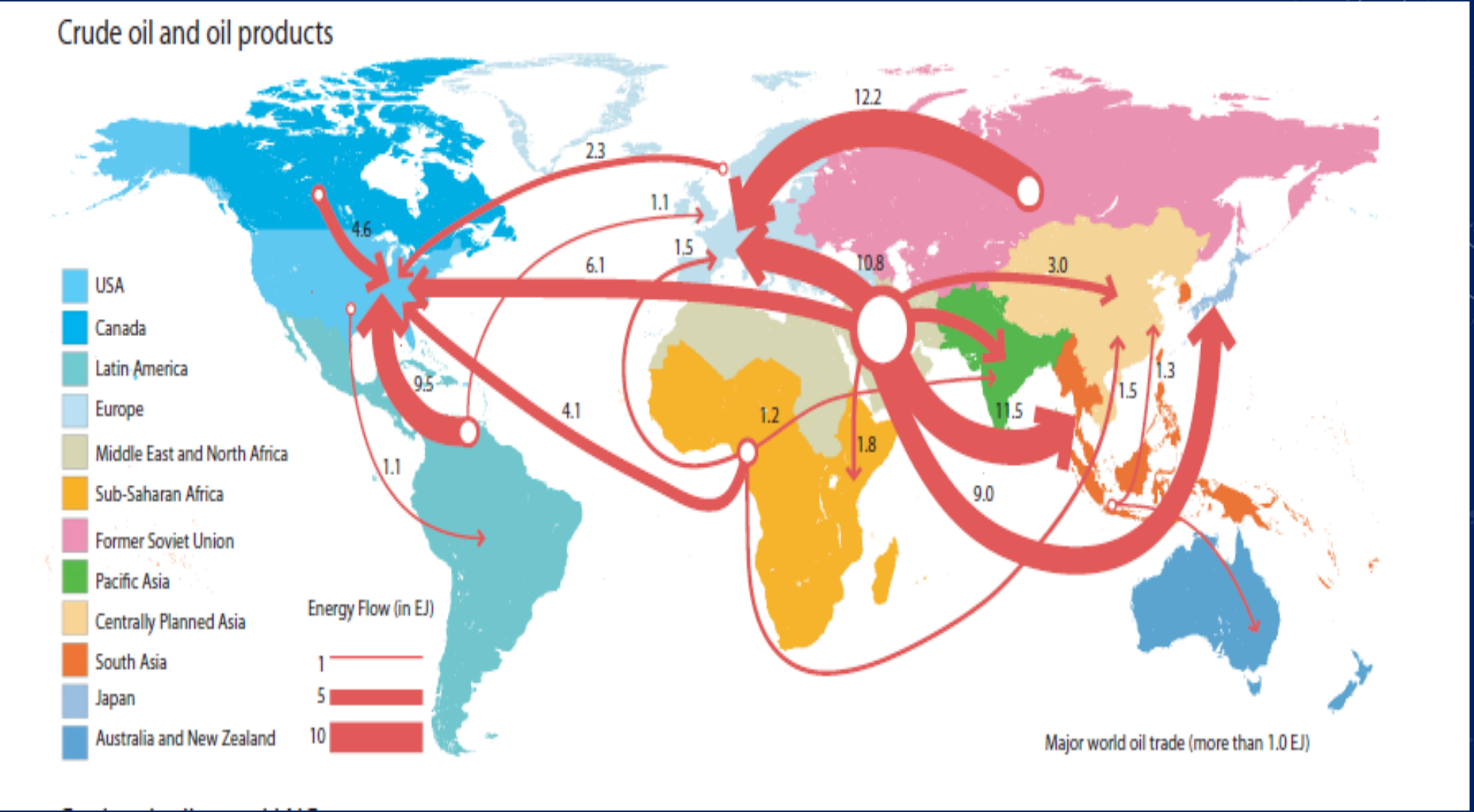
http://www.macrotrends.net/1369/crude-oil-price-history-chart'>Crude Oil Price History Chart

Energy security perspectives	Robustness		Sovereignty	Resilience	
Globally traded fuels					
	Global R/P ratio	Projected demand growth 2008–2035*	Share of international trade in global production in 2009	Number of people (billions) in countries with import dependencies over 25/50/75%	Diversity of global producers by region, SWDI
Oil	30 yr.	15%	66%	5.3/3.6/3.1	1.63
Gas	80 yr.	44%	29%	2.2/0.75/0.65	1.84
Coal	150 yr.	19%	14%	1.3/1.1/0.70	1.92
Other energy sources					
Nuclear	Aging of nuclear power plants; sensitivity to political interventions		Concentration of enriched uranium and reactor manufacturing technologies; nuclear fuel cycle controlled for non-proliferation reasons	Generally large facilities; difficult to substitute in case of failure	
Hydro	Sensitivity to water availability; vulnerability to climate change in some regions.		Hydroelectric facilities located on internationally shared rivers	In certain cases extremely large facilities providing majority of electricity of certain countries	
NRES	High initial costs; intermittency of supply		Technological dependencies; potential import dependencies for biofuels	Generally assumed to be higher than in the case of traditional sources due to distributed generation and more diverse energy mix	

Share of Energy Imports - India



Crude Oil and Oil Products - Trade



Source: GEA, 2012

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