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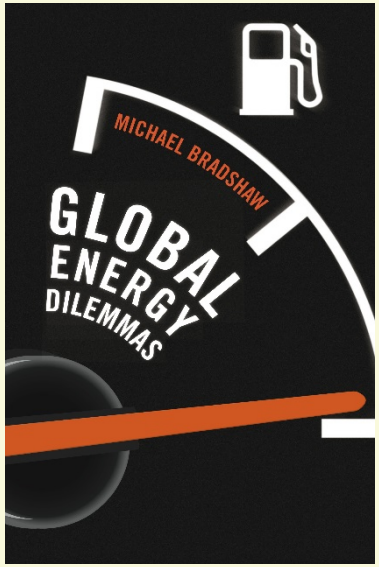
Energy security
Globalisation
Climate change
Global Energy Dilemmas



Global Energy Dilemmas:
energy security, globalization and climate change

SITE Energy Day 21st November 2013

Professor Mike Bradshaw

www.le.ac.uk http://www2.le.ac.uk/departments/geography/research/projects/global-energy-dilemmas

Plan

1. Introduction: the global energy dilemma
2. The 'Kaya Identity' and the Global Energy Dilemmas Nexus
3. Russia's Energy Dilemma
4. Conclusion

Introduction: Global Energy Dilemmas

'It is no exaggeration to claim that the future of human prosperity depends on how successfully we tackle two central energy challenges facing us today: **securing the supply of reliable and affordable energy; and effecting a rapid transformation to a low-carbon, efficient and environmentally benign system of energy supply.**'

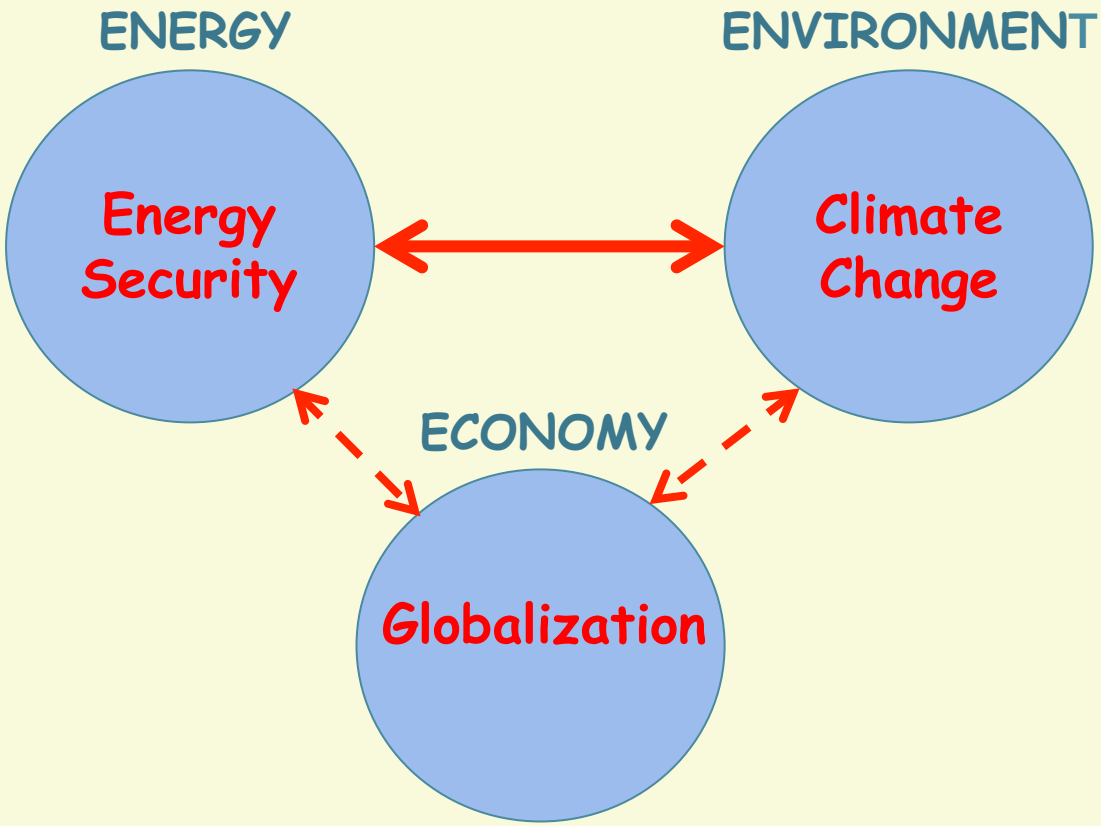
International Energy Agency 2008

The world is not on track to meet the target agreed by governments to limit the long-term rise in the average global temperature to 2 degrees Celsius (°C)— [WEO 2013 suggests we are on track for 3.6°C.]

International Energy Agency 2013

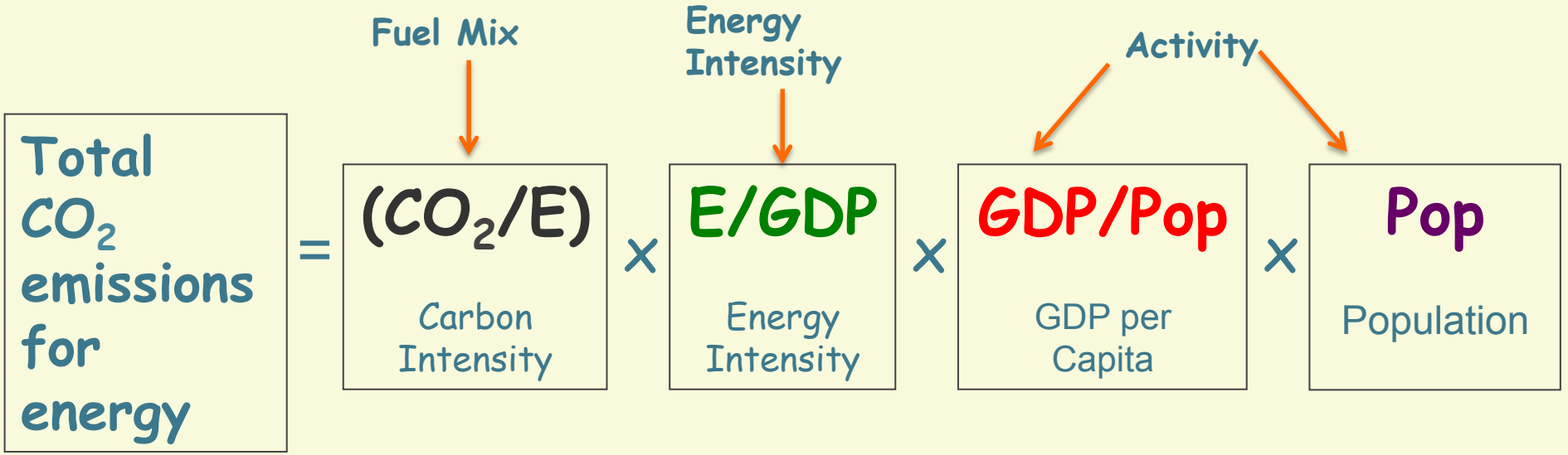
The Global Energy Dilemma

Can we have secure, affordable and equitable supplies of energy that are also environmentally benign?



