Energy and Society

Jan Osička

Development stages

- Pre-agricultural era (human power)
- Agricultural era (animal power)
- Mechanical power era
- Fossil fuels
- Electricity

Foraging society

- Energy needs covered by human body

What is the average power output of a human body?

Foraging society

- Energy needs covered by human body
- Sustained power 50-90 W, short-run power 100 W, maximum power 1000 W.
- Transformation efficiency:
  - Chemical energy food => muscles up to 99 %
  - Chemical energy => kinetic energy around 20-25 %
- Energy return on investment (EROI) up to 40, usually around 3, often around 1.
- Very low population density (0,1 person/sq. km)
- Exosomatic sources of power: fire, body extensions (bows)

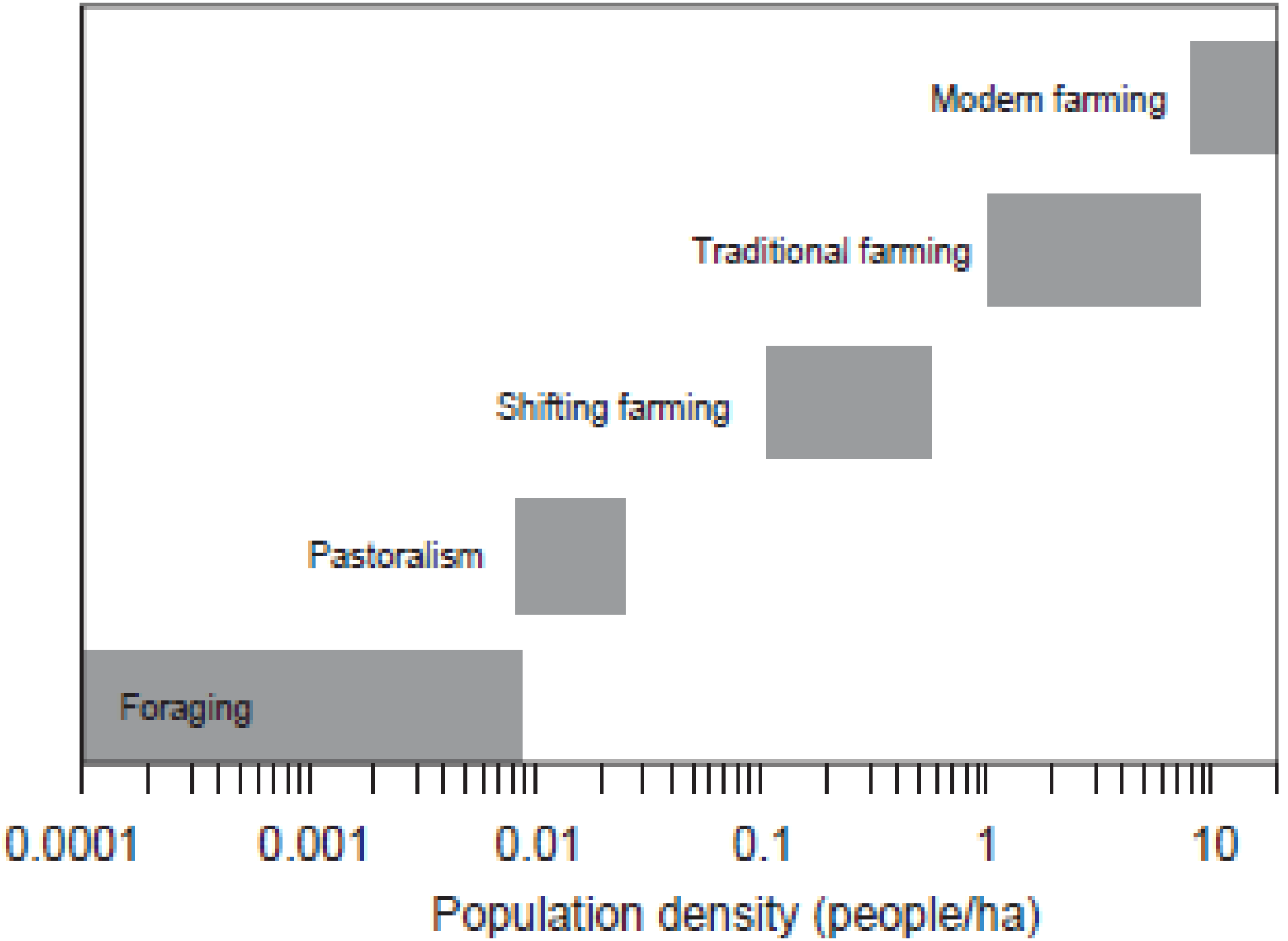
Agricultural society

- Very slow pace of transition (never finished)
- Greater population density (20-30 persons/sq. km)

- First exosomatic sources of power:
  - Oxes (200-500 W)
  - Charcoal (29 MJ/kg, no smoke)

- Metallurgy: low efficiency, high energy intensity (until 1750)

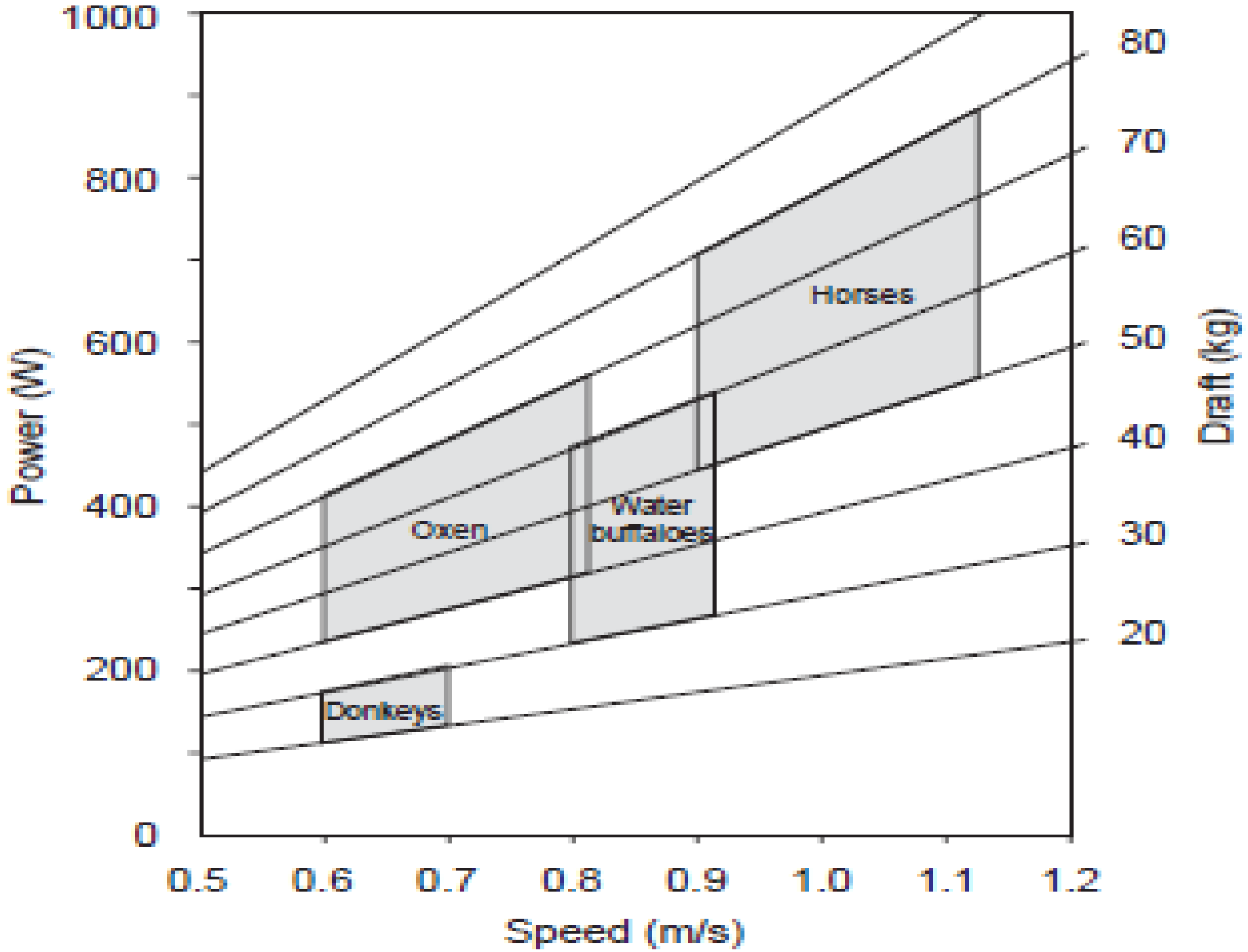
- Mechanical propulsion (windmills)


Modern farming
Traditional farming
Shifting farming
Pastoralism
Foraging
0.0001
0.001
0.01
0.1
1
10
Population density (people/ha)

Progress in the Middle Ages

- Organic prime movers still dominant
- Increased efficiency in energy transformation (treadwheels, horseshoes, fodder, breeding)

- Non-organic prime movers
  - Watermills (England, 11th century)
  - Wind power: sails (+ compass, heavy cannons, rear stear = colonization)
  - Fuel scarcity (England at 1710s: 12 000 tons of wood/year)

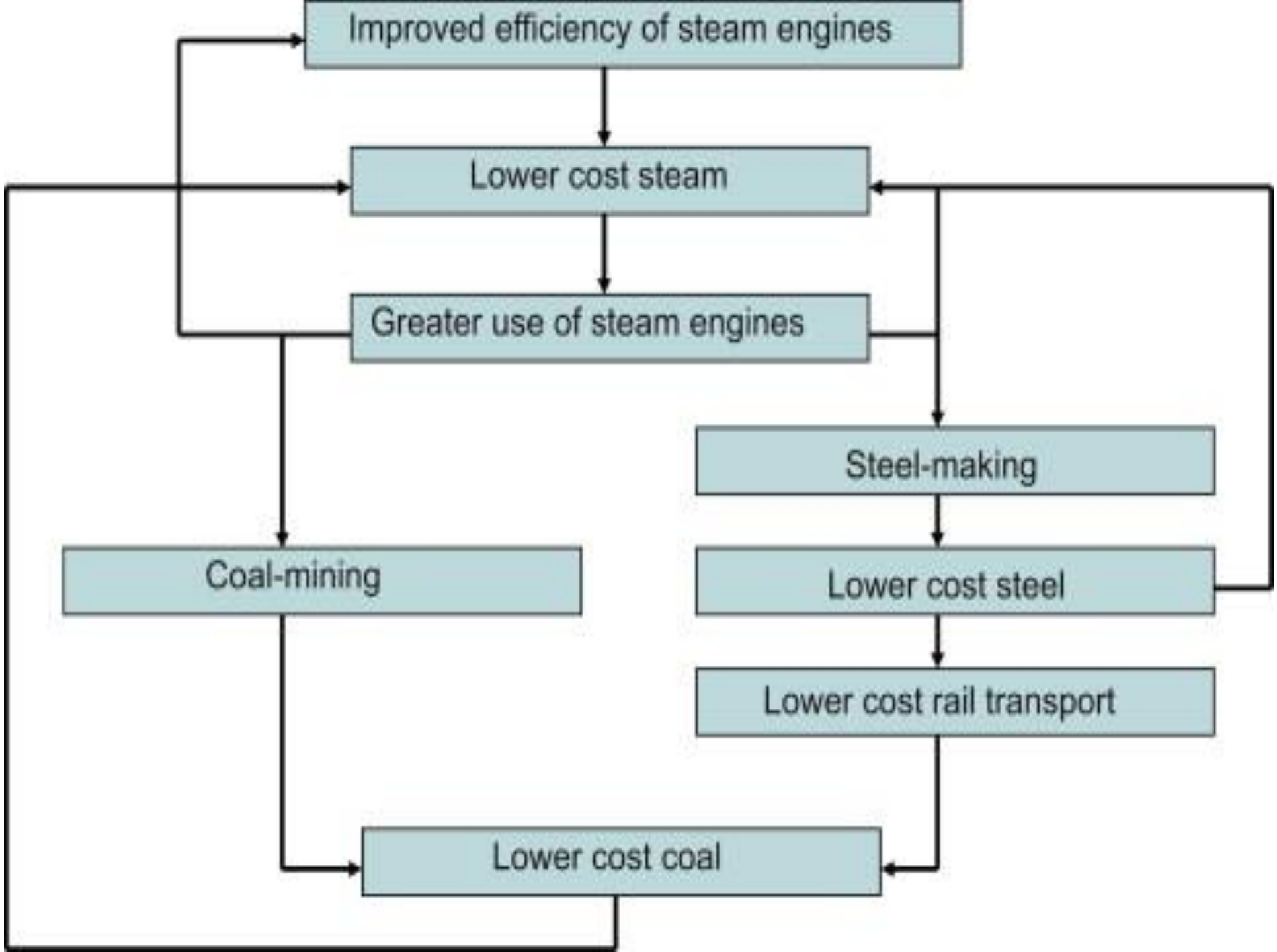

1000
800
600
400
200
0
Power (W)
80
70
60
50
40
30
20
Draft (kg)
Horses
Oxen
Water buffaloes
Donkeys
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
Speed (m/s)

Towards modernity: steam engine

- Europe: 1800-1950: Five distinct prime movers: humans, animals, watermills/turbines, windmills, steam engines

- Fossil fuels: peat replacing wood in Holand (17th Century)
- Steam engine (Newcomen, Watt)
  - 20 kW
  - Efficiency 5%
- Inland transport revolution
- „Industrial revolution“ powered by watermills and steam (positive feedback)

- 1870: mechanical power outweighs organic power in the U. S.
- 1900: North Sea windmills: 100 MW of installed capacity


Improved efficiency of steam engines
Lower cost steam
Greater use of steam engines
Steel-making
Coal-mining
Lower cost steel
Lower cost rail transport
Lower cost coal

Towards modernity: electricity

- Production, transport, and use of electricity introduced between 1880-1900
- Basics laid by T. A. Edison in early 1880s
- G. Westinghouse and N. Tesla: alternating current
- Ch. Parsons: steam turbine
- W. Stanley: transformer
- N. Tesla: electric motor

- 20th century: evolution of power industry
- USA 1930s: 80% of all mechanical power

- Profound change in work and personal life

Towards modernity: internal combustion engine

- 1890s:
  - Spark ignition engine (G. Daimler), carburator (W. Maybach), electrical ignition (K. Benz).
  - Compression ignition engine (R. Diesel)

- Three waves of automobile dissemination

- Aviation
  - 1904: the Wright brothers
  - 1961: Yuri Gagarin
  - 1969: Neil Armstrong, Boeing 747

- Fossil fuels-based transportation drives demand for oil, later on utilized in a variety of industries


PAN AM

Prime Mover	Sustained Power (W)
Working child	30
Small woman	60
Strong man	100
Donkey	150
Small ox	300
Typical horse	600
Heavy horse	800
***Early small tractor** (1920)*	10,000
***Ford's Model T** (1908)*	15,000
***Typical tractor** (1950)*	30,000
***Honda Civic** (2000)*	79,000
***Large tractor** (2000)*	225,000
***Large diesel engine** (1917)*	400,000
***Large marine diesel engine** (1960)*	30,000,000
***Four gas turbines of Boeing 747** (1970)*	60,000,000

Energy-intensive society

- Mechanization of agriculture and industry

- Geometrical growth of available power:

Foraging societies	100 W (human)
Early antiquity	300 W (ox)
Ancient Rome	2 kW (watermill)
The Middle Ages	5 kW (watermill)
17th century	8 kW (watermill
18th century	100 kW (Watt‘s steam engine)
Early 20th century	10 MW (water turbine)
Early 21st century	1,5 GW (gas turbine)

- Last 10,000 years:
  - Maximum power of the prime movers has increased 15,000,000x
  - 99% of this change occurred in 20th century

Energy-intensive society

- Increased quality of life

- Great differences among societies/nations
  - 10% consumes 40% of all primary energy
  - 50% consumes 10% of all primary energy

- Anthropocene

Conclusions

- Development stages reflect the power, efficiency, and flexibility of employed prime movers
- Harnessing more energy leads to greater complexity of society

Now, about the course..

What will we be doing here?

- Study and discuss the development of the World energy system since 1945.
- Learn about the roots of the contemporary energy policies.
- Identify and analyze the most influential trends in the past and present energy system.
- Discuss the future of energy.

Who will be guiding you through the course?

Jan Osička

2009 Istanbul Bilgi University

PhD thesis: Gas flows through the V4 region (linear modeling)

- Energy markets
- Natural gas in Central Europe
- Cross-border effects of Energiewende

Filip Černoch

PhD thesis: Energy policy of the EU

2016 Deutsche Gesellschaft für Auswärtige Politik

2016 Energy advisor to PM Sobotka

- Energy policy in the EU
- Energy transitions
- The regulation behind Energiewende

Masaryk University Center for Energy Studies

Founded by Břetislav Dančák in 2009

Dpt. of International Relations and European Studies: 8 full-time researchers

Multidisciplinary research platform dealing with energy

- Social dimension of energy transactions (public participation, local opposition, energy poverty)
- Energy geopolitics (Russia, pipelines, power)
- Energy transition (renewable energy, decarbonization)

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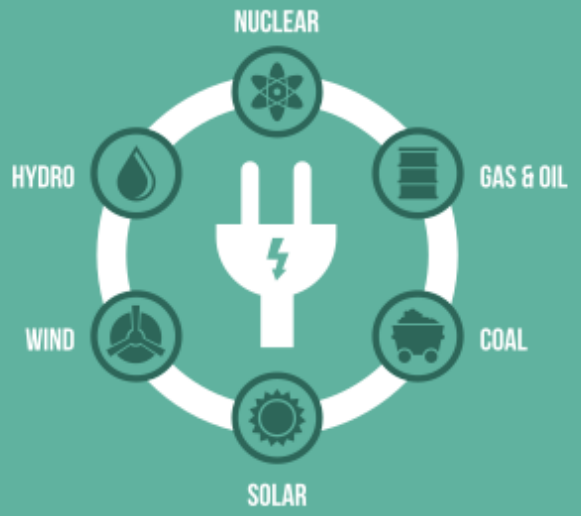


"Energy Infrastructure and Policy Repercussions"

July 29 - August 5, UNESCO city of Telč, Czech Republic

Consolidation after WW2

Jan Osička

Changes introduced by/throughout the war

What were they?

Changes introduced by/throughout the war

Regimes, institutions and economy

- War economy – nationalization of resources and supply chains (US/UK)
- US turns net energy importer – further pressure on relations with producing countries
- Emergence of „operations research“

Technological advancement

- ICT – radar, remote control, guiding systems, electrical computation, network communication
- Transportation – ICS-based mobility, jet engine-based aviation
- Rocket science – space program

- Chemical engineering – plastics (substitutes for rubber and glass)
- Piping/welding – oil and gas transfers
- Nuclear energy

Consolidating energy industries (region-specific)

Established industries

- Coal, oil, electricity

Emerging industries

- Nuclear energy, natural gas

Consolidating energy industries

Centralized approach

- Vertically integrated national monopolies
- Stable, secure, affordable supply of energy to the national economy

Market-based approach

- Market competition (or fragmentation)
- Energy supply as a by-product of a profit-seeking behavior

Consolidating the power industry: the business model

Year	Rated power (MW)	Thermal efficiency (%)	Price (USD1992/kWh)
1892		2.5	4.00
1907	12		1.56
1927	110	20	0.55
1947			0.19
1967	1,000	40	0.09

The “Grow and build“ strategy
(technological progress + cost/price decline)

- Promote electricity usage
- Build bigger and more efficient plants
- Bring down the costs and sell more electricity
- Promote further electricity usage
- …

The consolidation of nuclear industry in the U. S.

“The energy produced by breaking down the atom is a very poor kind of thing. Anyone who expects a source of power from the transformations of these atoms is talking moonshine.”

Lord Ernest Rutherford, 1933.

“It is not too much to expect that our children will enjoy in their homes [nuclear generated] electrical energy too cheap to meter.”

Lewis Strauss, Chairman, US Atomic Energy Commission, 1954.