2. The 'Kaya Identity': Putting it all together

(Named after the Japanese energy economist Yoichi Kaya)



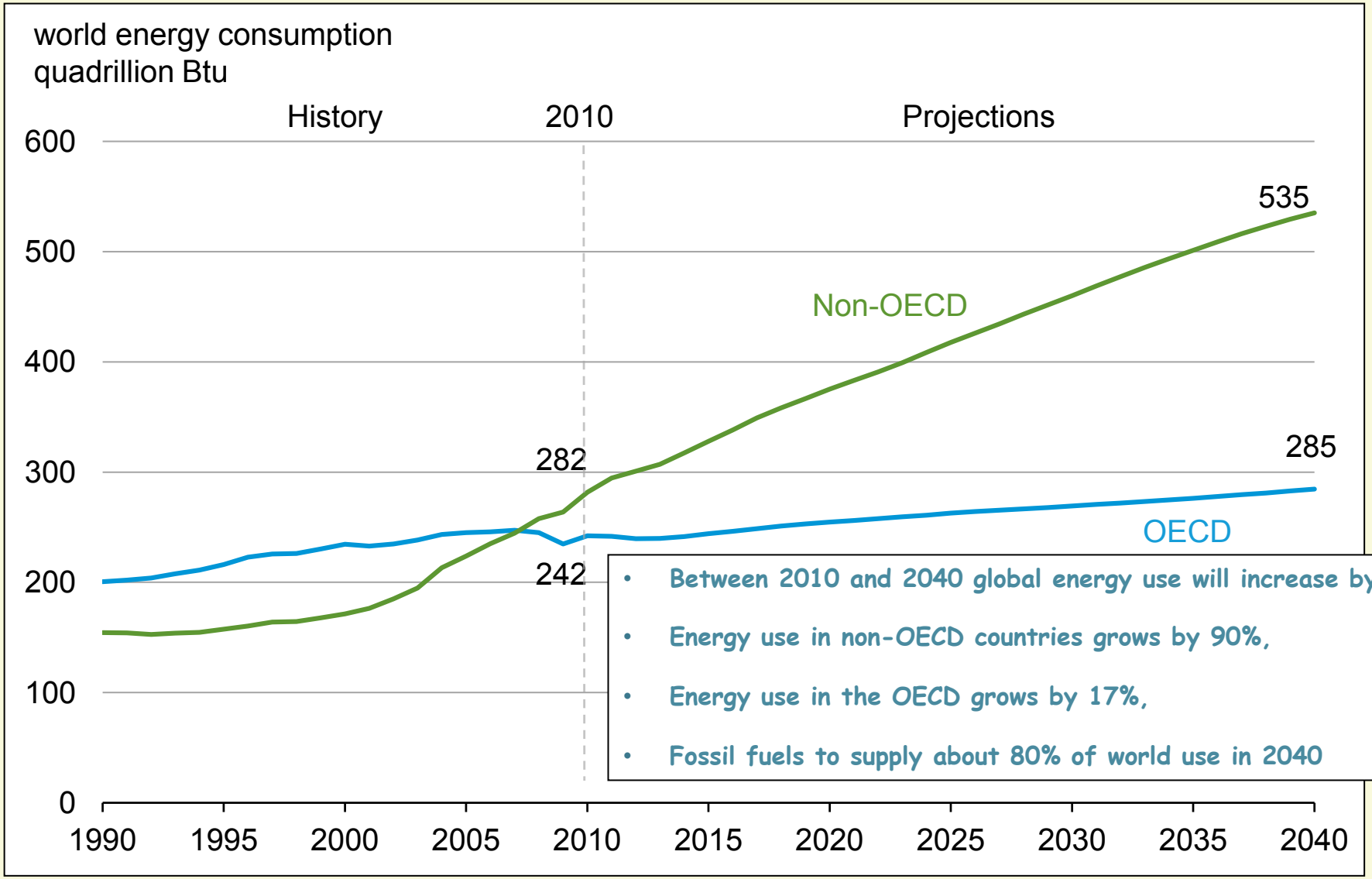
CO_2 = Carbon dioxide emissions

E = Energy consumption

GDP = Gross Domestic Product

Pop = Population

The Globalization of Energy Demand

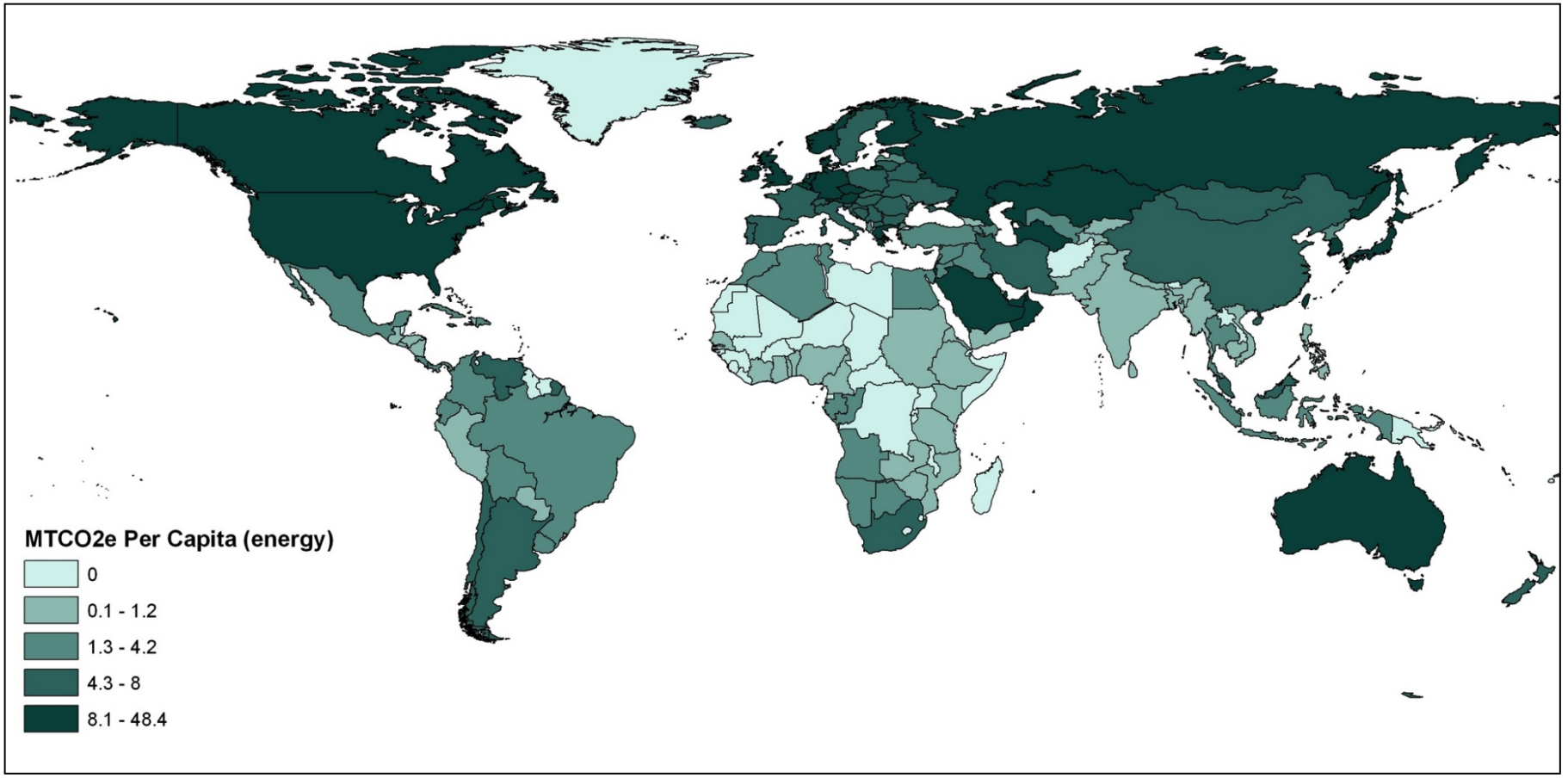


Source: EIA 2013 *International Energy Outlook*

CO_2 Emissions Per Capita in 2007