„The failure of the U.S. nuclear power program ranks as the largest managerial disaster in business history, a disaster on a monumental scale … only the blind, or the biased, can now think that the money has been well spent. It is a defeat for the U.S. consumer and for the competitiveness of U.S. industry, for the utilities that undertook the program and for the private enterprise system that made it possible.“

*Forbes cover story “*Nuclear Follies“, February 11, 1985

The origins

The Manhattan project (1942-1946)

The experimental breeder reactor (1951)

Atoms for Peace (1953)

Atomic Energy Act of 1954

- Regulatory oversight over nuclear energy assigned to the Atomic Energy Commission (AEC)

Commercialization of nuclear energy

- AEC‘s role: „*To ensure public health and safety from the hazards of nuclear power without imposing excessive requirements that would inhibit the growth of the industry*“ (NRC 2017)

- Insufficiently rigorous regulations in several important areas, including radiation protection standards, reactor safety, plant siting, and environmental protection

Commercialization of nuclear energy

- Rapid increase in power output
  - 1953-1962: below 300 MW
  - 1965: average 660 MW
  - 1970: average above 1,000 MW

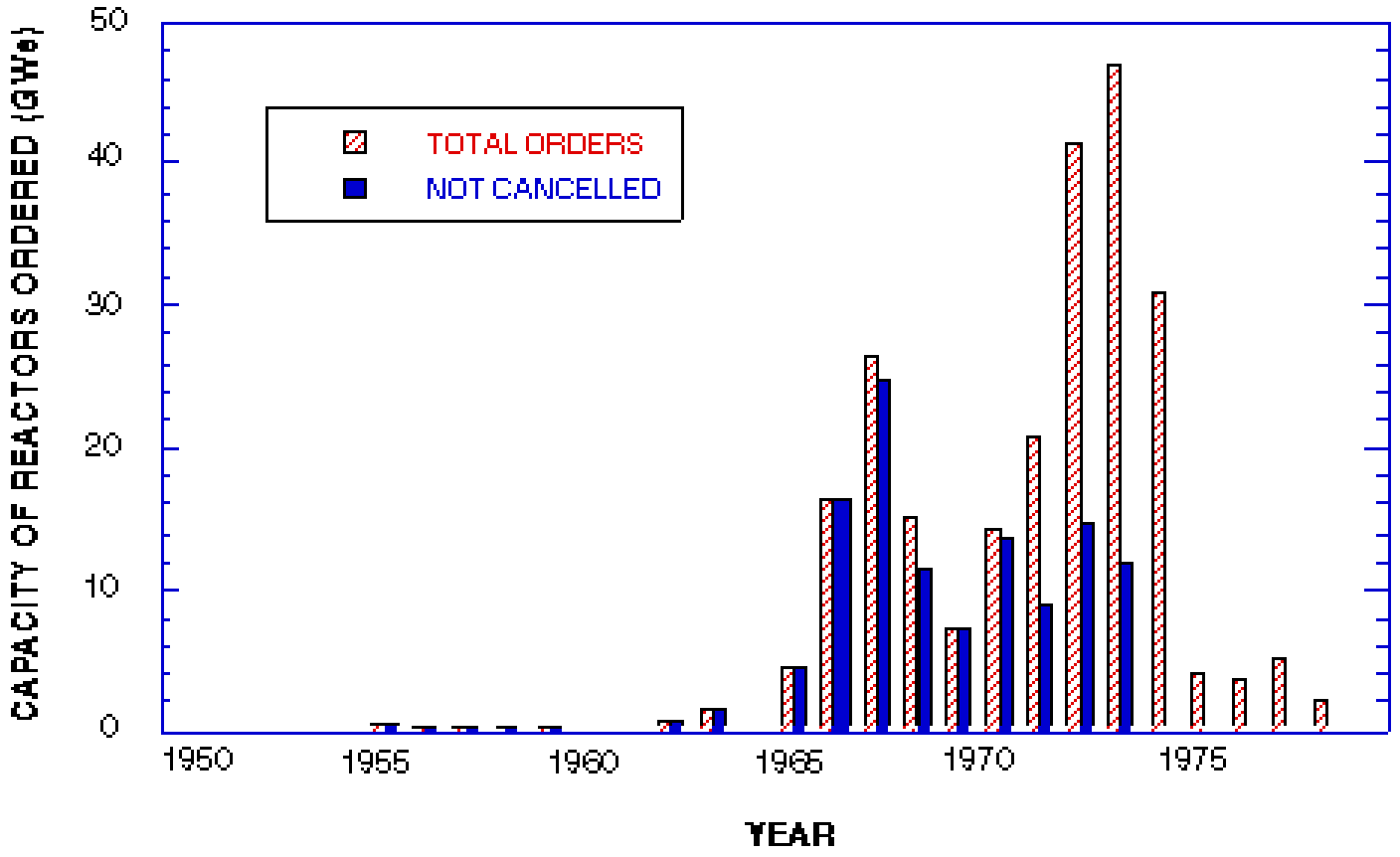
- Upscaling perhaps too fast to facilitate learning

- Multiple manufacturers (Westinghouse, Argonne National Laboratory, General Electrics, BWXT,…) => multiple reactor designs and sub-designs (each unit a prototype)

=> Economy of scale has not been achieved

1970s: industry in crisis

- Electricity demand increases with a slower pace
- Costs of nuclear power increase
- Political and local opposition towards nuclear



Shoreham NPP (Long Island, USA)

- Announced in 1965 by Long Island Light Company
- Expected to come on line by 1973 at $65 - $75 million

- 1968 LILCO decides to increase the unit‘s size from 540 to 820 MW
  - Cost overrun
  - Construction delay => more time for anti-nuclear movement to spread across Long Island

- 1979 Public opposition intensifies after the Three Mile Island accident => 1983 the county legislature does not approve the plant‘s evacuation plans
  - Costs reach $2 bn (low productivity and design changes ordered by federal regulators)

- 1984 The plant is completed, but does not receive operation license due to the unapproved evacuation plans

- 1994: The plant is fully decommissioned, the total costs reach $6 billion (covered by the LI consumers)

1960s-1970s: Energy geopolitics

Jan Osička

Session outline

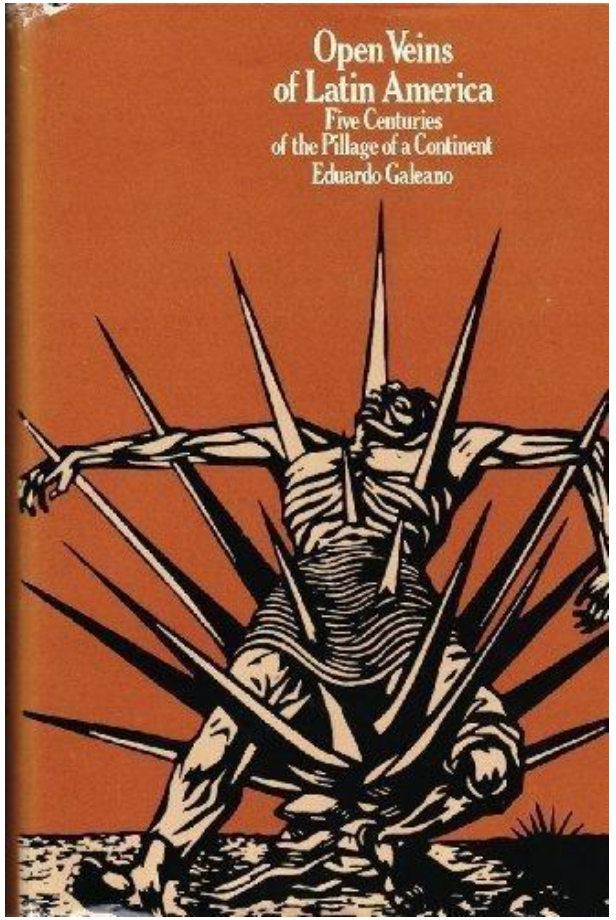
- The oil shocks of the 1970s: the context, impact mechanism and crossboder cashflow
- The effects on developing and developed countries
- The long-term consequences
- The energy weapon - discussion

International context

- 1960: *Declaration on the Granting of Independence to Colonial Countries and Peoples*
- 1960s: The first „Decade of Development“ (UN)
- Development program as a containment policy

- The rise of the structuralist thinking (R. Prebisch, ECLA)

- 1961: The Non-Alignment Movement
- 1964: The Geneva Conference (UNCTAD)
- G77: Diverse countries, common interest – a radical reform of GATT

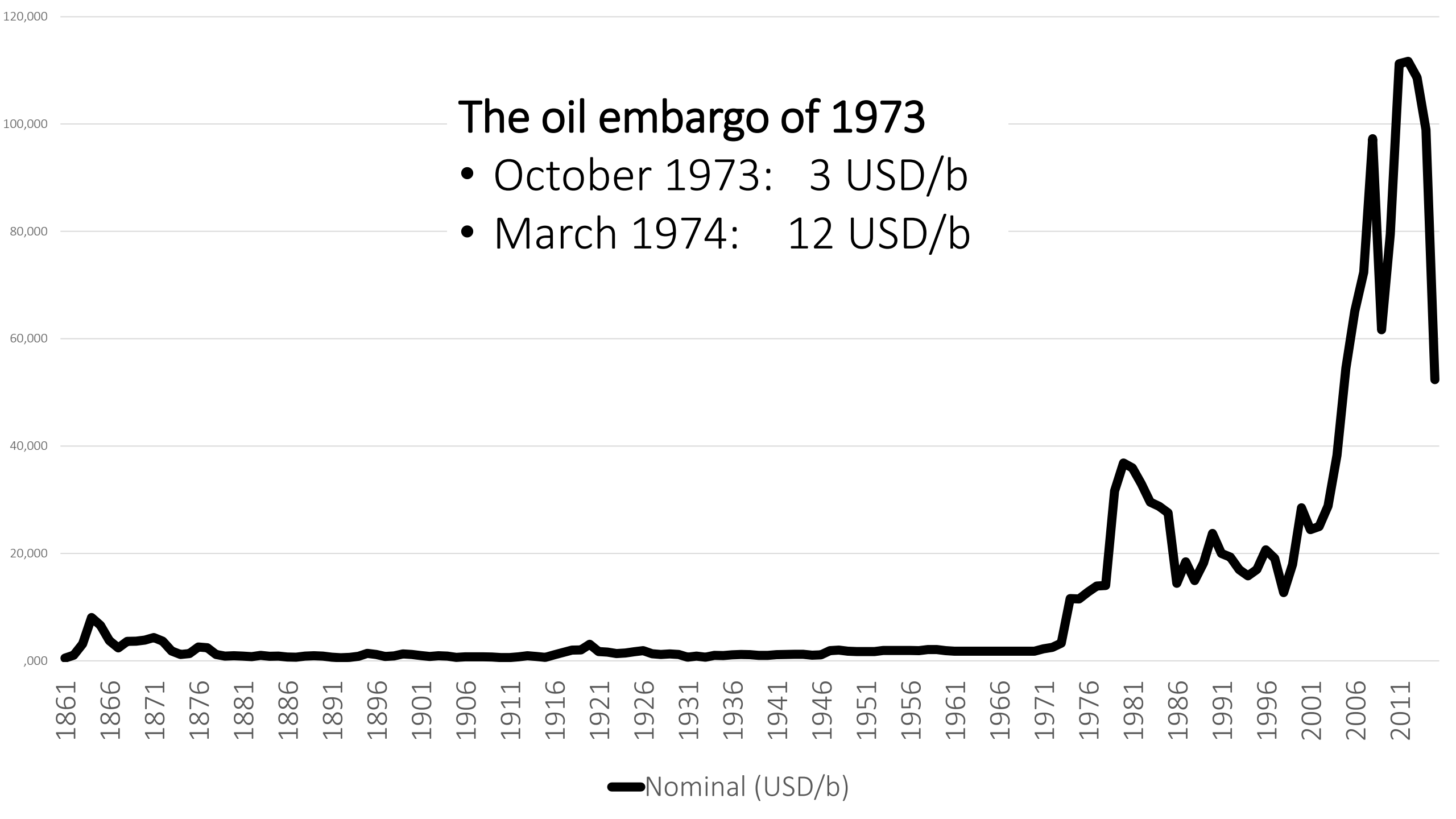


The road to the crisis (1949-1972)

- World‘s energy consumption tripples
- World‘s demand for oil increases 5.5 times
- U.S. demand for oil increases 3 times
- Western Europe‘s demand for oil increases 15 times
- Japan‘s demand for oil increases 137 times

- 2/3 of the new demand covered by the MENA producers
- 1967-1972: U.S. domestic production peaks and import dependence increases from 19% to 36%

- 1970-1973: World‘s spare production capacity decreases from 3 mbd to 0.5 mbd (less than 1% of total consumption)


The oil embargo of 1973
• October 1973: 3 USD/b
• March 1974: 12 USD/b
120,000
100,000
80,000
60,000
40,000
20,000
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1861
1866
1871
1876
1881
1886
1891
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1911
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1926
1931
1936
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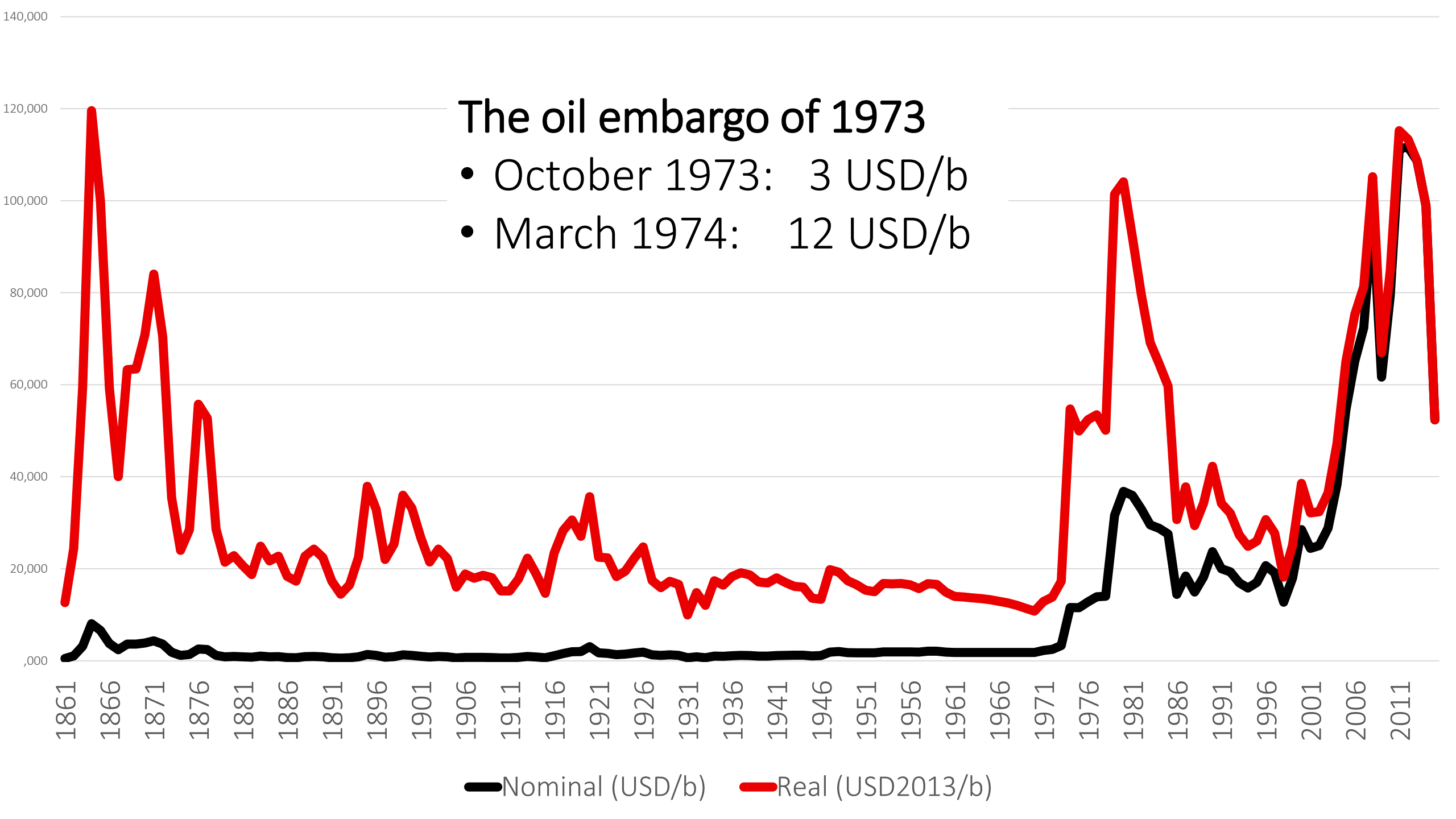
1981
1986
1991
1996
2001
2006
2011
Nominal (USD/b)


The oil embargo of 1973
• October 1973: 3 USD/b
• March 1974: 12 USD/b
140,000
120,000
100,000
80,000
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1941
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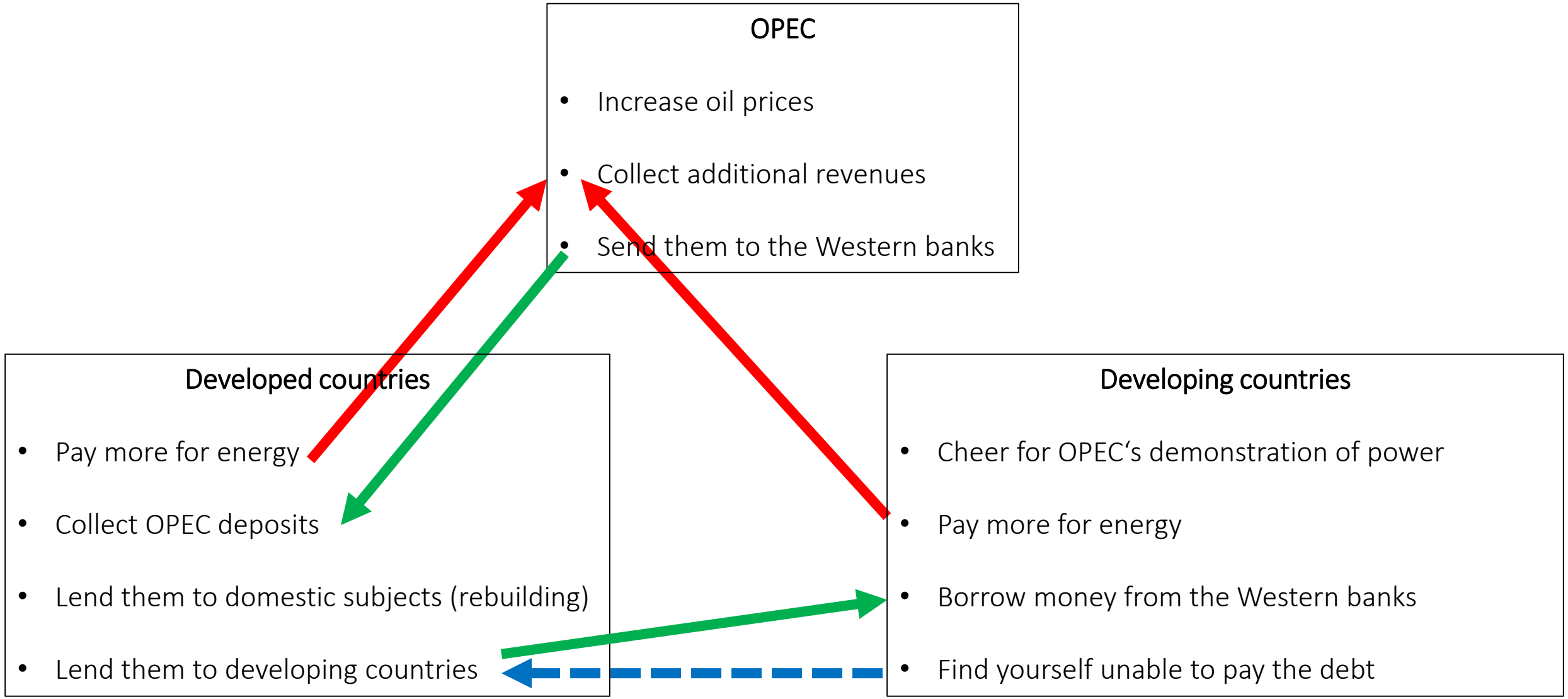
1956
1961
1966
1971
1976
1981
1986
1991
1996
2001
2006
2011
Nominal (USD/b)
Real (USD2013/b)

The to-do lists and cashflow of the 1970s oil shocks



The 1970s crisis in numbers

Saudi Arabia‘s current account surplus:

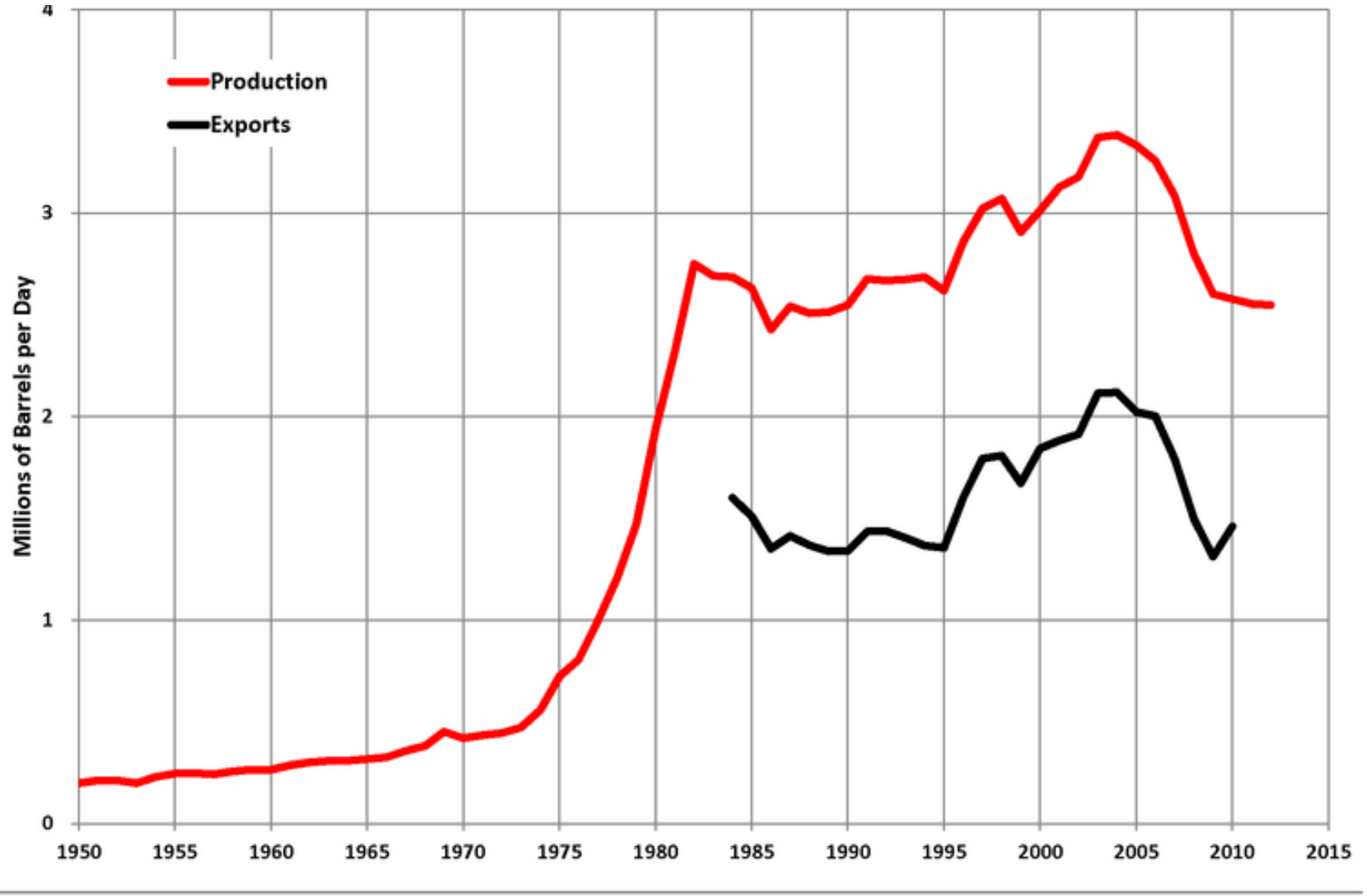
- 1973: 2.5 bn USD
- 1974: 23 bn USD

Additional costs associated with higher oil prices between 1970 and 1980: 260 bn USD

Increase in foreign debt (bn USD):

	Argentina	Brazil	Mexico	Developing world
1970	5.8	5.7	7.0	72.7
1980	27.2	71.5	57.4	586.7
1984	48.9	103.9	94.8	921.8

Mexico oil production and exports



Macroeconomic consequences: developing countries

Developing countries (mainly Latin America) hit particularly hard during the 1970s:

Internal factors: the „import substitution industrialization“ development strategy

- Effective isolation of the national economy from the international markets
- Subsidies to selected sectors/industries
- Requires imports of goods and capital, compromises exports

External factors: oil shocks

- Countries unable to reduce demand for oil, decrease imports or increase exports
- Non-existent financial reserves to cover the higher energy costs

=> Massive borrowing from the U. S. and European banks

- The investments did not produce anything of economic value sufficient to enable the borrowers to repay their loans
- By 1988: the debt costs higher than incoming loans => the „Debt crisis“

The Debt crisis

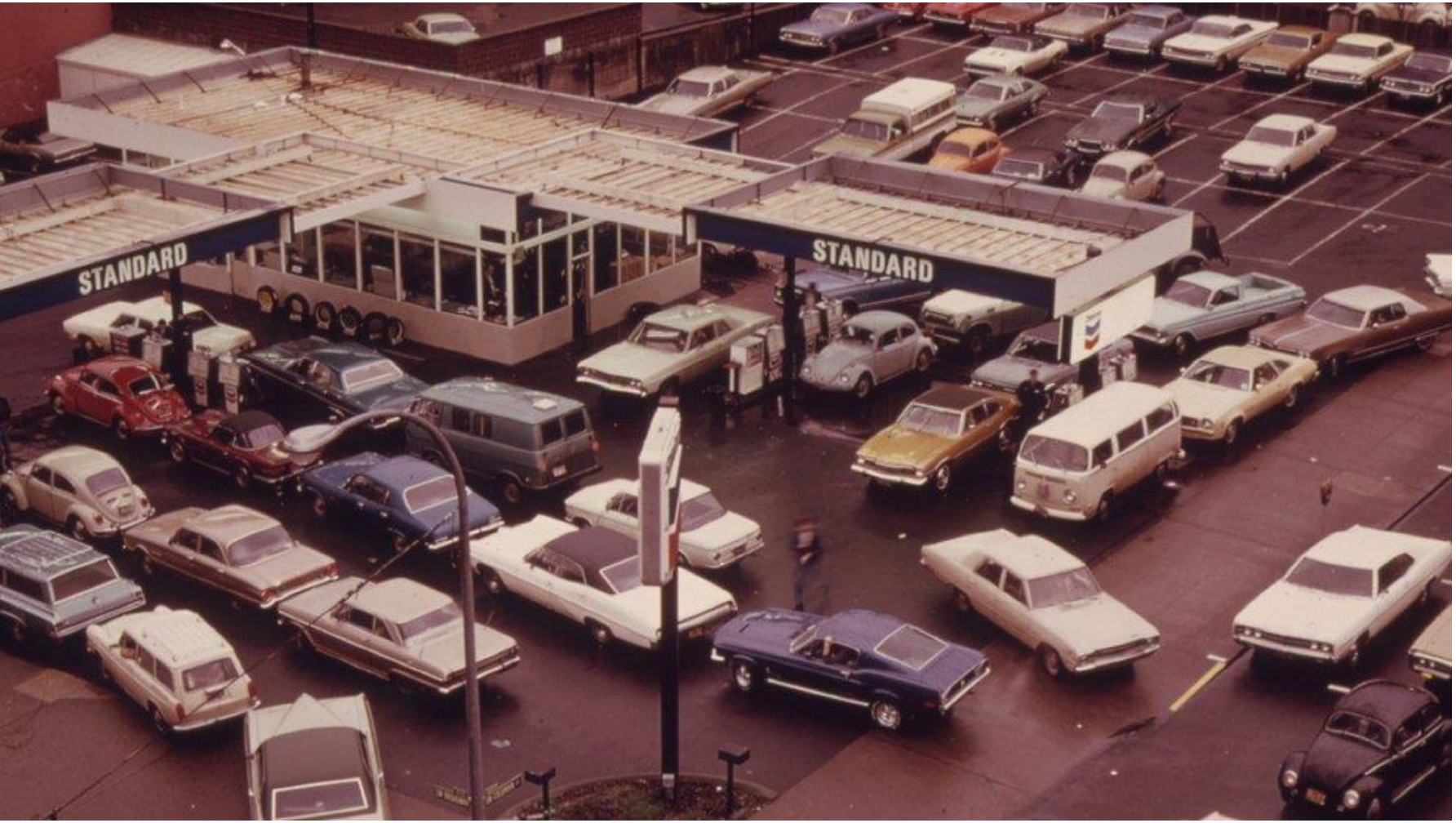
- Inability to pay back the loans + no new loans coming
- Risk of another global recession caused by multiple state defaults
- The governments turn to the international economic institutions (WB, IMF) for assistance
- Until 1985: macroeconomic stabilization
  - Reduction of government budget deficits: reduction of domestic consumption => reduction of imports, reduction of domestic consumption => unemployment => reduced wages => exports => current account surpluses
- After 1985: Structural adjustment
  - Debts reduced or written-off in exchange for lowering tarrifs, privatizing industries, reducing subsidies and general opening up of the economy.

The Debt crisis

Table 14.6
Economic Conditions in Latin America, 1982–1990

	1980–81	1982	1983	1984	1985	1986–90
GDP[1]	100	95.6	91.3	92.2	92.7	94.1
Consumption[1]	77.0	74.0	70.3	70.4	69.9	71.6
Investment[1]	24.4	19.6	14.9	15.2	16.1	15.9
Unemployment[2]	6.7				10.1	8.0
Real Wages[3]	100.0				86.4	68.9
Imports[4]	–12.3	–9.7	–7.5	–8.0	–7.9	–9.2
Exports[4]	12.5	12.6	13.6	14.5	14.2	15.2
Net Transfers[4]	12.2	–18.7	–31.6	–26.9	–32.3	
Fiscal Deficit[5]	3.7	5.4	5.2	3.1	2.7	
Inflation	53.2%	57.7%	90.8%	116.4%	126.9%	

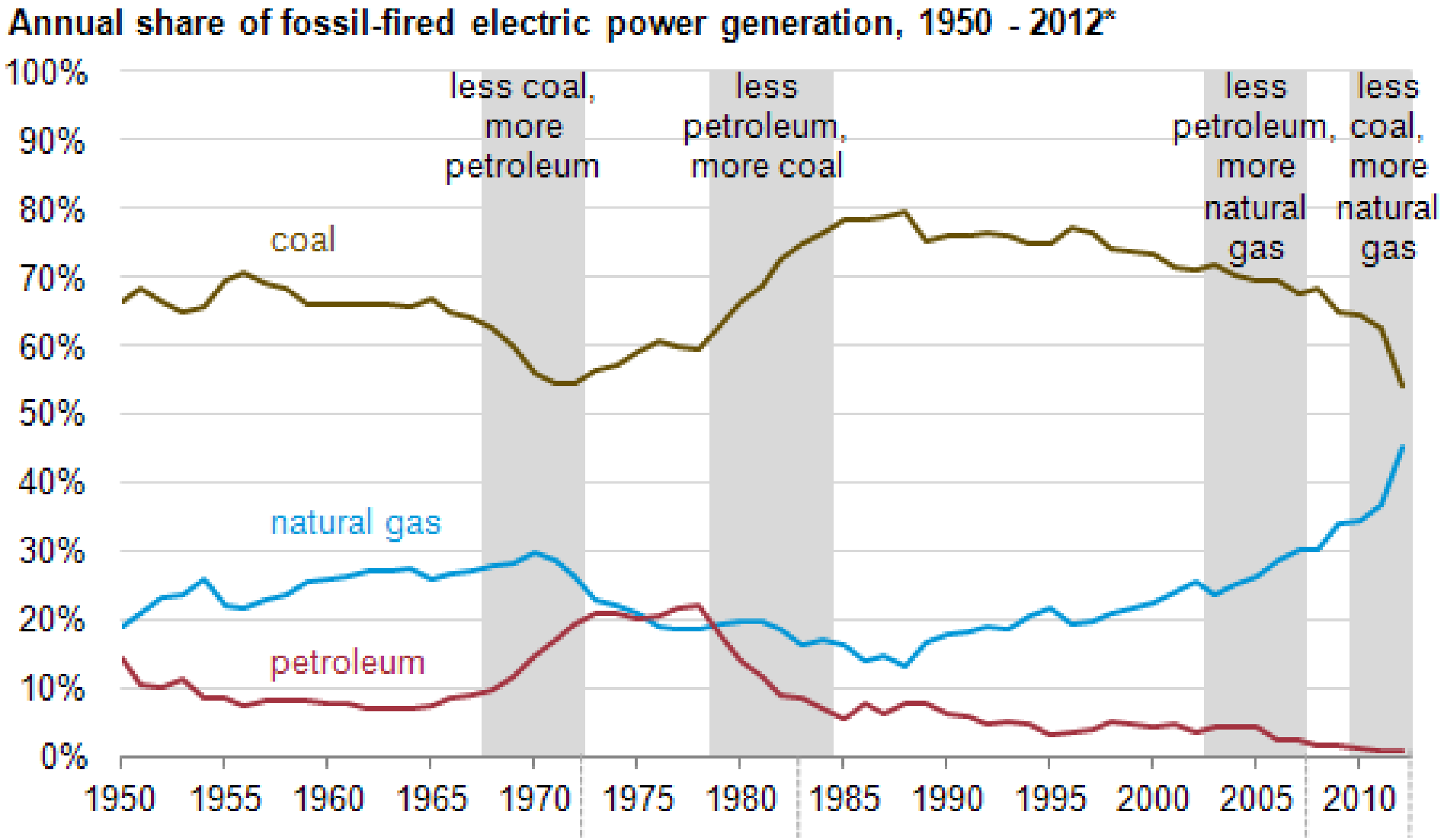
[1]As a percentage of 1980–81 GDP.
[2]Rate of open unemployment as a percentage of total labor force.
[3]Index of real wages in unemployment.
[4]$US billions.
[5]Percent of GDP.
Source: Thorp 1999; Edwards 1995, 24; Edwards 1989, 171.


STANDARD
STANDARD

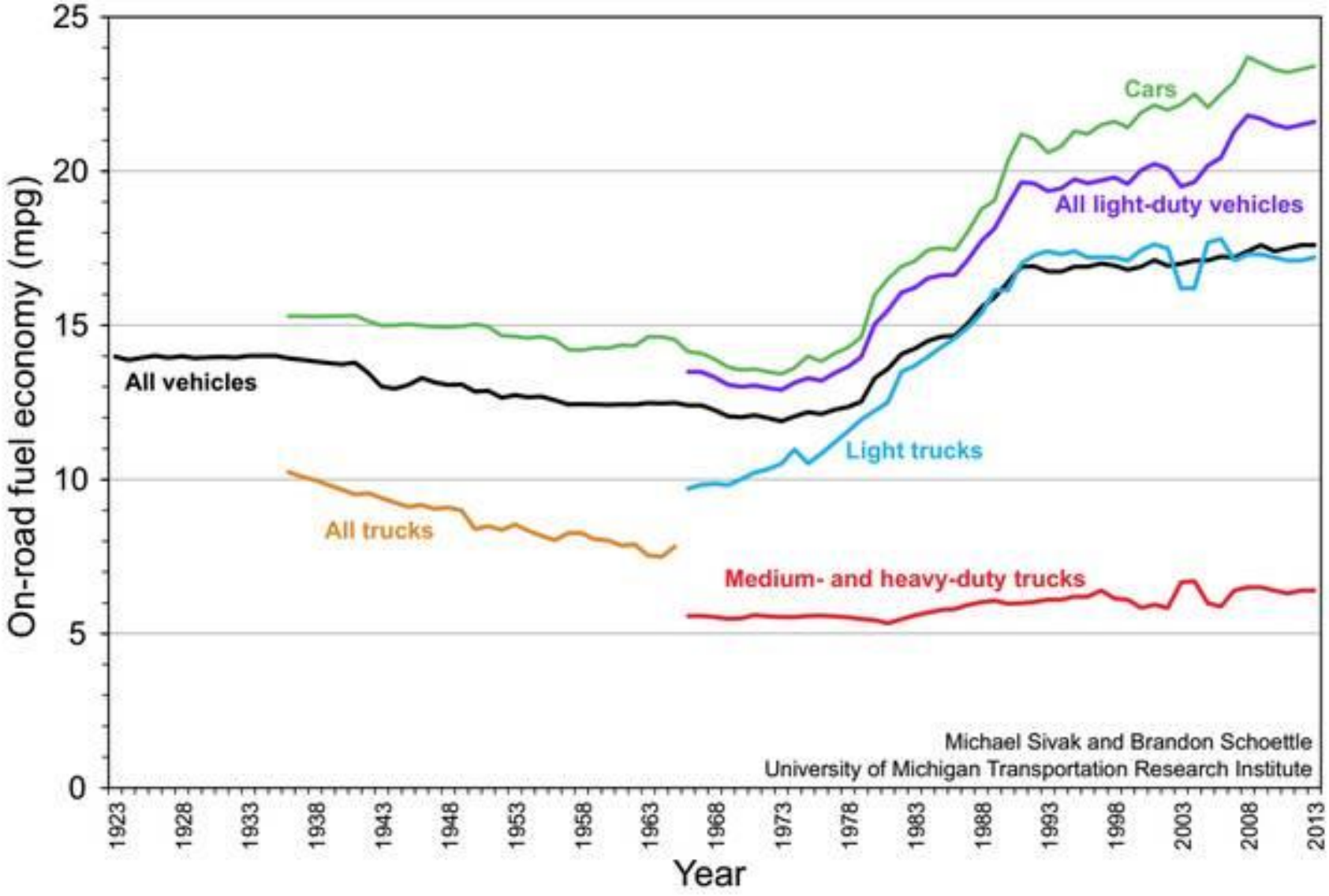
Developed countries

- USA does not alter its support for Israel
- The U.S. obsession with the Middle East/foreign oil begins
  - The Carter‘s doctrine
  - YouTube: „American presidents promise security through energy independence“
  - Energy is typically tackled as a „crisis issue“ ever since
- The establishment of the International Energy Agency
- Structural changes in Western economies (Japan moving from energy-intensive industries to electronics; car industry boom)

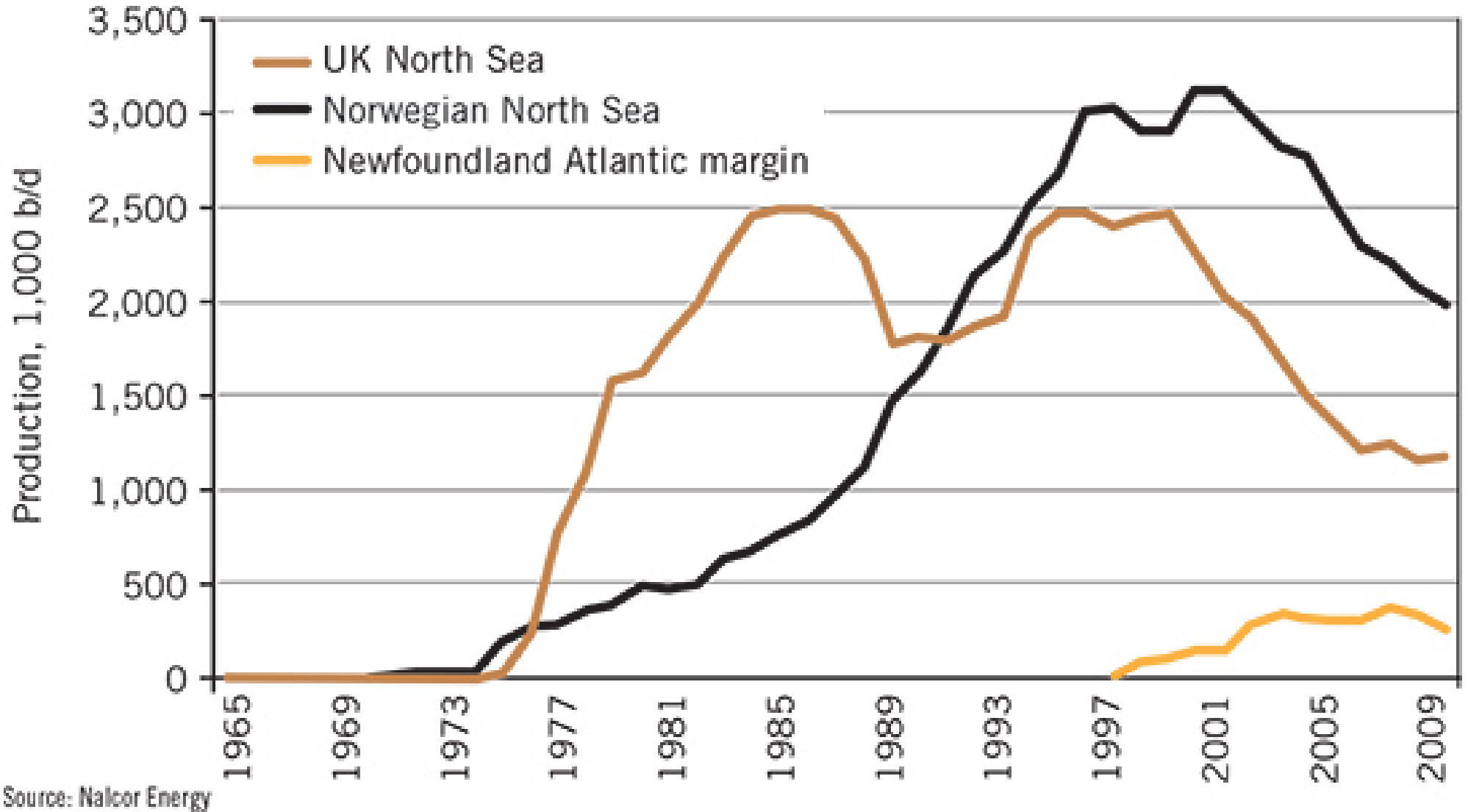
Developed countries: Energy conservation/diversification