In 2009 the United States accounted for 20.9% of total CO_2 emissions and 4.6% of the World's population.

In 2009 the level of CO_2 emissions per capita was 19.3 metric tons in the US, 9.4 in the UK, 4.7 in China and 0.3 in Bangladesh.



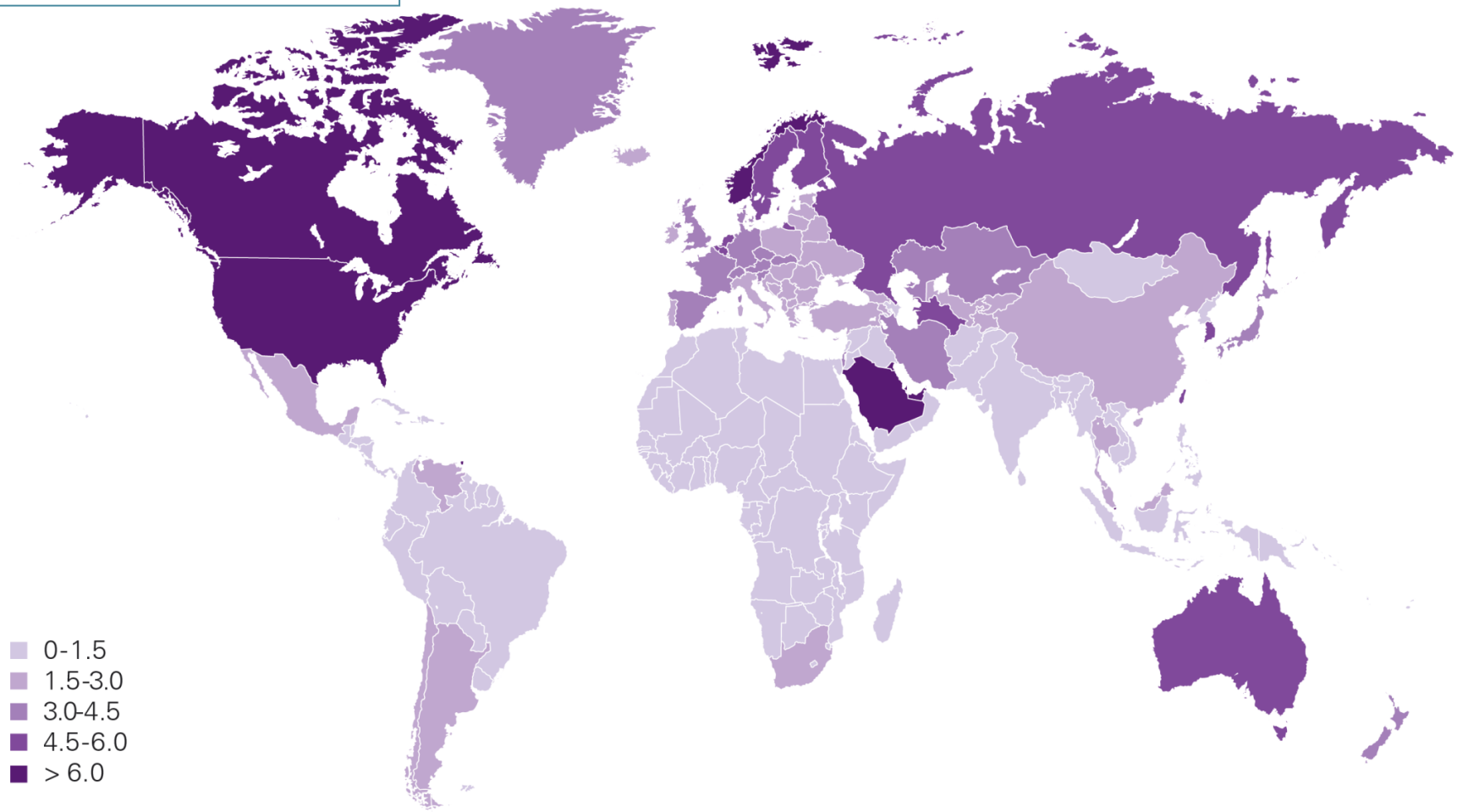
Source: CAIT

Primary energy consumption per capita

Worldwide, nearly 2.4 billion people still use traditional biomass fuels for cooking and nearly 1.6 billion people do not have access to electricity.