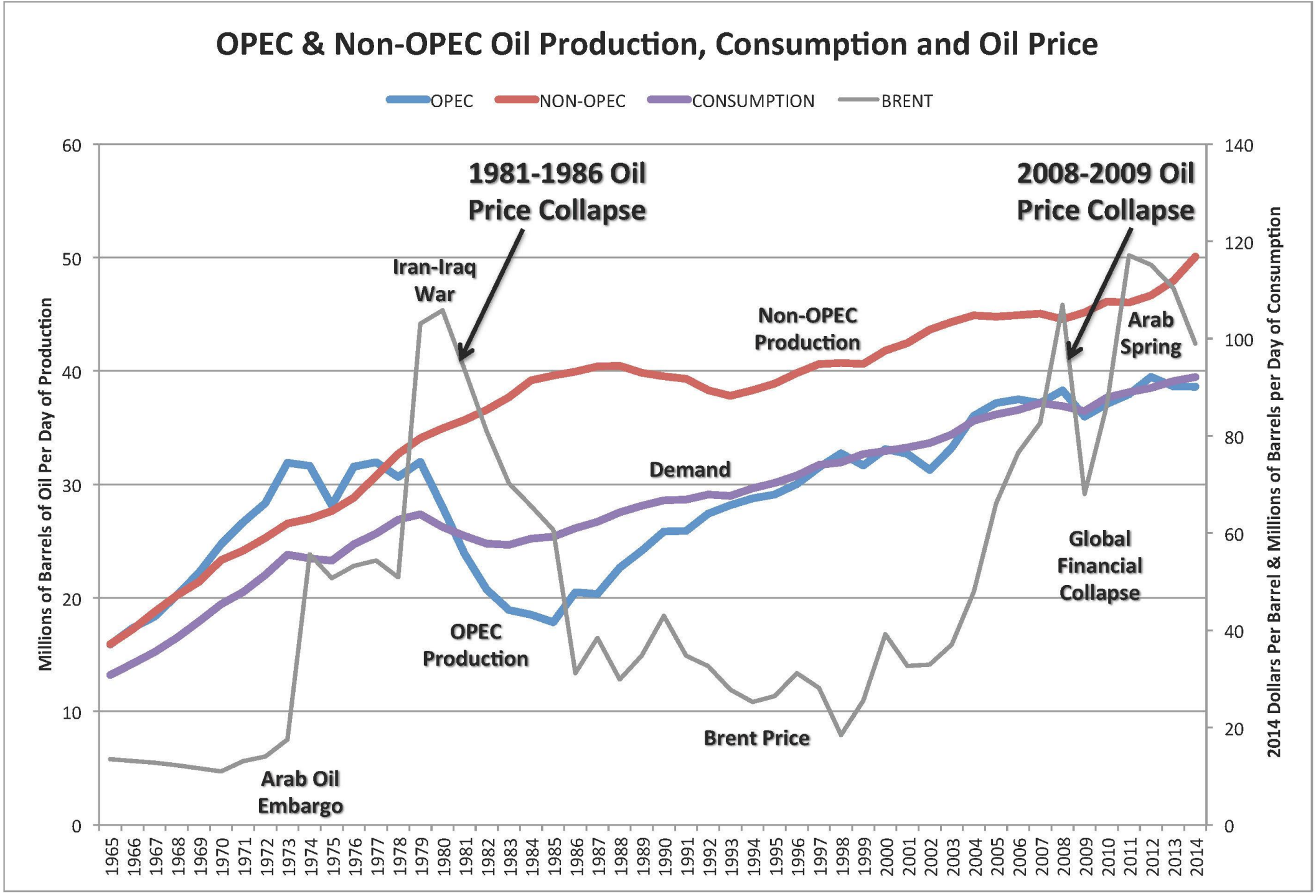
Developed countries: Energy conservation/diversification



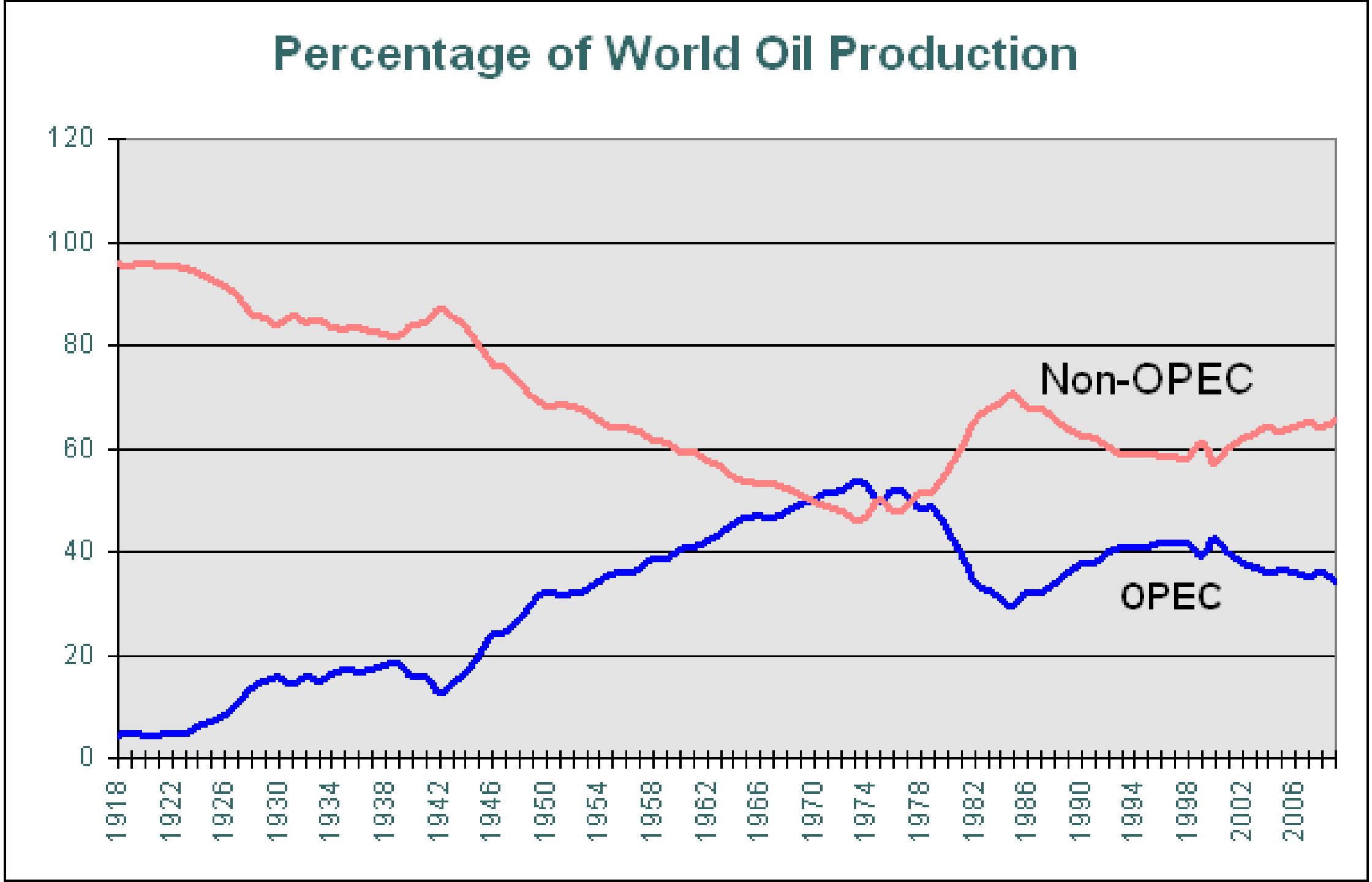
Developed countries: Energy conservation/diversification



Energy conservation/diversification



Energy conservation/diversification



Oil shocks consequences

"The oil crisis set off an upheaval in global politics and the world economy. It also challenged America's position in the world, polarized its politics at home and shook the country's confidence“

Daniel Yergin, 2013

- The debt issue placed at the center of North-South relations
- U.S. obsession with the Middle East/foreign oil/energy independence begins
- Energy conservation and diversification measures take off
- Long-term weakening of OPEC begins
- The International Political Economy scientific discipline is born

Discussion: the energy weapon

- What other cases of its use do you know?

Discussion: the energy weapon

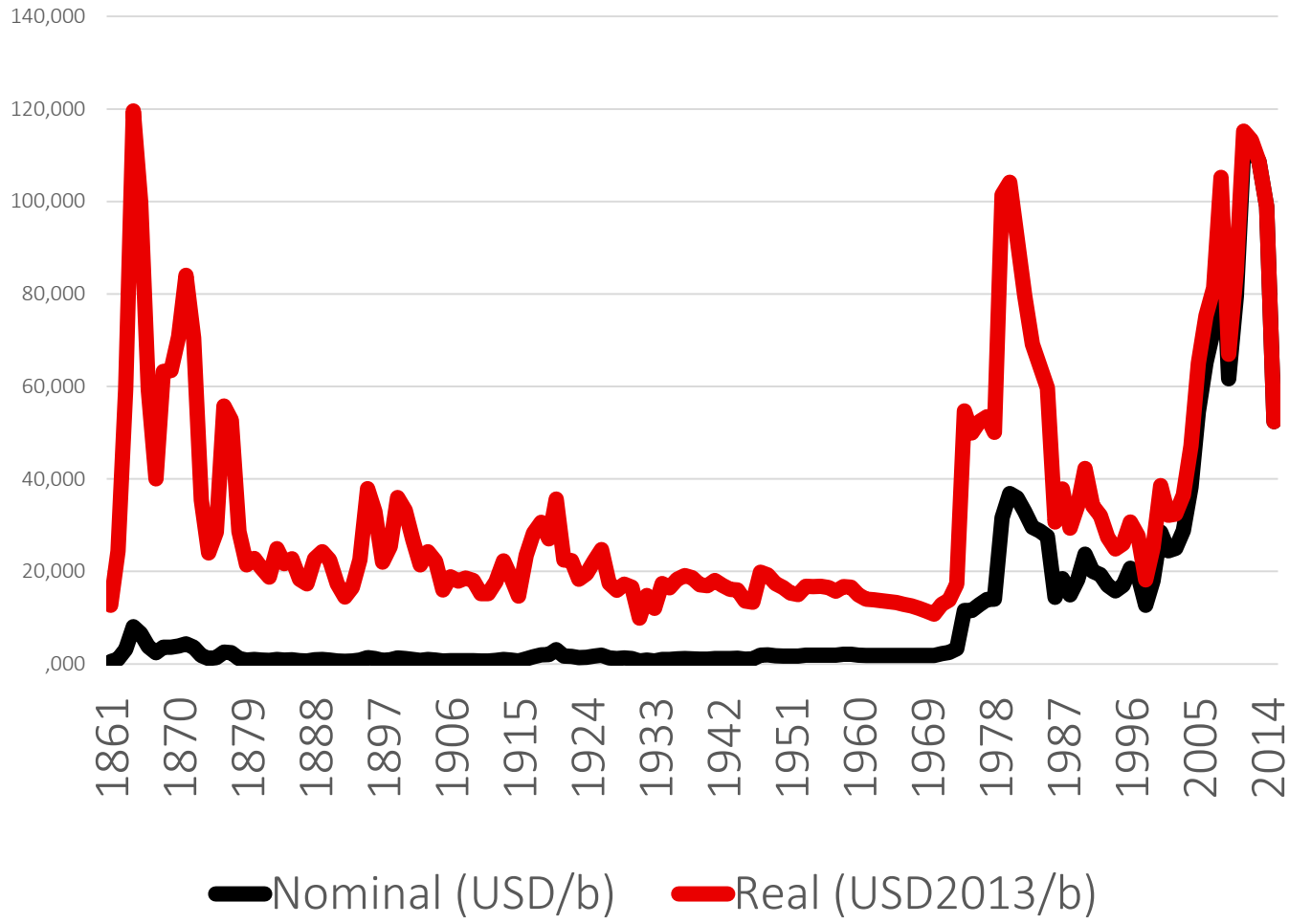
- What other cases of its use do you know?
- Under which circumstances it can be effective?

Coping with oil revenues

Jan Osička

1980s: financialization of energy

- Globalization of the oil market
- Oil market‘s exposure to financial markets
- Oil glut of 1985
- Falling prices reveal macro-economic importance of oil



Session outline

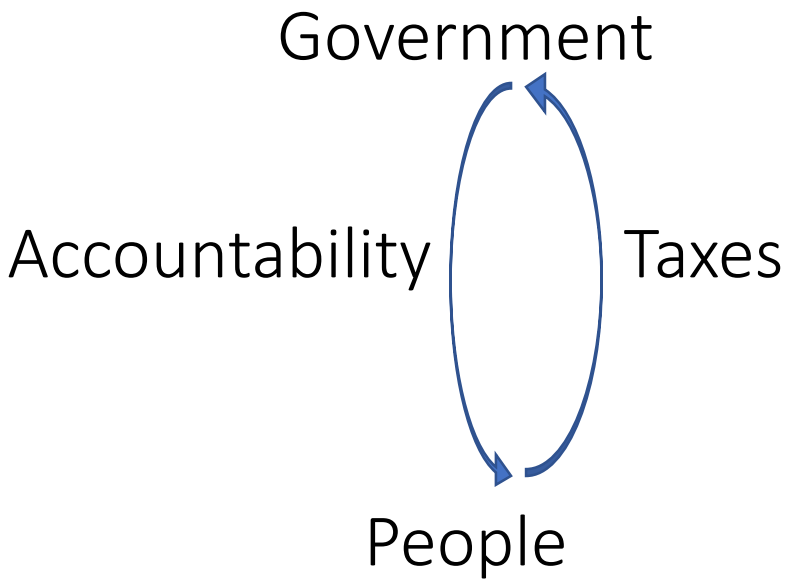
- Developing countries, oil and state-building
- Developed countries, oil and changes in economy

Developing countries: the resource extractive state concept

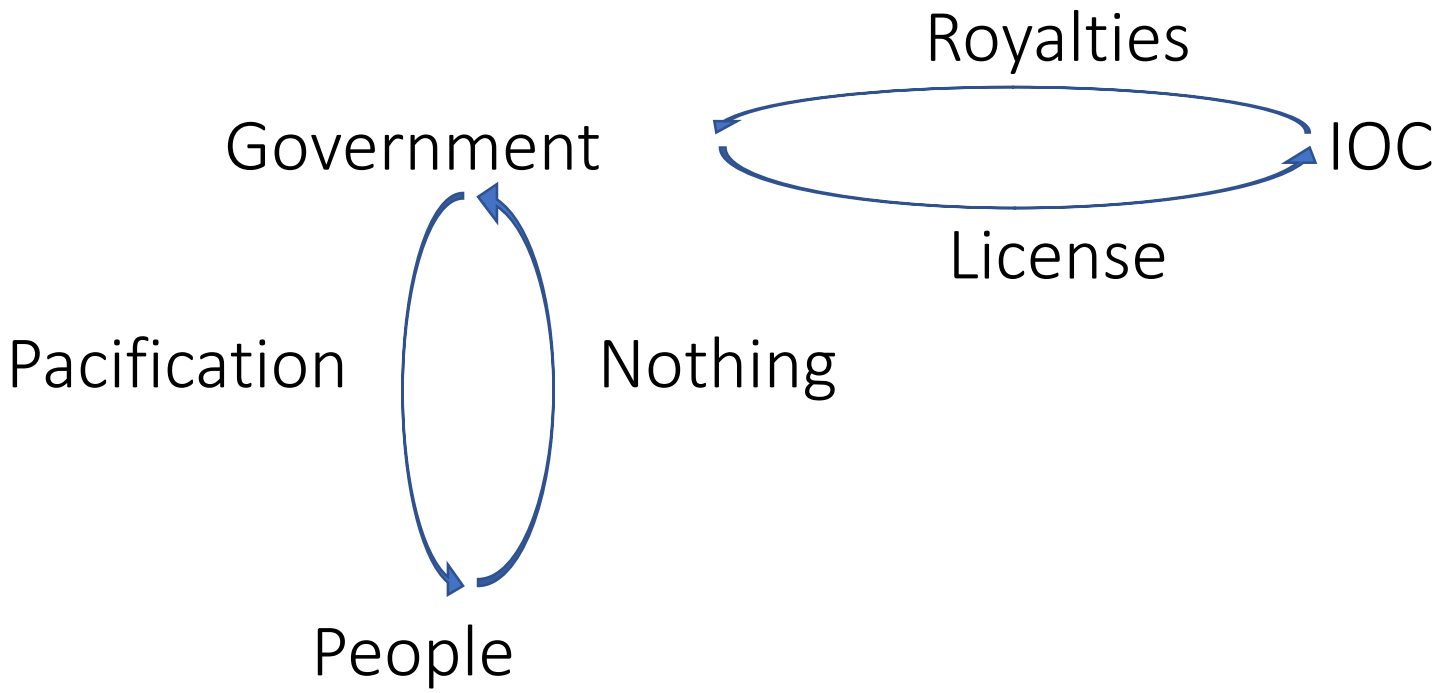
- Hossein Mahdavy (1970): *The Pattern and Problems of Economic Development in Rentier States: The Case of Iran.*

- Presumption: Tax extraction and redistribution is the core of the Government – people relationship.