Sustainable Energy for all, by 2030:

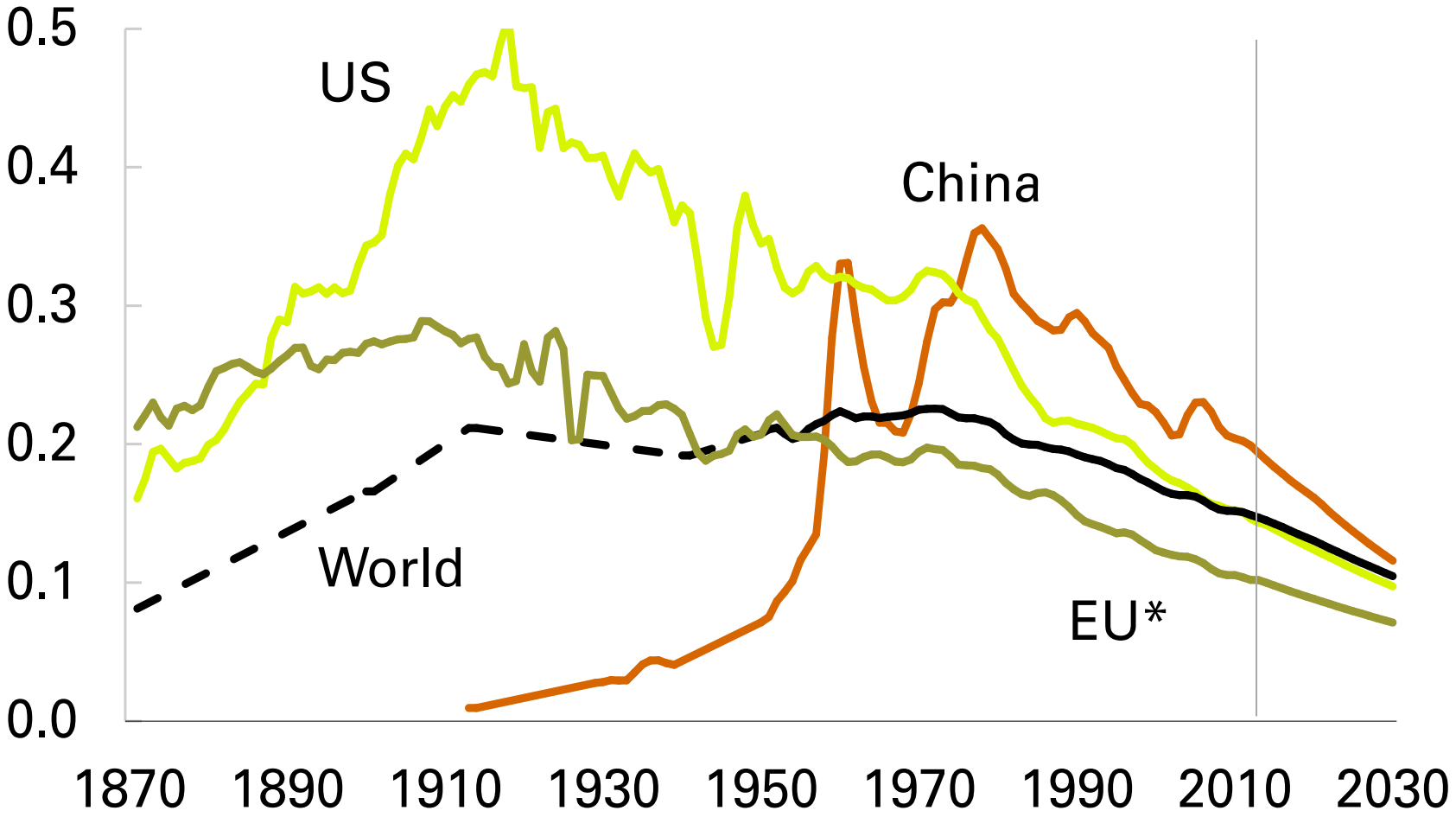
- Ensuring universal access to modern energy services;
- Doubling the rate of improvement in energy efficiency; and,
- Doubling the share of renewable energy in the global energy mix.



BP Statistical Review of World Energy 2013

Energy intensity by region

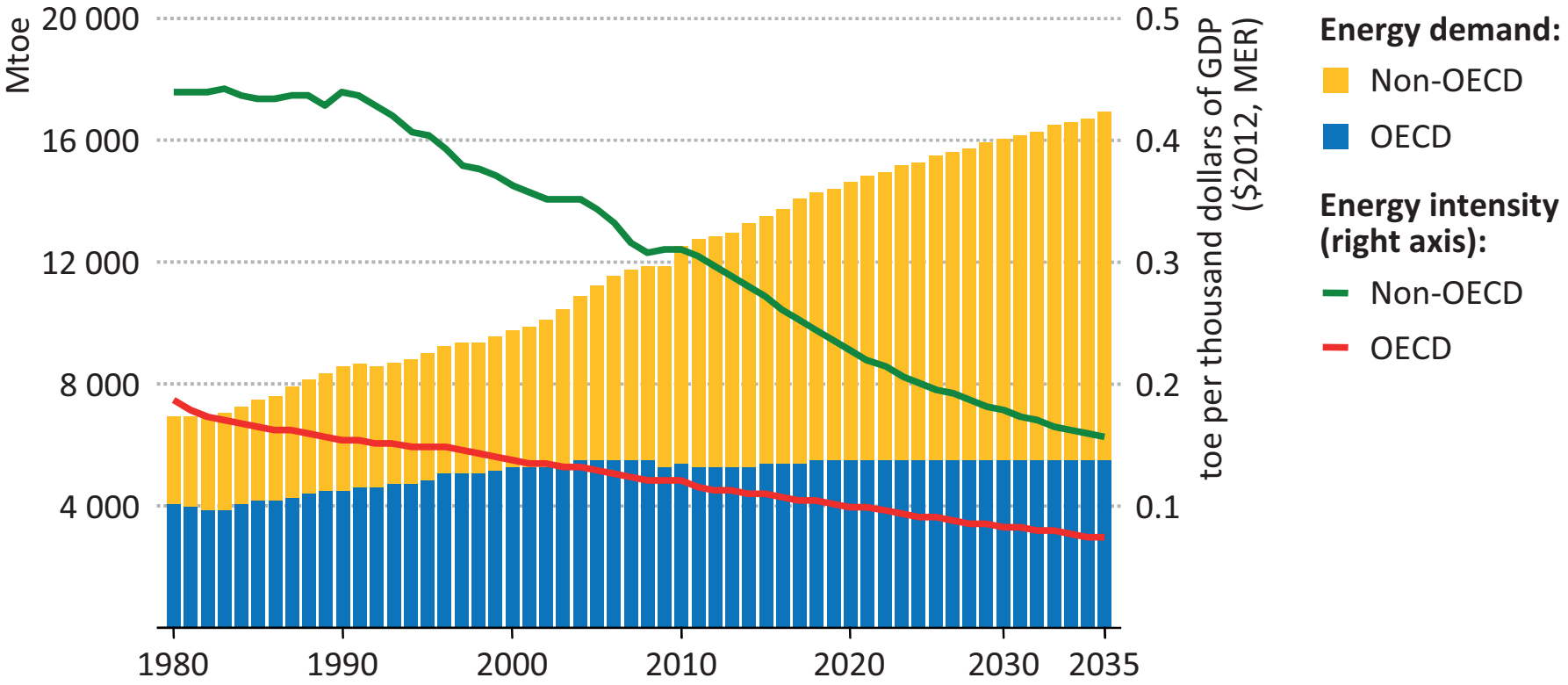
Toe per thousand $2011 GDP (PPP)