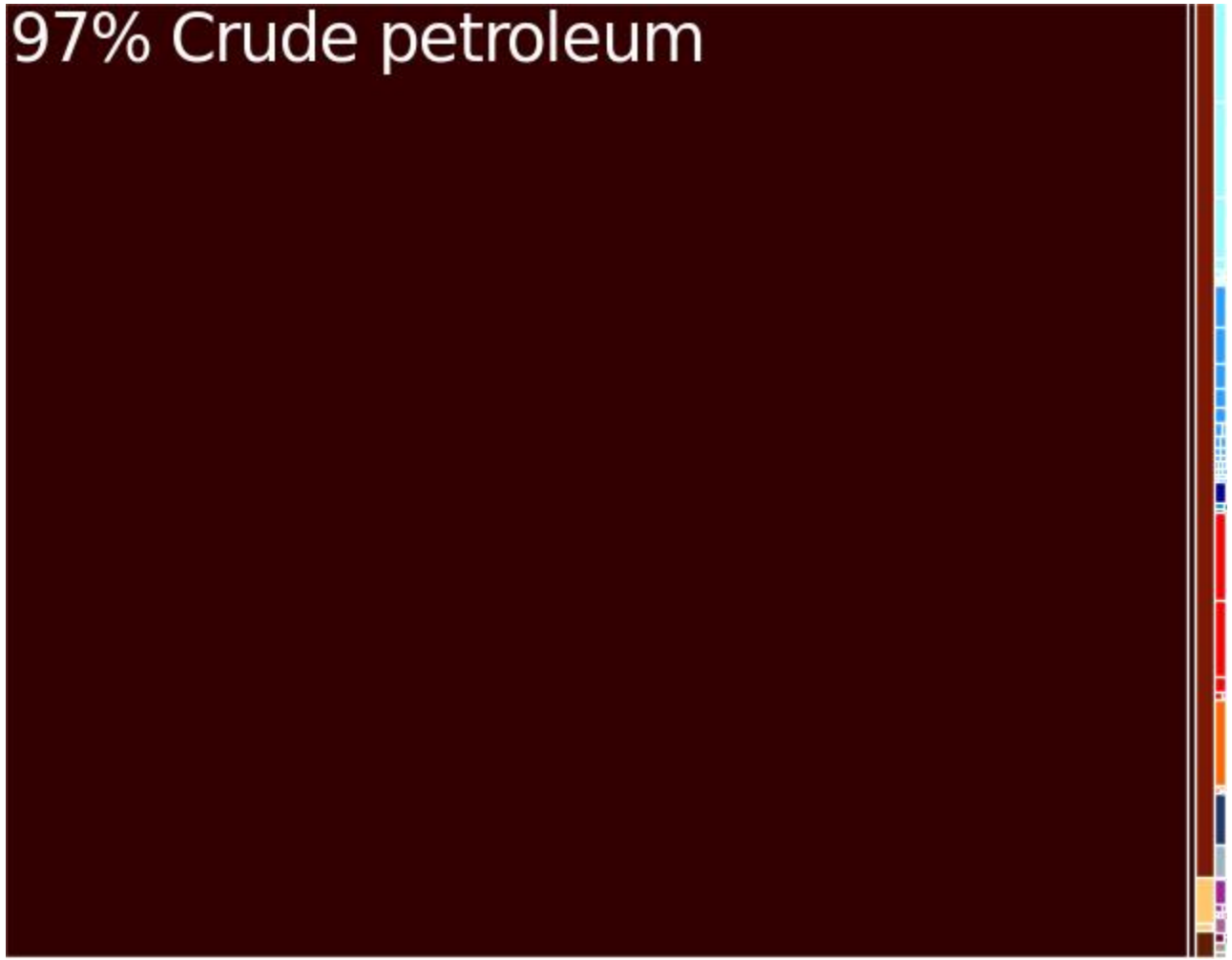
The backbone of modern state building…



…altered by oil-revenues



Export structure, the case of Angola



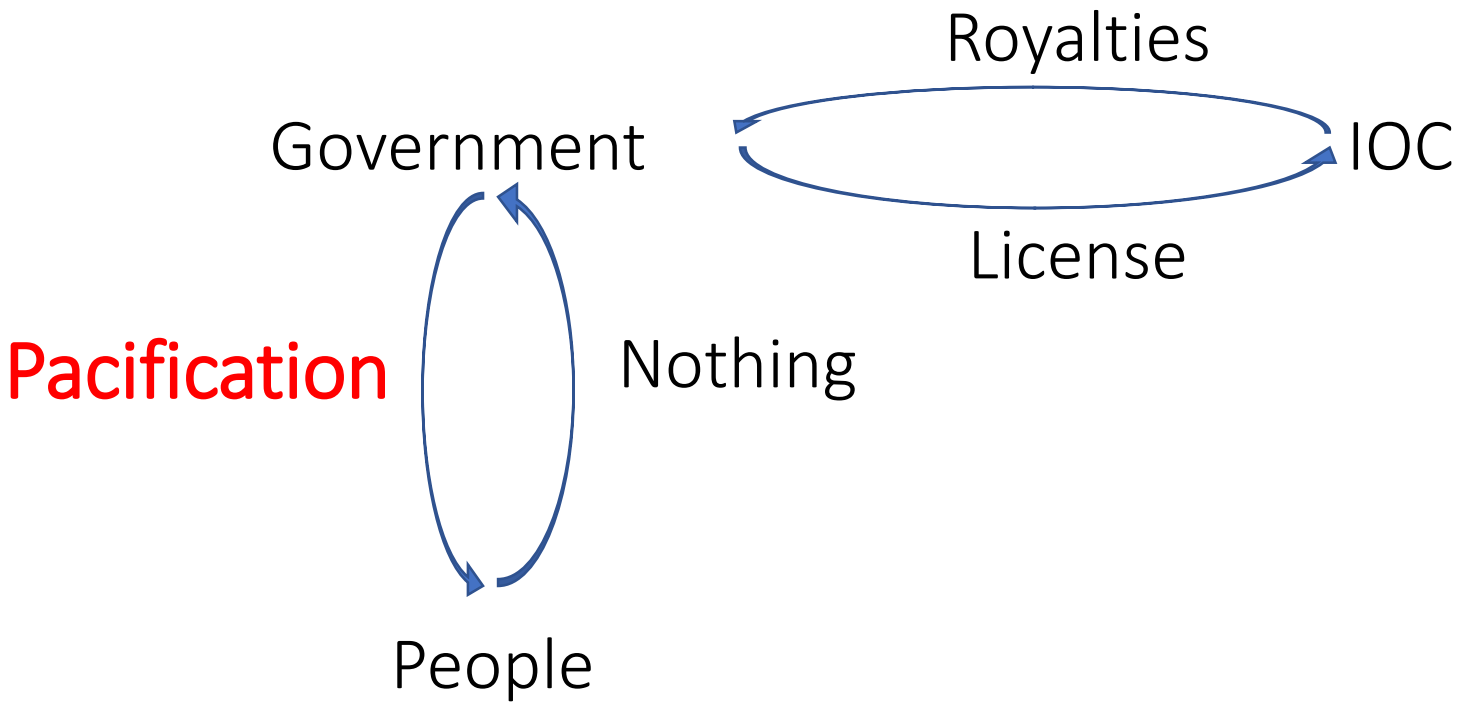
"Tree map export 2009 Angola" by R Haussmann, Cesar Hidalgo, et. al. - Electronic Complexity Observatory, MIT Media Lab and the Center for International Development at Harvard University.

Oil and gas exports as a share of government income

- South Sudan 98%
- Iraq 97%
- Eastern Timor 94%
- Bahrain 91%
- Libya 91%
- Alaska 90%
- Saudi Arabia 90%
- Kuwait 83%
- Angola 79%
- Azerbaijan 74%
- Algeria 70%
- Nigeria 70%
- Gabon 64%
- Qatar 53%
- Iran 50%
- Trinidad & Tobago 44%
- Kazakhstan 39%
- Mexico 33%
- Russia 28%
- Camerun 25%
- Egypt 10%

www.resourcegovernance.org

Pacification: the „stick“ and „carrot“ way



The „stick“ pacification

- Government policies centered around its physical survival
- The legitimacy is derived from arms expenses (defence against internal and external enemies)
- Revaluated currency
- Oil revenue distributed within the governing strata only (cronyism)
- Domestic problems ignored or delegated to the international community
- Benefits for the population practically non-existent

External enemy, the case of Chad

- 4/75 president Tombalbaye (1960-1975) calls for national disobedience, fearing a coup
- 4/75 president Tombalbaye is killed in a coup supported by France (in reaction to the U.S. oil companies finding oil in the country)
- President Habré (1982-1990) supports the U.S. companies in exchange for protection from the U.S.
- President Déby (since 1990) – former close collaborator of president Habré, supported by France he removes Habré from the office and awards oil exploration/production licenses to French companies.

Domestic problems and benefits for the population

Angola

- Oil production 2000-2004: 0.75 mbd => 1.2 mbd
- Approx. 1 billion USD/year diverted from the government budget (according to Global Witness)
- Humanitarian crisis 2000-2004 at the end of the civil war (1975-2002): millions of people survived only due to the international aid (World Food Program)

Nigeria

- Oil revenues 1984-2009: 300 mld. USD
- Average income in 2009: 1 USD/day
- In real terms: average income in 2003 was lower than in 1960

The „carrot“ pacification

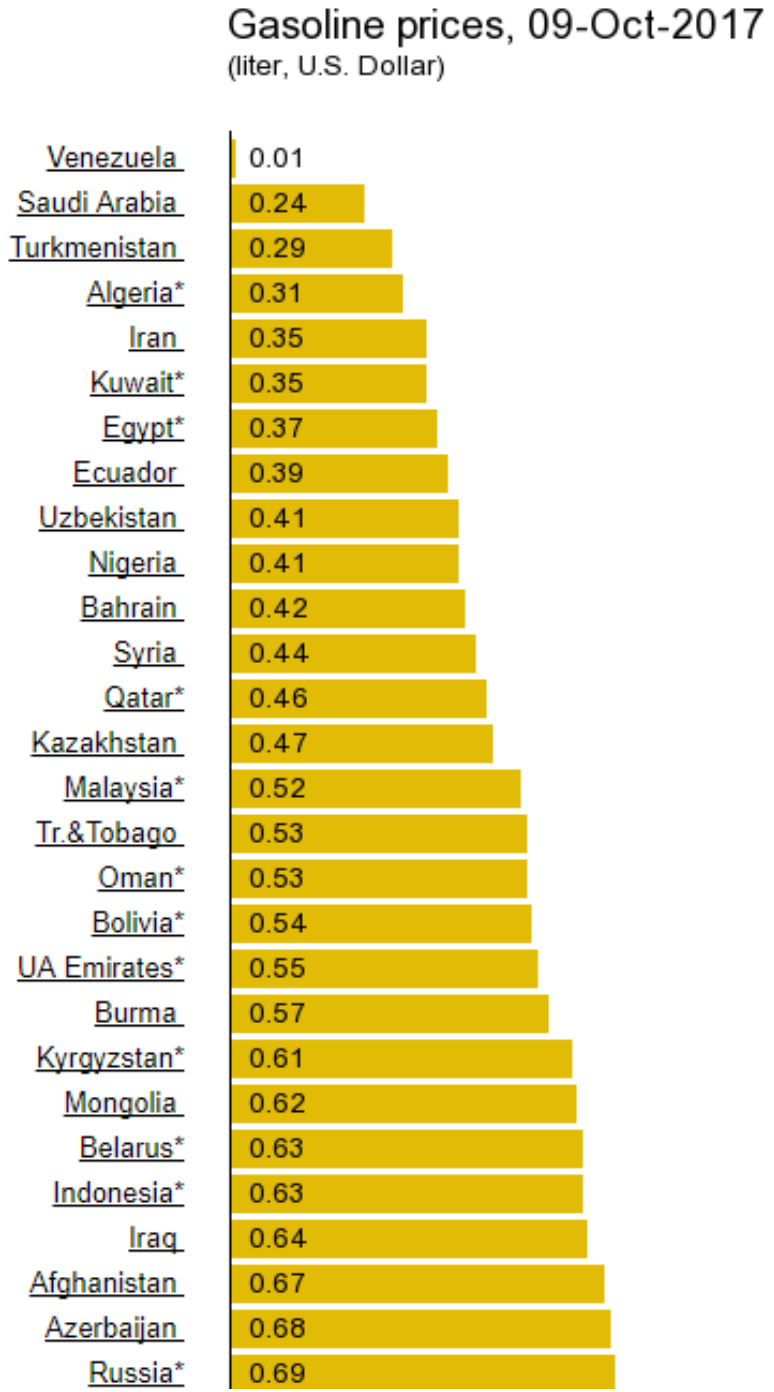
- Typical for consolidated regimes
- Main threat stemming from cross-generation cohesion (the young need to accept the regime)
- Maximum benefits for the population

Benefits for the population

- Free
  - Education
  - Healthcare
  - Accommodation
- Heavily subsidized
  - Energy
  - Gasoline
- Retirement
  - 80% of salary after 20 years in public sector
- Taxes
  - Non-existent

Division of labor according to citizenship:

- UAE
  - 0% of foreigners in the public administration
  - 0.04% of the UAE citizens in the private sector
- Average sallary in Bahrain 2008:
  - Citizens: 15,000 USD/y
  - Foreigners: 5,000 USD/y

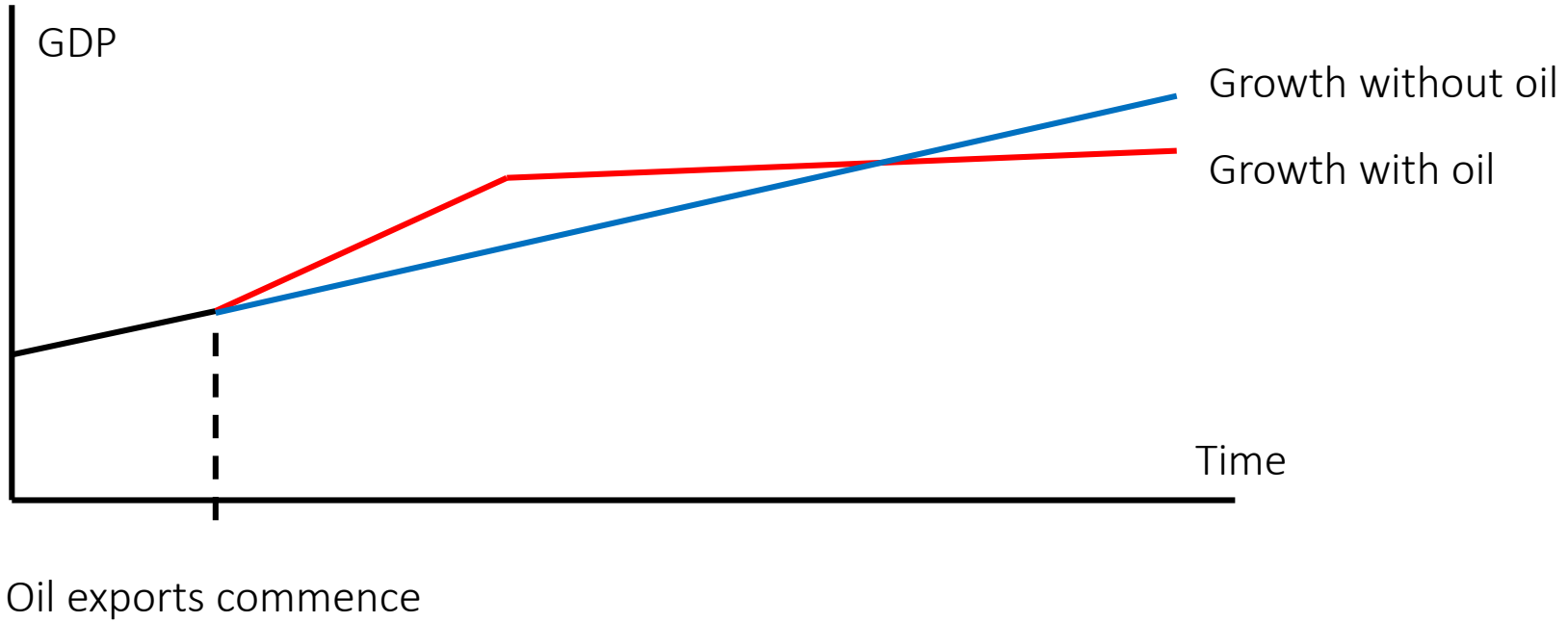


Developed countries: Dutch disease

Developed countries: Dutch disease

The Netherlands after vast natural gas exploitation in the 1960s.

Key point: resource development can actually hinder economic growth/development



Dutch disease

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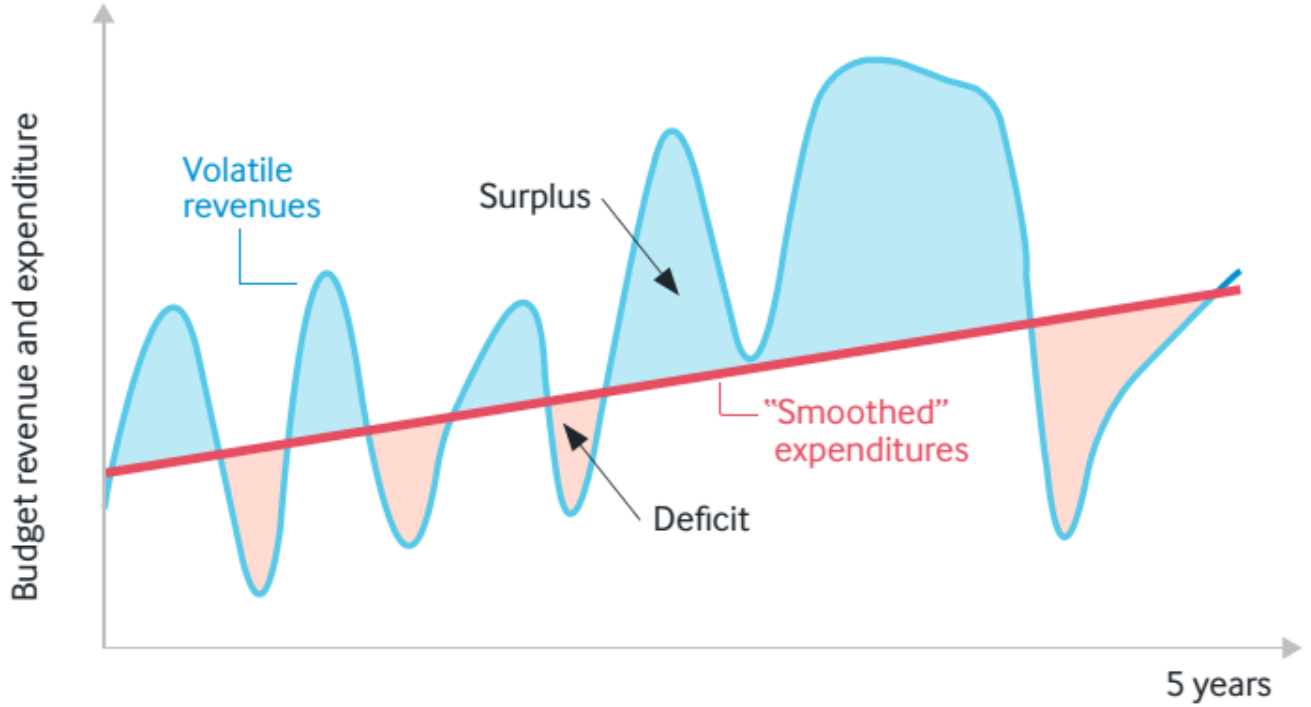
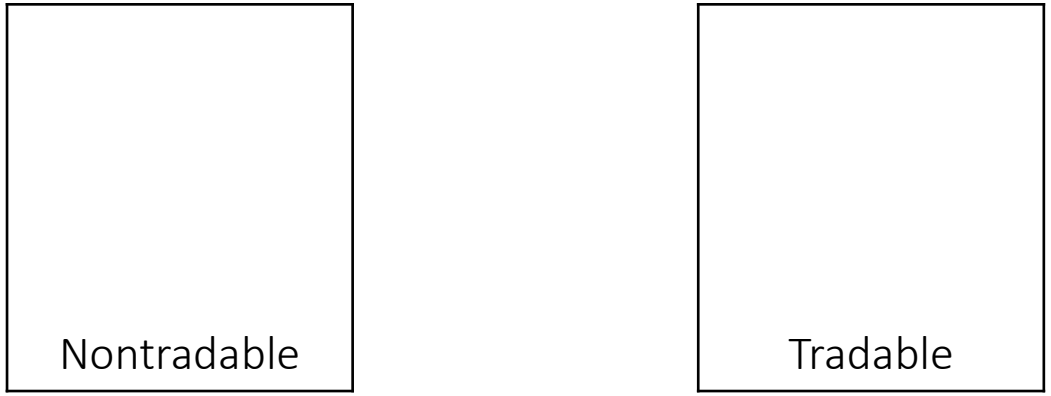
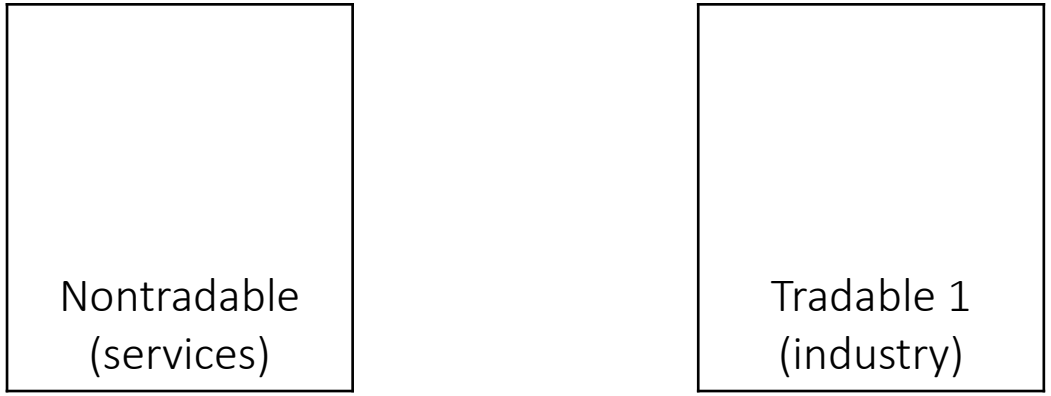


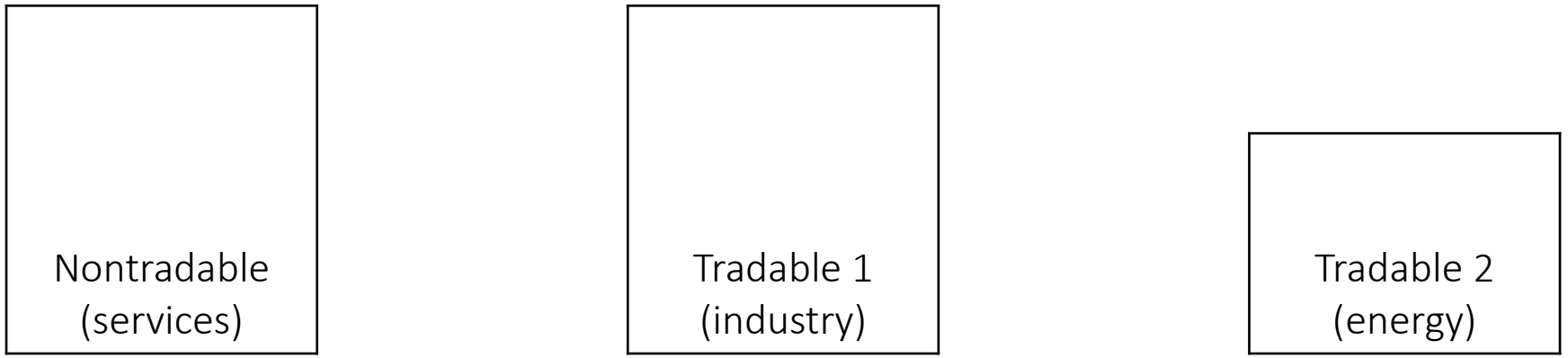
Dutch disease



Dutch disease

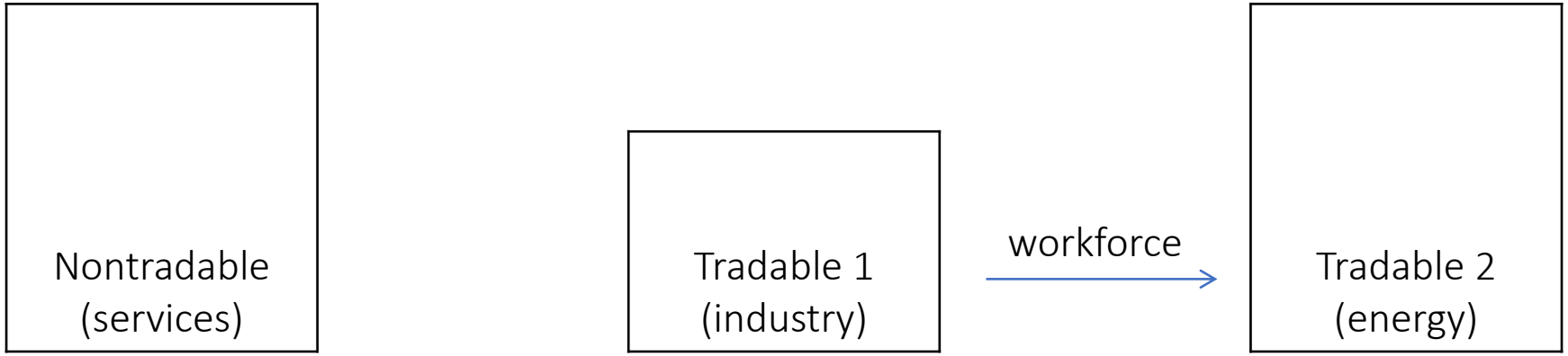


Dutch disease



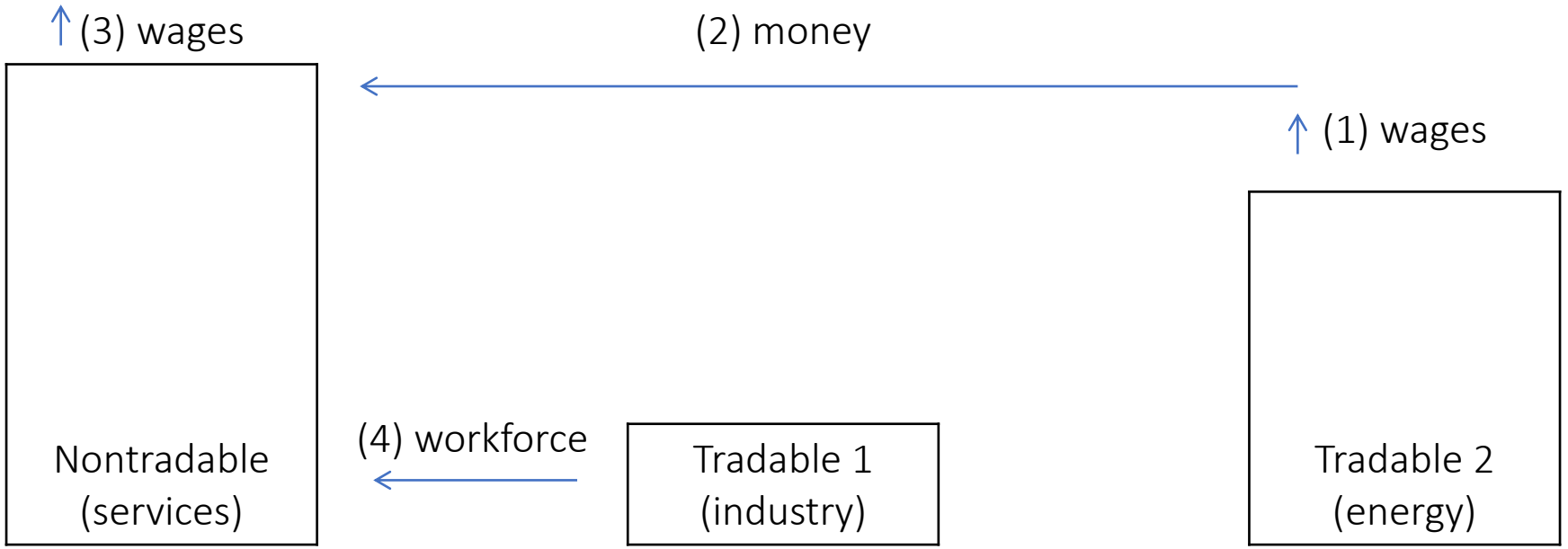
New expanding tradable sector emerges

Dutch disease



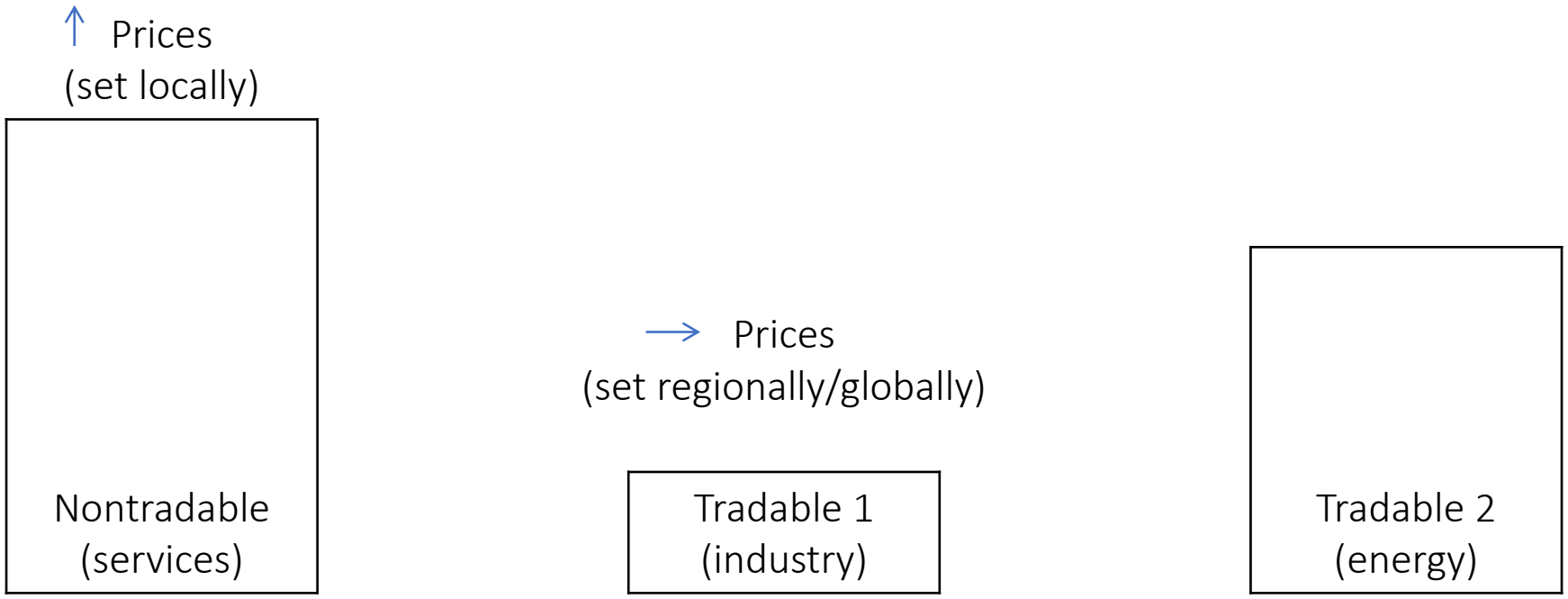
Direct deindustrialization: workforce movement

Dutch disease



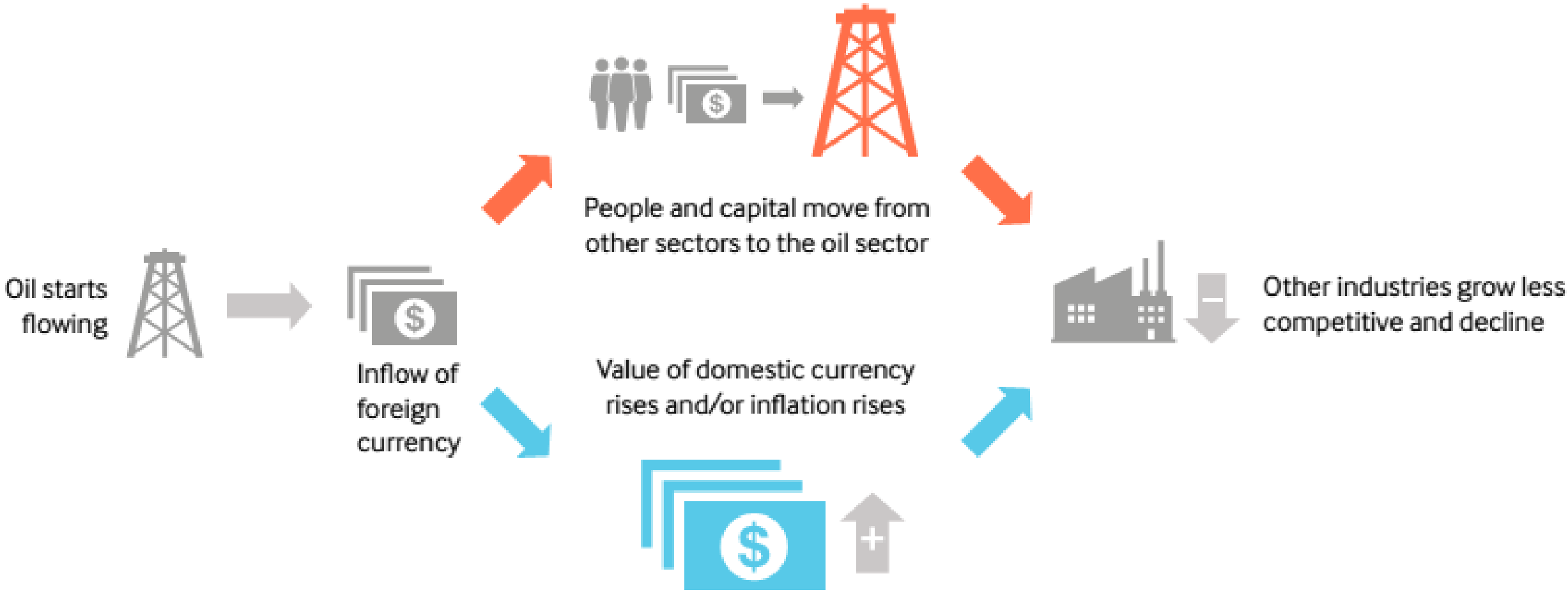
Indirect deindustrialization 1: workforce movement

Dutch disease



Indirect deindustrialization 2: price difference induces currency appreciation that hinders tradable goods exports

Dutch disease: summary



Dutch disease: some statistics

Gylfason, T. (2001): 162 countries, 1965-1998:

+ 3% of export in the expanding sector => - 1% of total export

+ 5% workforce in the expanding sector => - 1% of foreign direct investment

Dutch disease: some statistics

Mehrara, M (2008): 13 oil exporters, 1965-2005:

Growth in oil revenues:

- smaller than 18% per year: + 10% in oil revenues => + 1,3% other GDP
- larger than 18% per year: + 10% in oil revenues => - 2.1 % other GDP

Growth in „other“ export, 1980-2000

East Asia and Pacific	212%
Botswana	139%
Chile	99%
Iran	46%
Norway	15%
Camerun	0%
Venezuela	-8%
Algeria	-17%
Nigeria	-24%
Kongo	-52%

Stevens, Dietsch (2008): Resource curse: An analysis of causes, experiences and possible ways forward.

Findings

In developing countries, oil revenues can amplify existing conflicts, destabilize societes and prevent state-building and institutions-building from taking place. Alternatively, it can conserve societies in economically underdeveloped, yet welfare abundant state of being.

In developed (industrialized) countries, oil revenues can compromise the added value-producing industries and alter the economic development of a country.

Oil is good, when:

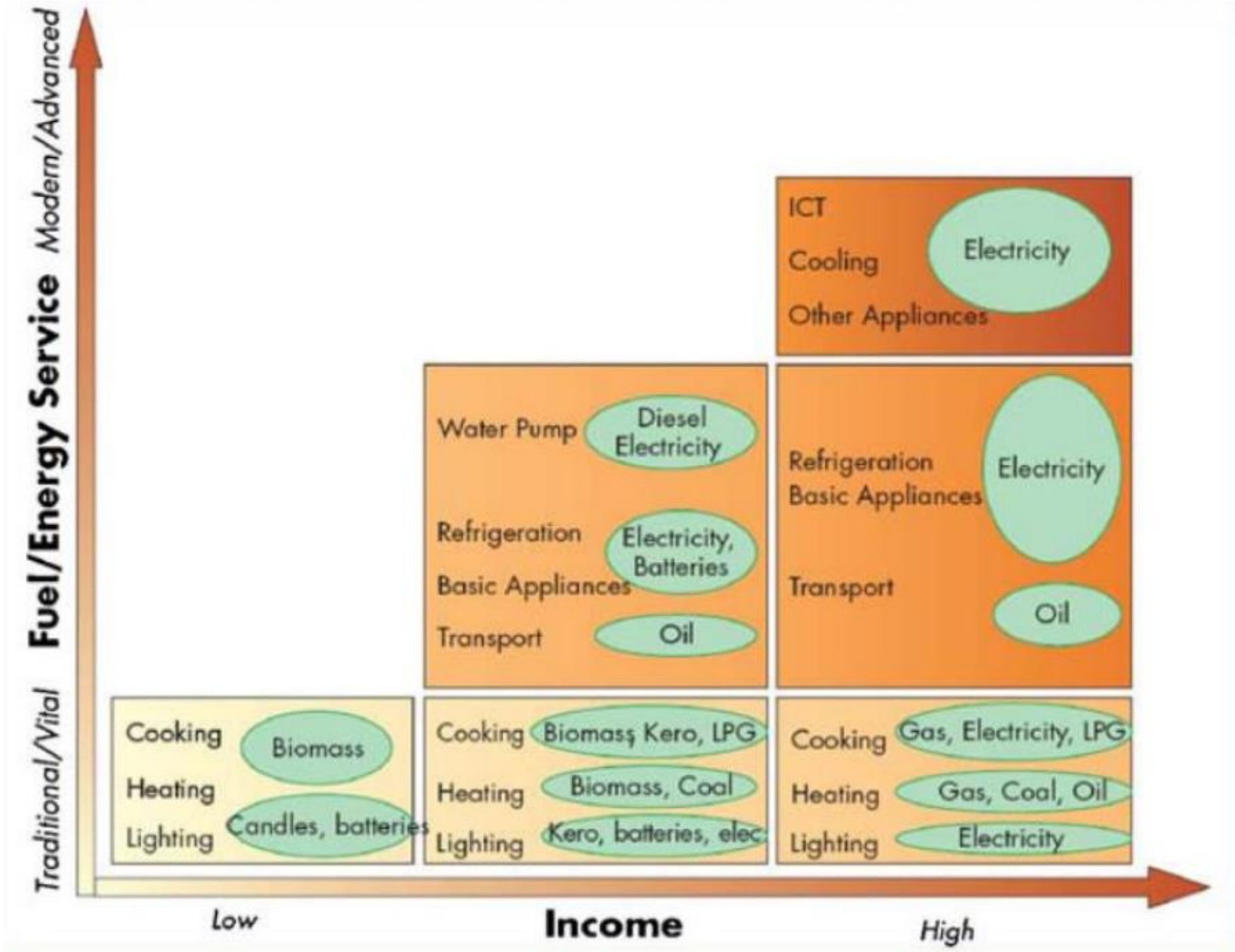
- Strong institutions exist before it is developed
- Oil revenues come gradually
- Oil revenues are managed thoughtfully