*Euro4 (France, Italy, Germany, UK) pre-1970

BP (2013) *Energy Outlook 2030*

Primary Energy Demand and Energy Intensity in WEO 2013 New Policies Scenario

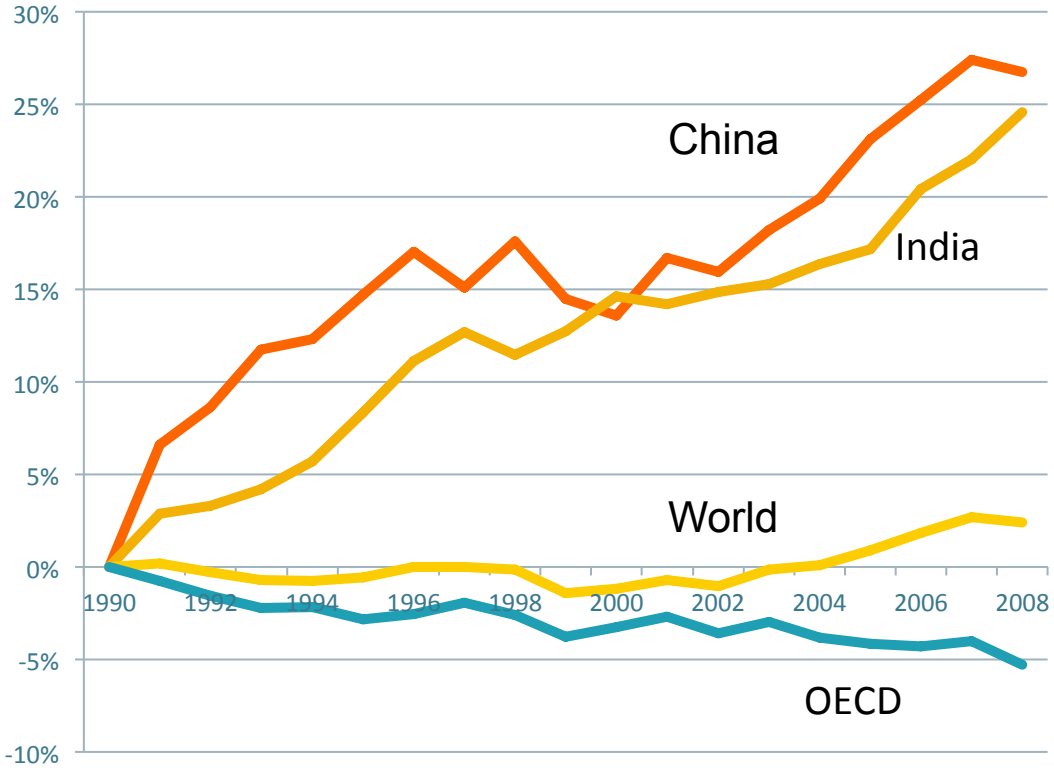


Note: toe = tonne of oil equivalent; MER = market exchange rate.

Source: IEA, WEO 2013

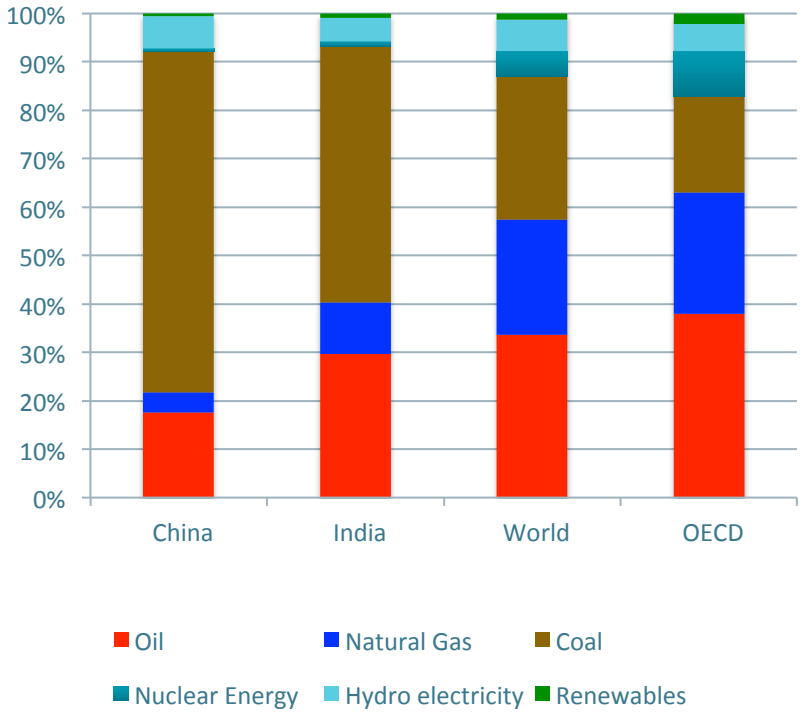
Carbon Intensity of Energy Use

Changing Carbon Intensity of Energy Use: 1990=100



Source: CAIT

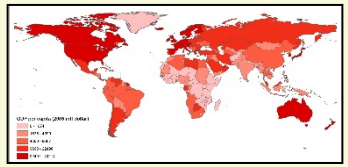
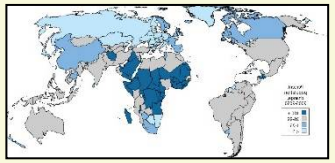
Primary Energy Mix in 2010



Source: BP

The Kaya Identity



$$CO_2 = (CO_2/E) \times E/GDP \times GDP/Pop \times Pop$$

(CO_2/E)	Carbon Intensity
E/GDP	Energy Intensity
GDP/Pop	GDP per Capita
Pop	Population

CO_2 = Total energy related carbon dioxide emissions

E = Energy consumption

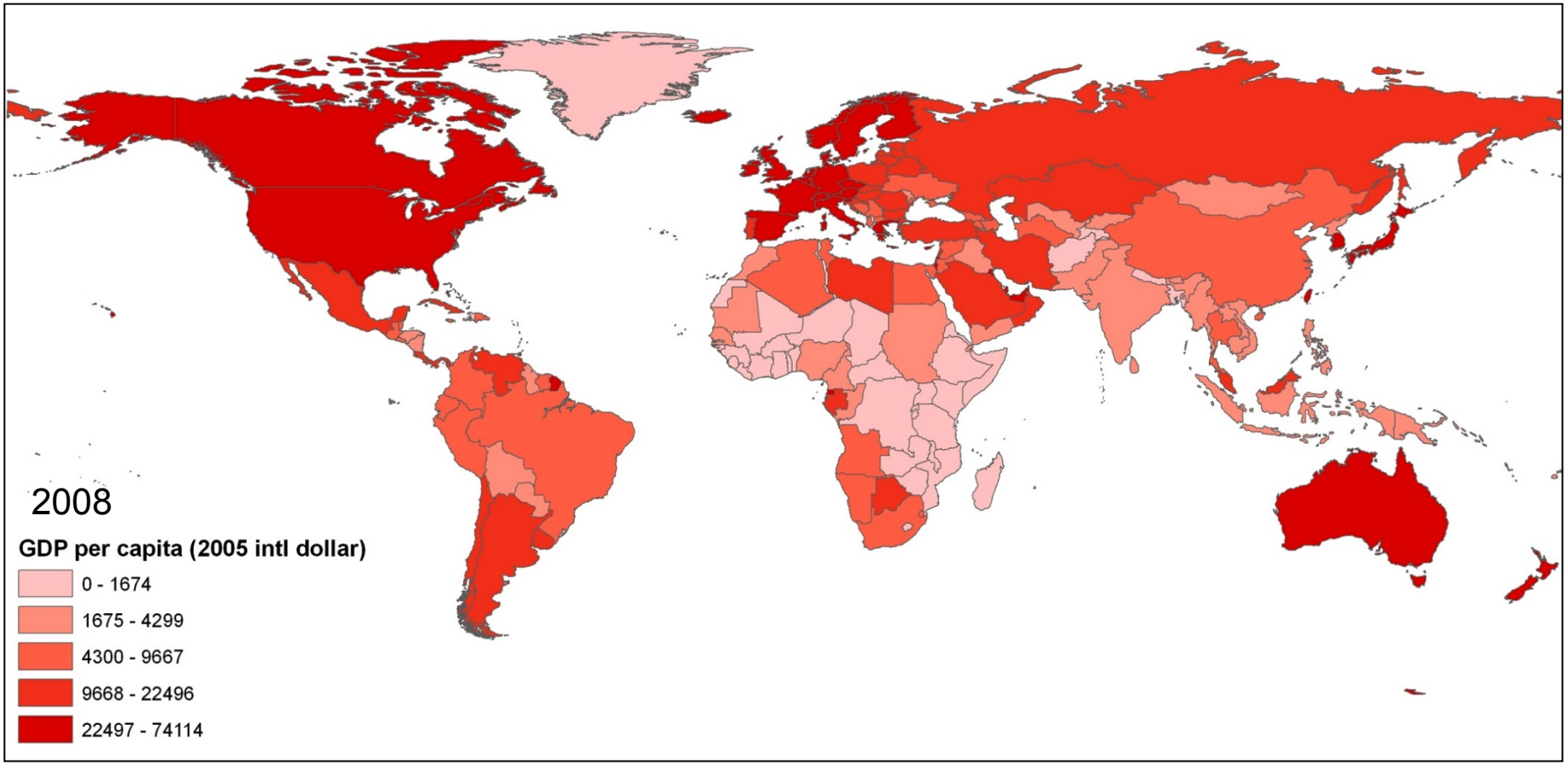
GDP = Gross Domestic Product

Pop = Population

A global shift in economic output

The number of people living on less than $1.25 a day fell to 1.4 billion in 2005 from 1.8 billion in 1990

In 2010, Japan's economy was worth $5.474 trillion, China's economy was closer to $5.8 trillion in the same year.