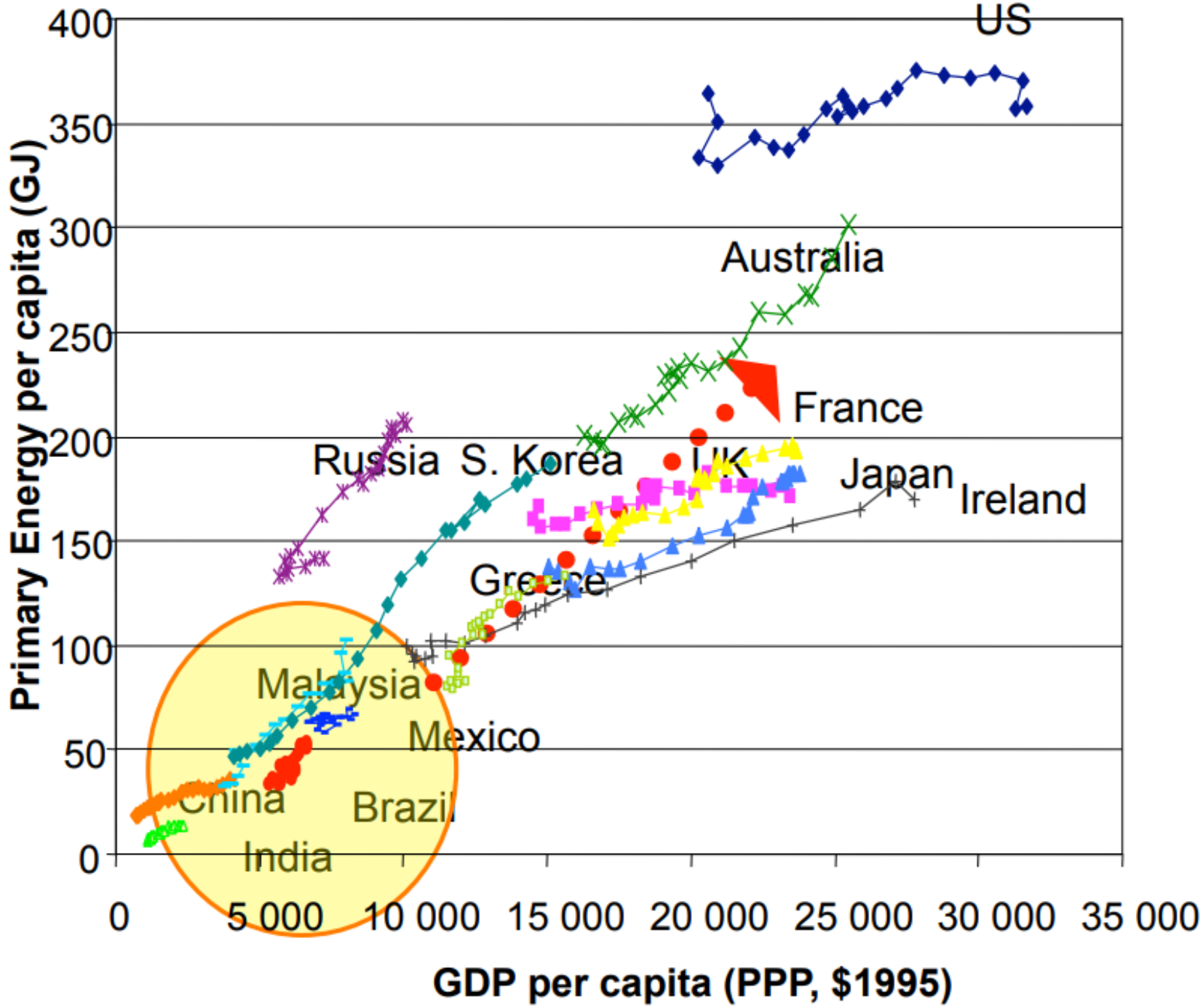
Energy poverty

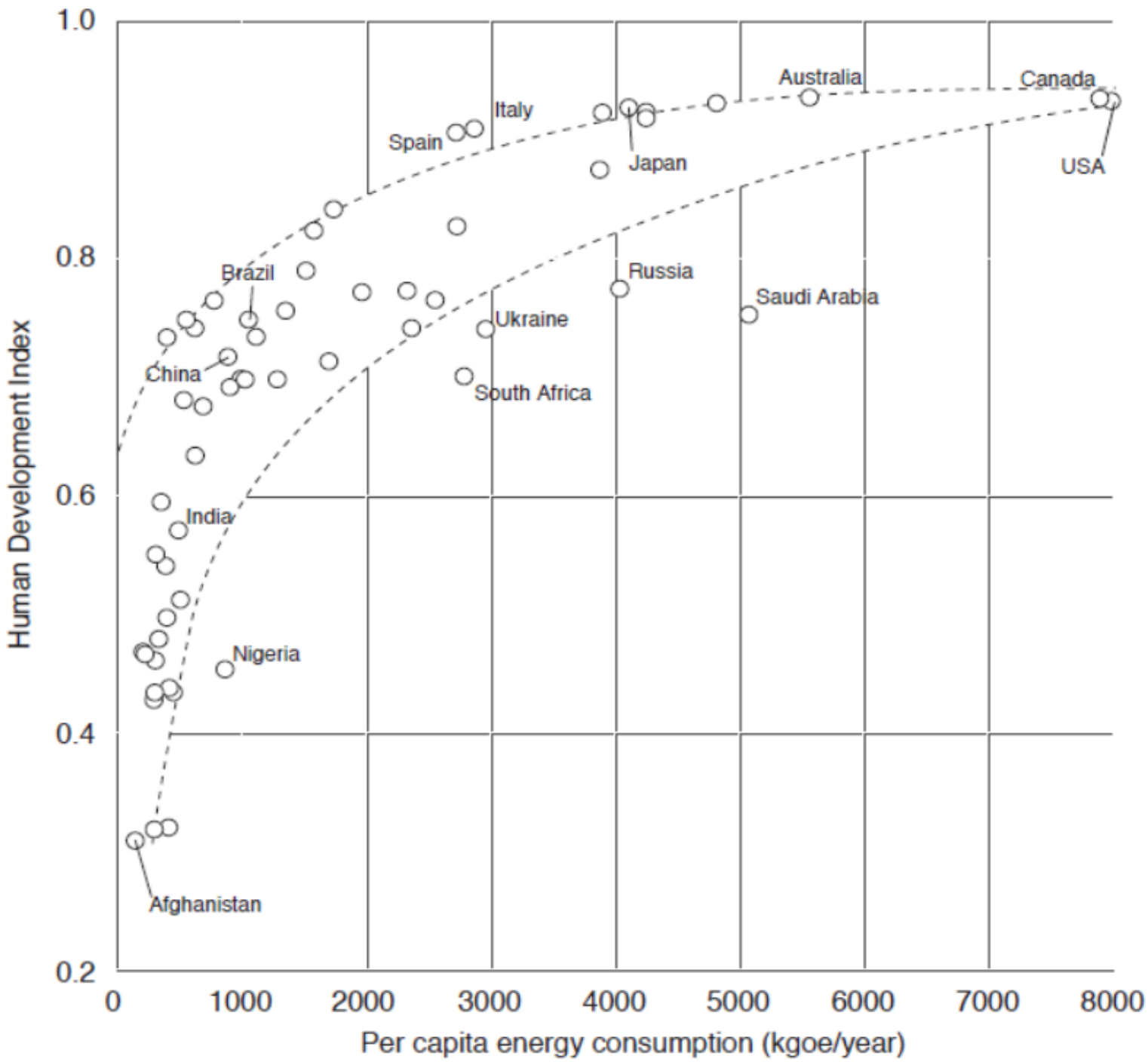
Jan Osička

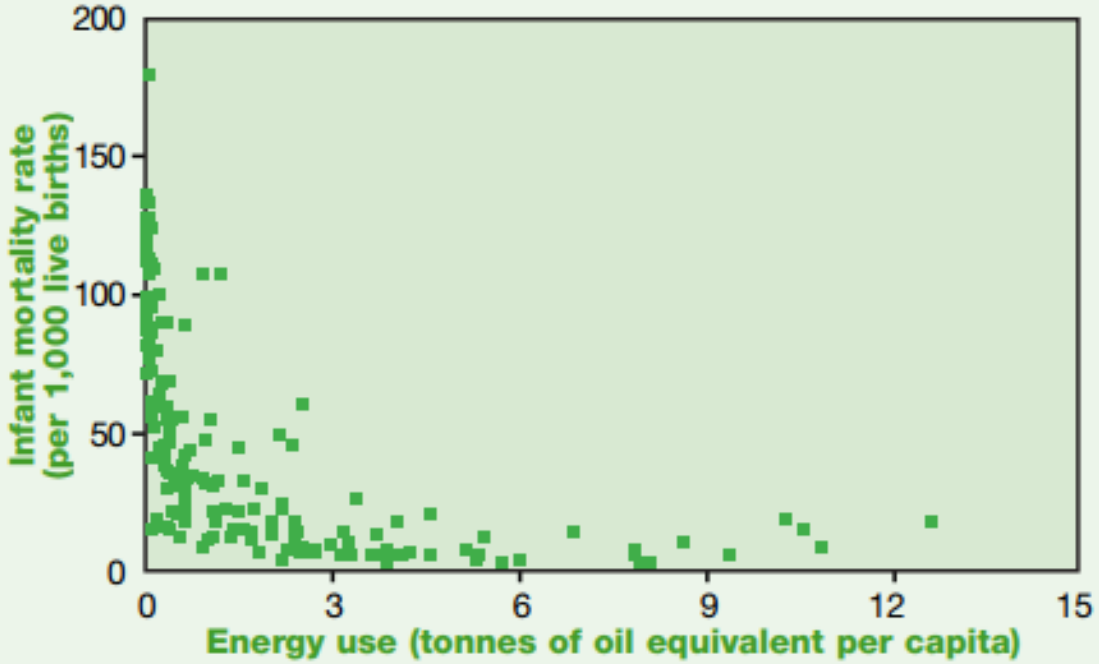
Session outline

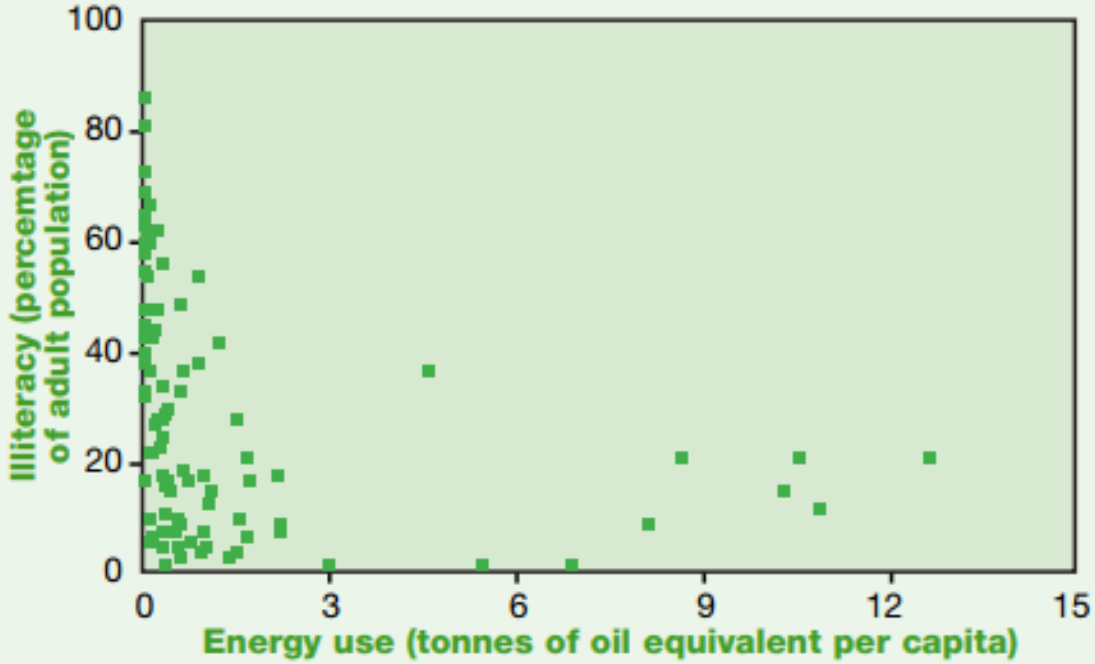
- Energy, development, inequality
- Energy poverty in energy-unintensive countries
- Energy poverty in energy-intensive countries

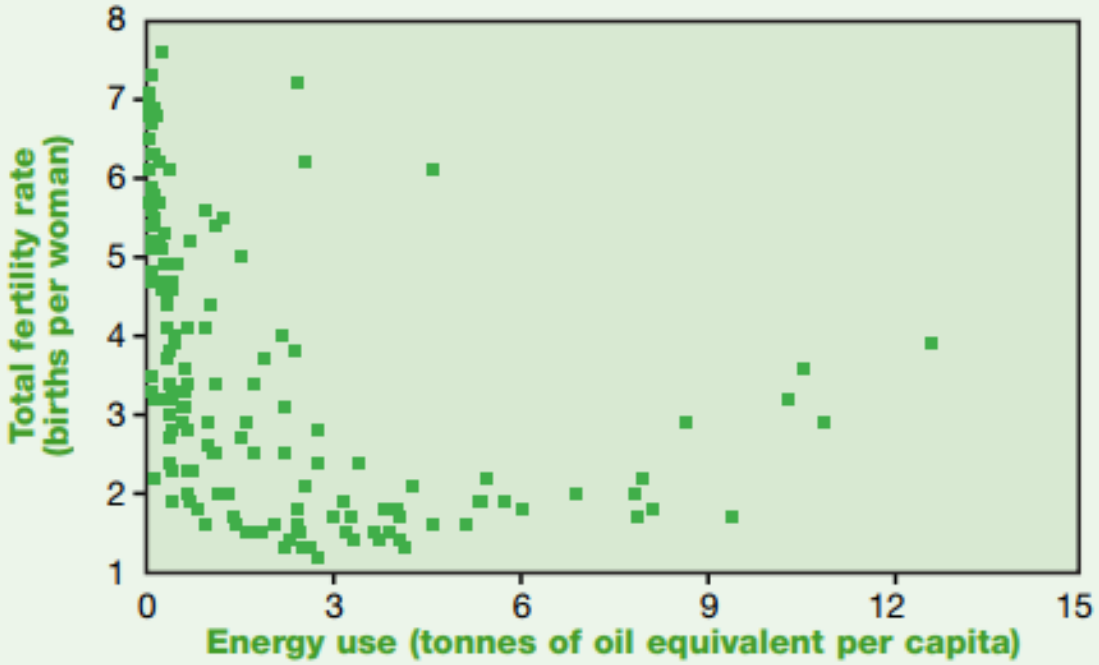

Traditional/Vital
Fuel/Energy Service
Modern/Advanced
ICT
Cooling
Other Appliances
Electricity
Water Pump
Diesel
Electricity
Refrigeration
Basic Appliances
Transport
Electricity,
Batteries
Oil
Refrigeration
Basic Appliances
Transport
Electricity
Oil
Cooking
Biomass
Heating
Lighting
Candles, batteries
Cooking
Biomass, Kero, LPG
Heating
Biomass, Coal
Lighting
Kero, batteries, elec
Cooking
Gas, Electricity, LPG
Heating
Gas, Coal, Oil
Lighting
Electricity
Low
Income
High

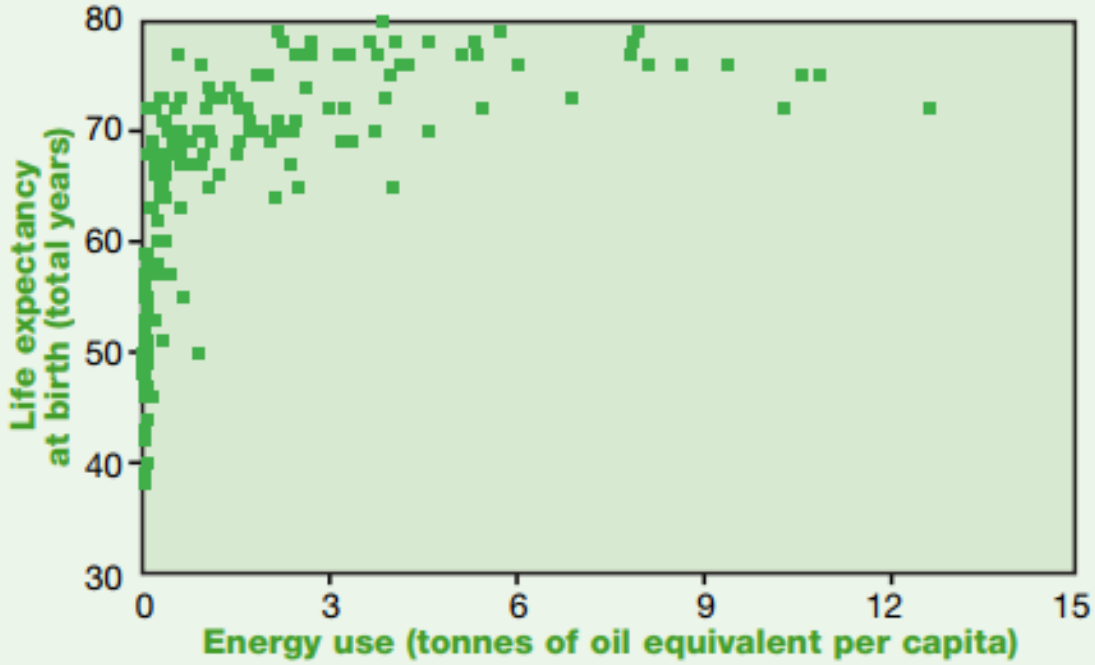

US
Australia
France
Russia
S. Korea
UK
Japan
Ireland
Greece
Malaysia
Mexico
China
Brazil
India
Primary Energy per capita (GJ)
0
50
100
150
200
250
300
350
400
0
5 000
10 000
15 000
20 000
25 000
30 000
35 000
GDP per capita (PPP, $1995)

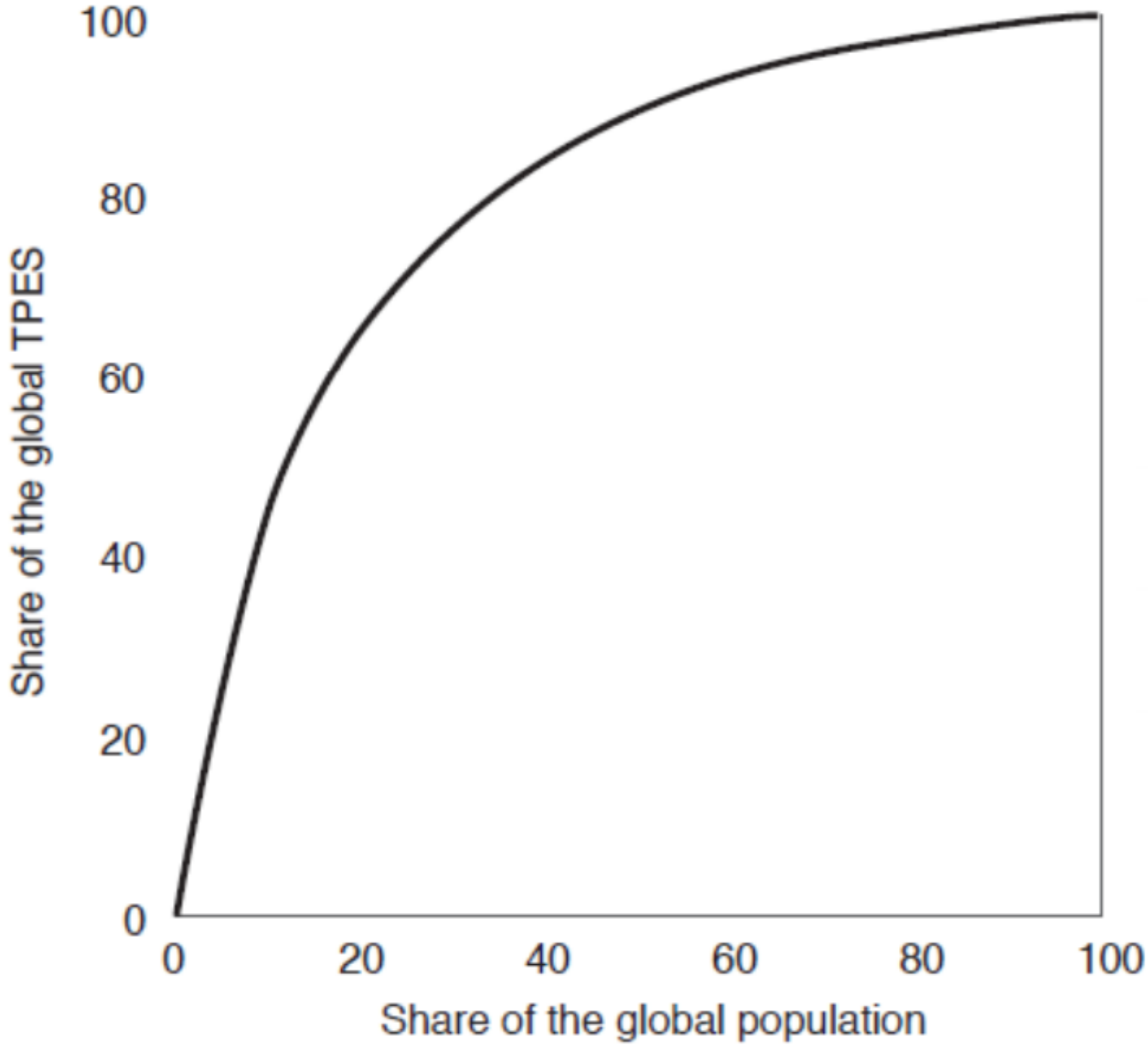

1.0
0.8
0.6
0.4
0.2
Human Development Index
0
1000
2000
3000
4000
5000
6000
7000
8000
Per capita energy consumption (kgoe/year)
Australia
Canada
Italy
Spain
Japan
USA
Brazil
Russia
Saudi Arabia
Ukraine
China
South Africa
India
Nigeria
Afghanistan


Infant mortality rate (per 1,000 live births)
200
150
100
50
0
0
3
6
9
12
15
Energy use (tonnes of oil equivalent per capita)


Illiteracy (percemtage of adult population)
100
80
60
40
20
0
0
3
6
9
12
15
Energy use (tonnes of oil equivalent per capita)


Total fertility rate (births per woman)
8
7
6
5
4
3
2
1
0
3
6
9
12
15
Energy use (tonnes of oil equivalent per capita)


Life expectancy at birth (total years)
80
70
60
50
40
30
0
3
6
9
12
15
Energy use (tonnes of oil equivalent per capita)


100
80
60
40
20
0
Share of the global TPES
0
20
40
60
80
100
Share of the global population

Energy poverty and fuel poverty: the meaning

- Energy poverty = lack of (physical) access to modern energy services
- Fuel poverty = inability to adequately heat (or provide necessary energy services in) one‘s home at affordable cost
- Often in literature however: energy poverty = fuel poverty
- No agreement on how to measure energy/fuel poverty

=> What policies shall be drafted to address the issue?