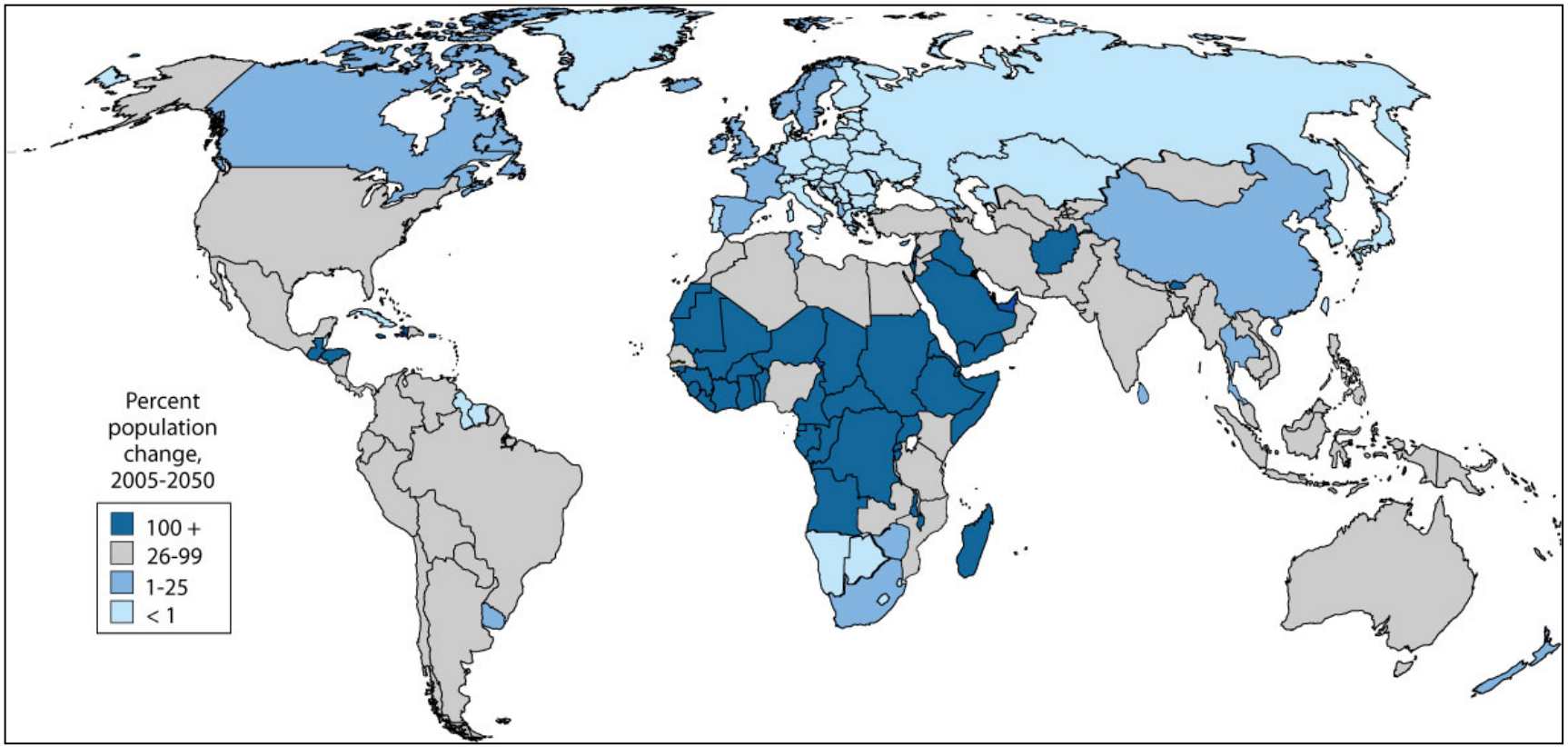


Projected Population Change

World population reached 7 billion in late 2011, is currently 7.2 and could surpass 9.6 billion people by 2050.

'...slowing population growth could provide 16-29% of the emission reductions suggested to be necessary by 2050 to avoid dangerous climate change.' 'Neill et al. (2010)

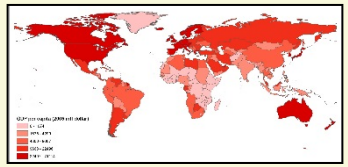
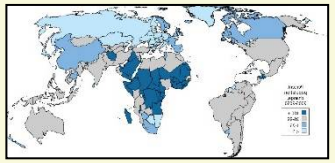
Projected Population Change 2005-2050



Source: Population Reference Bureau, *2005 World Population Data Sheet*.

The Kaya Identity



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Pop	Population

CO_2 = Total energy related carbon dioxide emissions

E = Energy consumption

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Pop = Population

The Global Energy Dilemmas Nexus

	Energy Rich (Exporting)	Energy Poor (Importing)
Developed	Canada, Norway Australia	EU-15, Japan, Korea
Post-Socialist	Russia, Azerbaijan, Kazakhstan, Turkmenistan	Baltic States and Central Europe, Ukraine, Moldova, Belarus
Emerging	(Russia), (Brazil), Saudi Arabia, UAE	(China), India, South Africa, Indonesia
Developing	Nigeria, Sudan, Venezuela, Angola	The rest of the Global South!

The Triple Challenge

- To **improve energy intensity**, that is to reduce the amount of energy used per unit of economic output.
- To **reduce the carbon intensity of energy use**, that is to reduce the amount of CO_2 produced per unit of energy used.
- To achieve the above in ways that are: **equitable, secure and affordable** (and that does not threaten economic growth).

Kaya Characteristics by Macro Region (Per cent of global total*)

	CO_2 Emissions		Energy Use		GNI (PPP)		Population	
	1990	2007	1990	2008	1990	2009	1990	2010
Developed	41.7	39.0	48.6	42.2	58.6	47.6	16.1	14.1
Post-Socialist	18.8	9.1	19.7	10.7	8.9	7.6	7.8	5.9
Emerging	23.4	38.3	22.2	34.7	17.8	29.9	50.5	49.9
Developing	7.0	8.8	8.4	11.0	12.0	12.8	25.3	29.7

* Columns do not add up to 100 due to unclassified countries in the World Bank data.

Source: World Bank Database

3. Russia's Energy Dilemmas

'… is Russia to remain predominantly an exporter of raw materials, highly dependent on the oil and gas sector for economic growth; or will Russia foster a more broadly based and diversified economy, served—but not dominated—by a market-driven energy sector?'

IEA 2011, *World Energy Outlook 2011 – Outlook for Russia*, p. 247.

'The central paradox of this strategy [modernization and diversification] for overcoming the 'resource curse' is that the necessary volume of revenue in the energy sector can only be generated by massive new investment in the upstream and power generation, so priority in resource allocation effectively cannot be changed.'

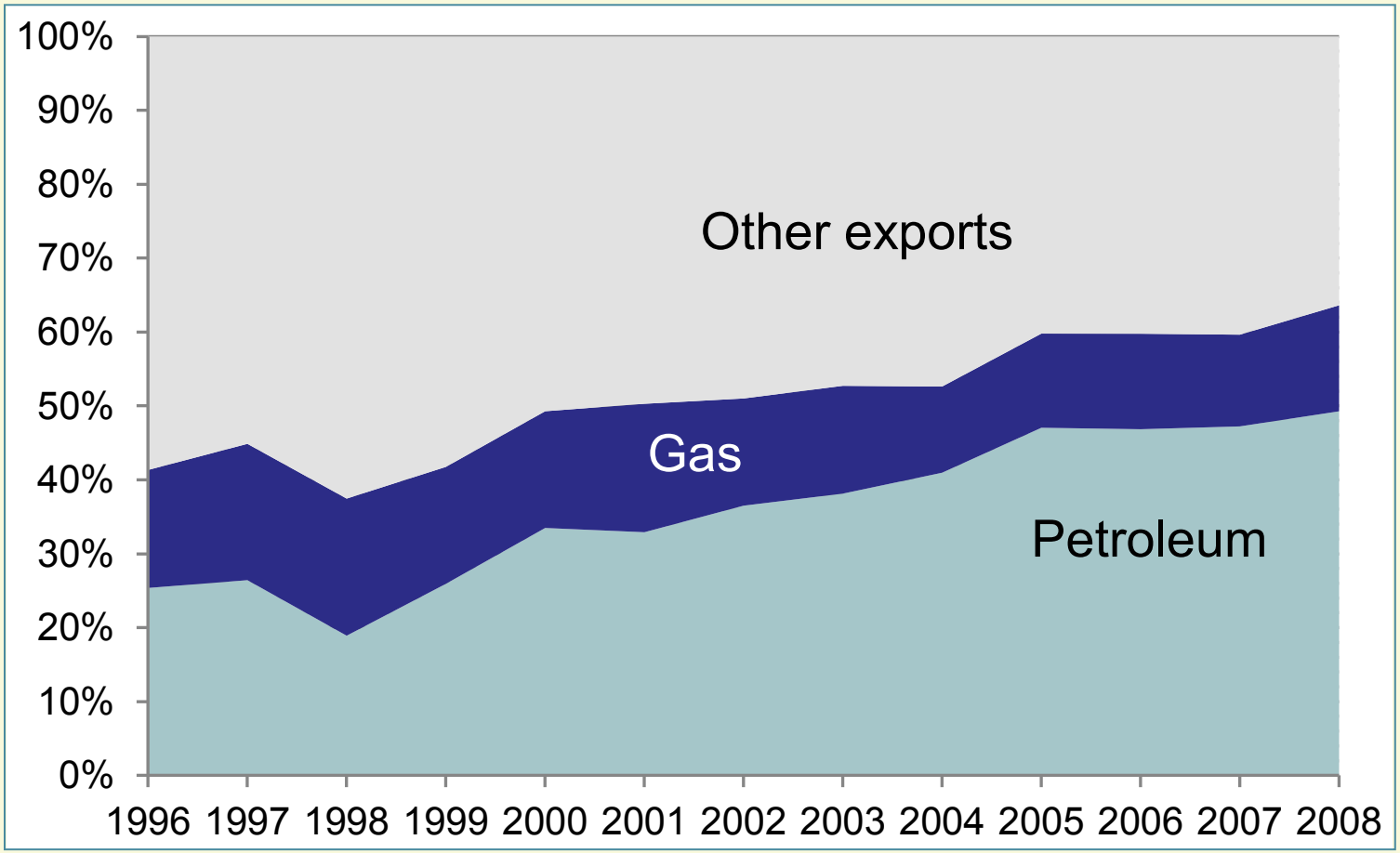
Pavel Baev 2010, p. 893.