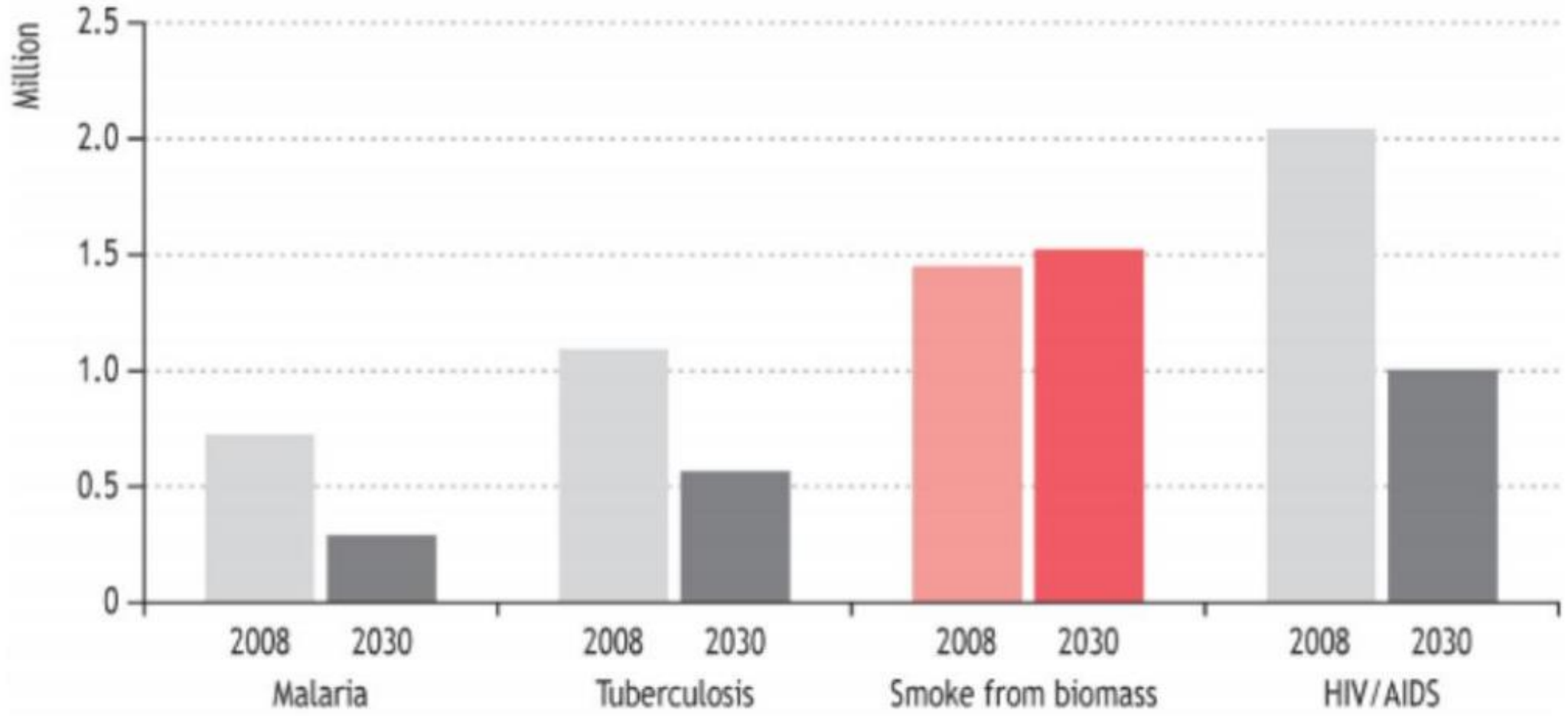
Energy poverty in energy-unintensive countries/regions

Energy poverty in energy-unintensive countries/regions

Reliance on biomass

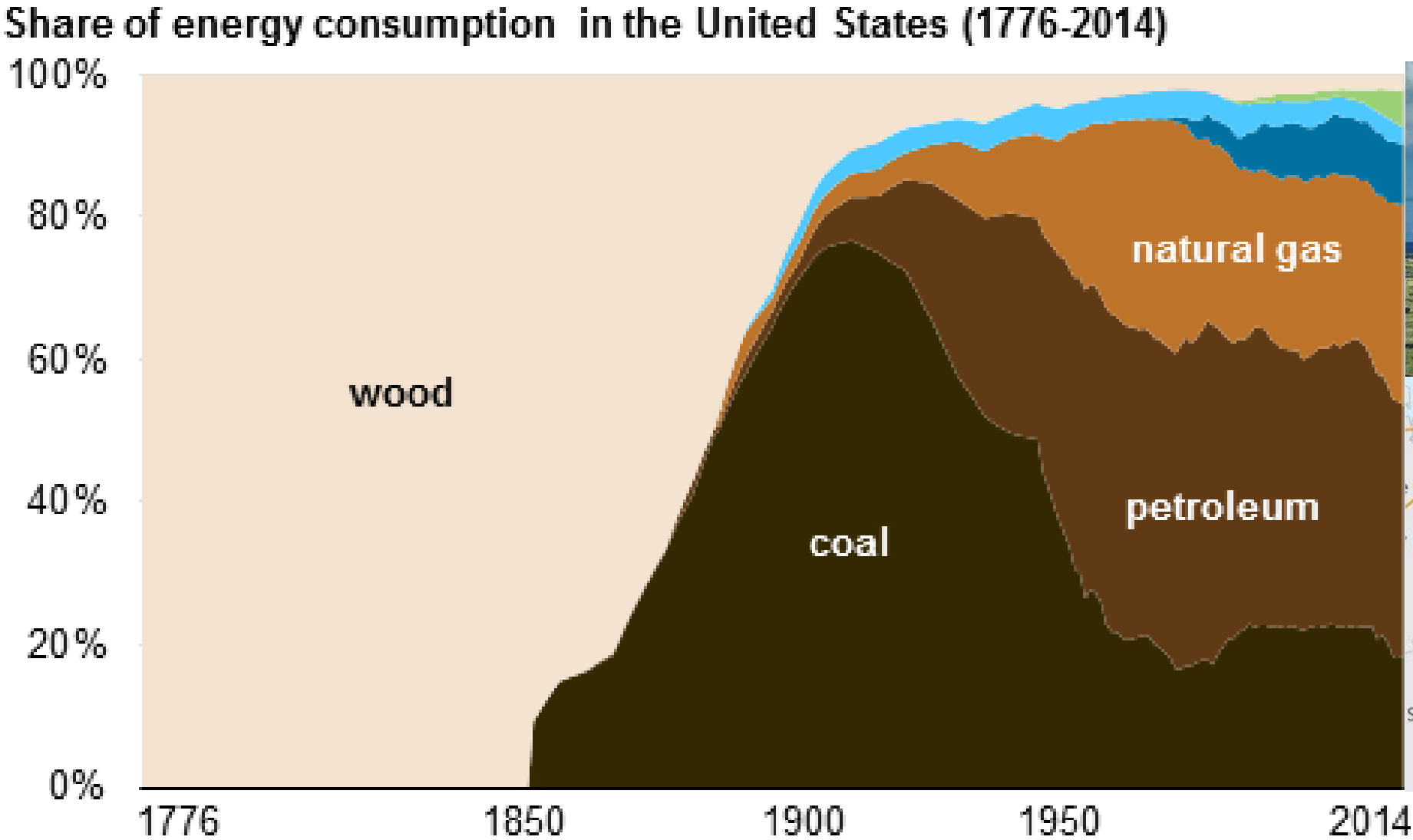
- Indoor air pollution
- Time and effort in collecting biomass
- Unsustainable harvesting practices

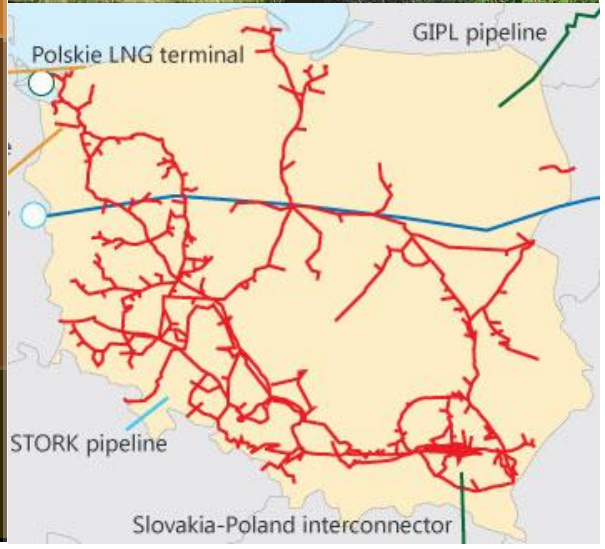
Premature annual deaths from household air pollution and other diseases



Sources: Mathers and Loncar (2006); WHO (2008); Smith *et al.*, (2004); WHO (2004) and IEA analysis.

100% reliance on wood





Energy poverty in energy-unintensive countries/regions

Energy poverty alleviation pathway: breaking the missing return on investment problem

- Scattered and small demand for energy
- Low purchasing power

=> Centralized solutions do not work

=> Micro-solutions need to be developed

Energy poverty in energy-intensive countries

- Recognized and reflected only recently (UK as a frontrunner – effects of market liberalization?)
- EU gathers data and discusses appropriate policies (defining vulnerable consumers)

  (see for example https://ec.europa.eu/energy/sites/ener/files/documents/INSIGHT_E_Energy%20Poverty%20-%20Main%20Report_FINAL.pdf)

- The issue of redistribution
- The social sustainability – environmental sustainability nexus

Equity and redistribution

- Should energy be subsidized?

- If yes, what and how?

Subsidized energy prices

- Alleviate (energy) poverty
- Foster purchasing power and consumer demand

- Burden state treasury
- Encourage overconsumption
- Challenge competitiveness of energy suppliers
- Leak to unintended groups

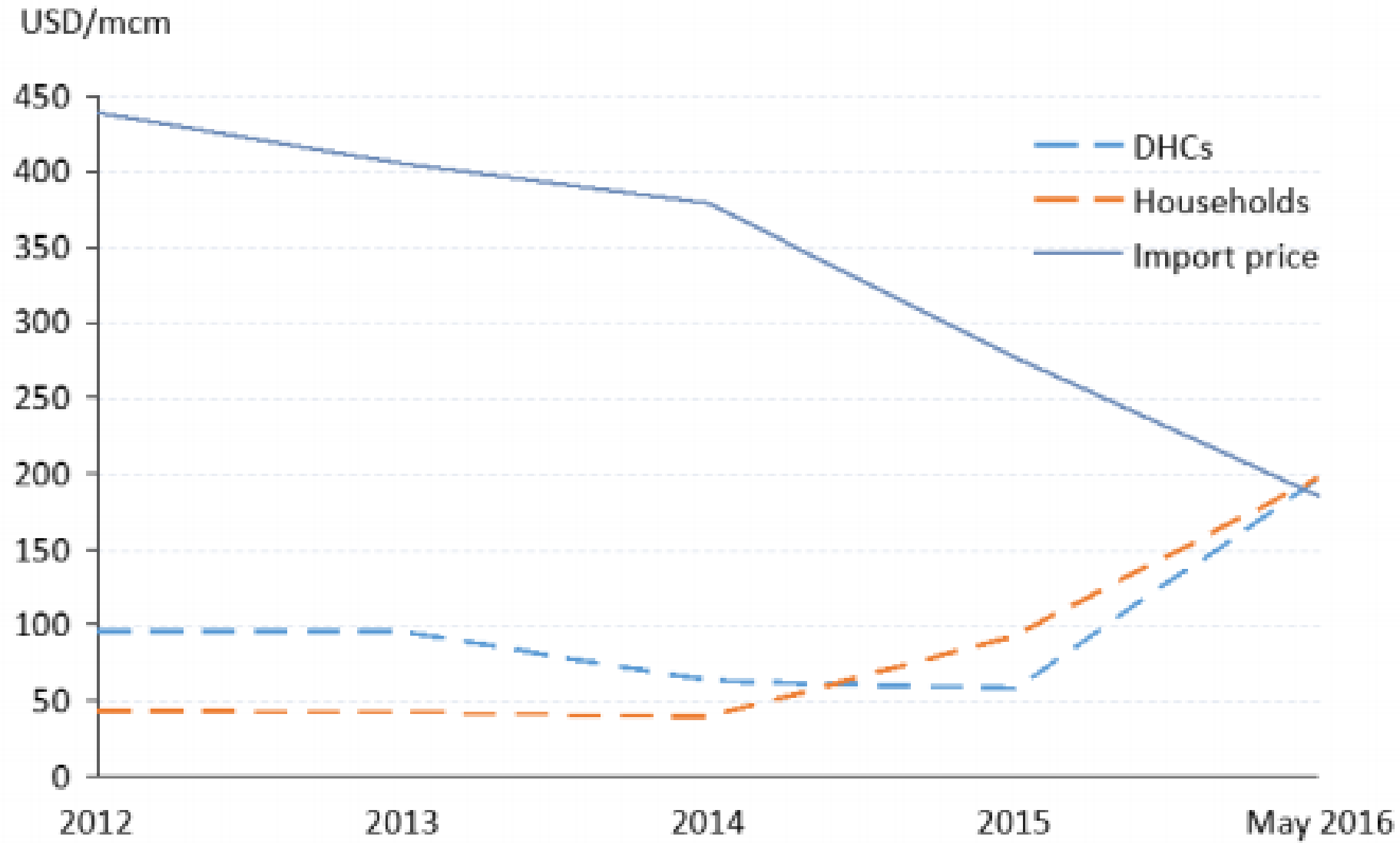
Natural gas wholesale market in Poland

- Goal: to decrease natural gas price for the end customers
- Tool: mixing cheap domestic production (30%) with expensive imports (70%) to reduce the wholesale price
- Result: even more expensive imports

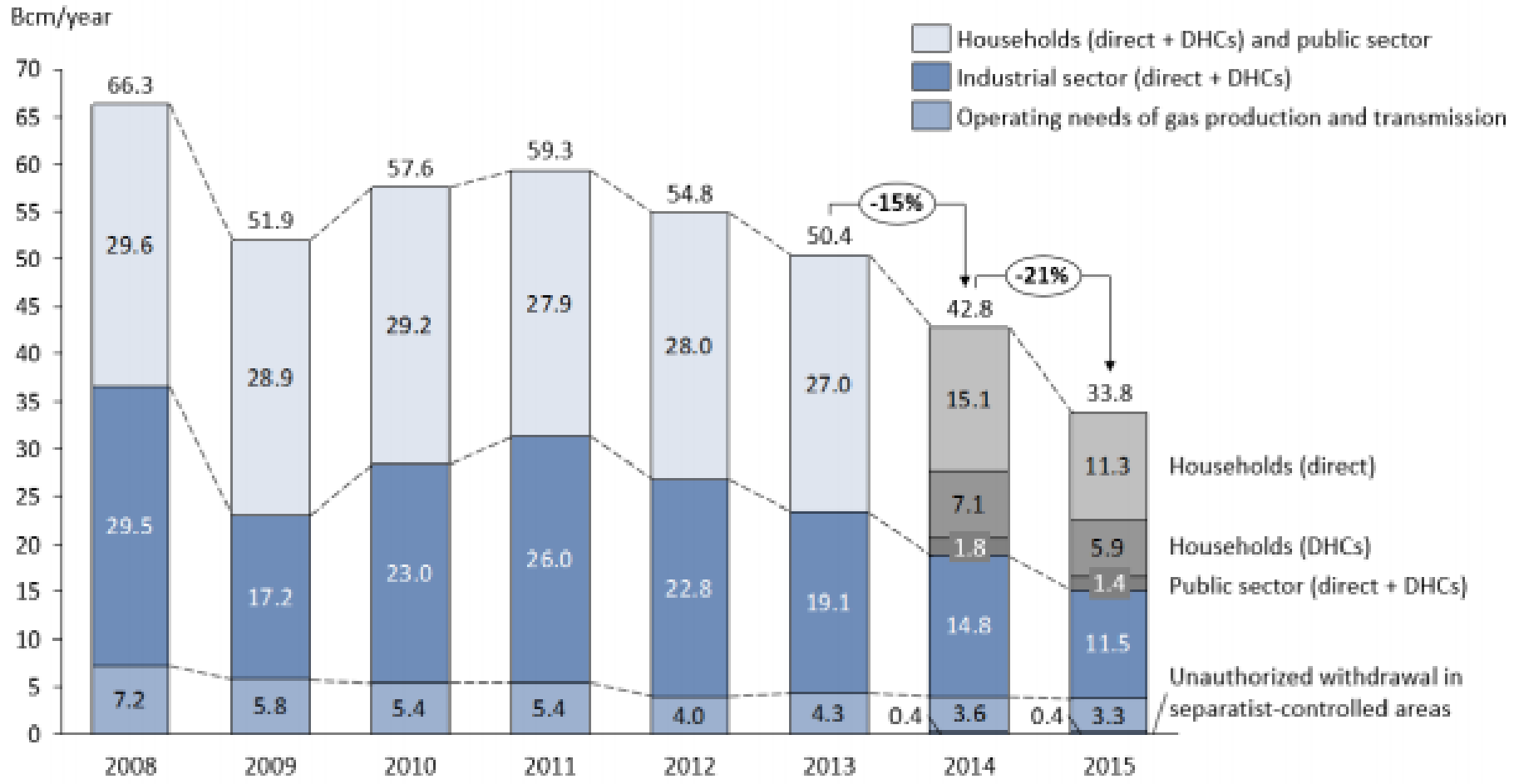
Natural gas retail market in the Ukraine

- Goal: affordable heat for households
- Tool: regulated retail gas price (subsidies equaled to 5.6% of GDP)
- Result: overconsumption which contributed to the political and national security crisis of 2014

Natural gas retail market in the Ukraine



Natural gas retail market in the Ukraine



The social sustainability – environmental sustainability nexus

Should the following measures/technologies be subsidized?

- Thermal efficiency of buildings
- Large scale renewable energy production sites
- Decentralized renewable energy sources
- Electrical mobility

The measurement issue: Energy Efficiency

How would you measure energy efficiency?

Energy Efficiency

How would you measure energy efficiency?

- Energy intensity: GDP/energy consumption
- Energy consumption per capita

Energy efficiency: the best of the best (USD2005 GDP PPP/kgoe)

1981-1985 | 1986-1990 | 1991-1995 | 1996-2000 | 2001-2005 | **2006-2010**

Country name	2006	2007	2008	2009	2010
Lesotho	136.1	142.1			
Vanuatu	26.4	25.0			
Kiribati	21.9	20.0			
Hong Kong SAR, China	19.5	19.3	20.0	18.4	
Solomon Islands	17.7	18.0			
Comoros	16.3	16.8			
Guinea-Bissau	15.8	15.4			
Cape Verde	13.8	14.8			
Singapore	10.9	14.6	13.9	12.5	
Peru	14.3	14.4	15.1	14.4	
Gambia, The	15.5	14.0			
Dominica	13.1	13.4			
Panama	11.5	13.4	14.2	13.2	

Energy efficiency: the worst of the worst (USD2005 GDP PPP/kgoe)

Tanzania	2.4	2.5	2.6	2.7		
Kazakhstan	2.4	2.4	2.4	2.5		
Iceland	2.6	2.3	2.2	2.1	2.0	
Ukraine	2.1	2.2	2.3	2.3		
Zambia	1.9	2.0	2.1	2.1		
Togo	2.0	2.0	2.0	2.0		
Ethiopia	2.4	1.9	2.0	2.2		
Mozambique	1.7	1.8	1.8	1.9		
Trinidad and Tobago	1.5	1.6	1.7	1.5		
Turkmenistan	1.3	1.3	1.4	1.7		
Uzbekistan	1.2	1.3	1.3	1.5		
Congo, Dem. Rep.	0.8	0.8	0.8	0.8		

Energy consumption: the lowest (kgoe per capita)

1981-1985 | 1986-1990 | 1991-1995 | 1996-2000 | 2001-2005 | **2006-2010**

Country name	2006	2007	2008	2009	2010	
Lesotho	9	9				
Timor-Leste	57	58				
Comoros	64	60				
Guinea-Bissau	64	67				
Gambia, The	74	84				
Kiribati	107	116				
Solomon Islands	122	129				
Eritrea	150	150	137	142		
Vanuatu	143	157				
Djibouti	174	170				
Bangladesh	178	184	192	201		

Energy consumption: the highest (kgoe per capita)

Country name	2006	2007	2008	2009	2010	
Czech Republic	4,464	4,430	4,281	4,004	4,022	
Turkmenistan	3,934	4,512	4,570	3,933		
Korea, Rep.	4,421	4,584	4,669	4,701	5,044	
Russian Federation	4,706	4,733	4,850	4,561		
Netherlands	4,700	4,844	4,837	4,729	5,016	
Belgium	5,509	5,367	5,470	5,300	5,221	
Sweden	5,529	5,472	5,380	4,883	5,414	
Saudi Arabia	6,380	5,650	5,888	5,888		
Oman	5,548	5,765	6,235	5,554		
Norway	5,817	5,849	6,249	5,849	6,332	
Australia	5,910	5,929	6,019	5,971	5,636	
Finland	7,076	6,953	6,641	6,213	6,639	
United States	7,692	7,749	7,481	7,045	7,232	
Canada	8,224	8,248	8,001	7,532	7,486	

GDP vs. Energy Efficiency
(Top 40 Economies by GDP)