A False Sense of Security?

- In 2012 Russia produced 520 million tons of crude oil, accounting for 12.6% of global production, making it the second largest oil producer and exporter after Saudi Arabia.
- In 2012 Russia produced 659 bcm of natural gas, accounting for 19.1% of global production, making it the world's top producer and exporter of natural gas (185 bcm).
- In 2011, oil and gas revenues were 10.4% of GDP, equal to half of federal revenue. In 2009, they were only 7.6%, equal to two-fifths of federal revenues.
- The price assumption in the federal budget increased from $75 a barrel in 2011 to $ 100 in 2012.

Oil and Gas Dominate Russian Exports

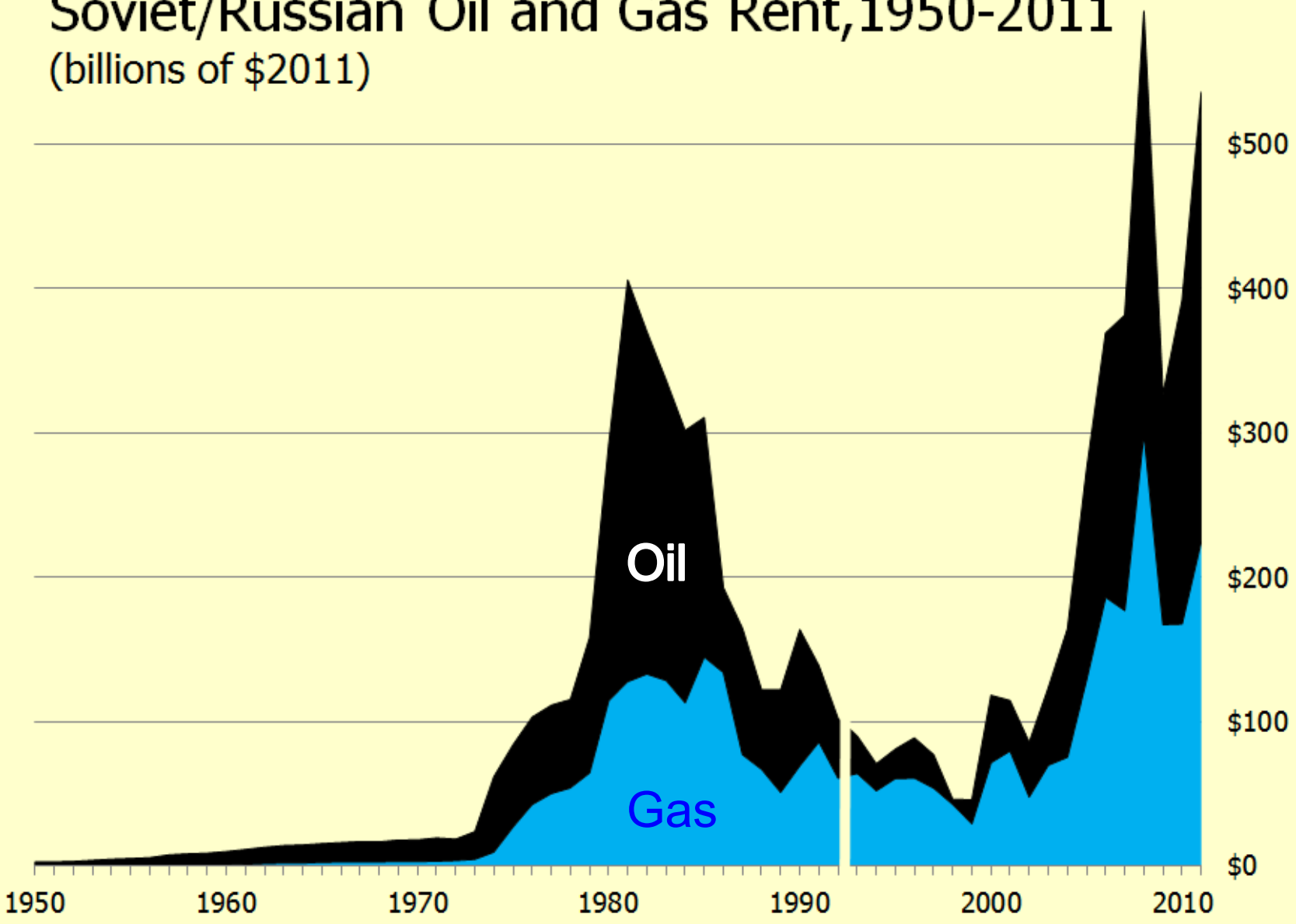
'Russia's revealed comparative advantage (RCA) is concentrated in sectors that do not create many forward or backward linkages to the economy.'



Source: World Bank (2012) *Export Diversification through competition and Innovation: Overview*, World Bank, Moscow.

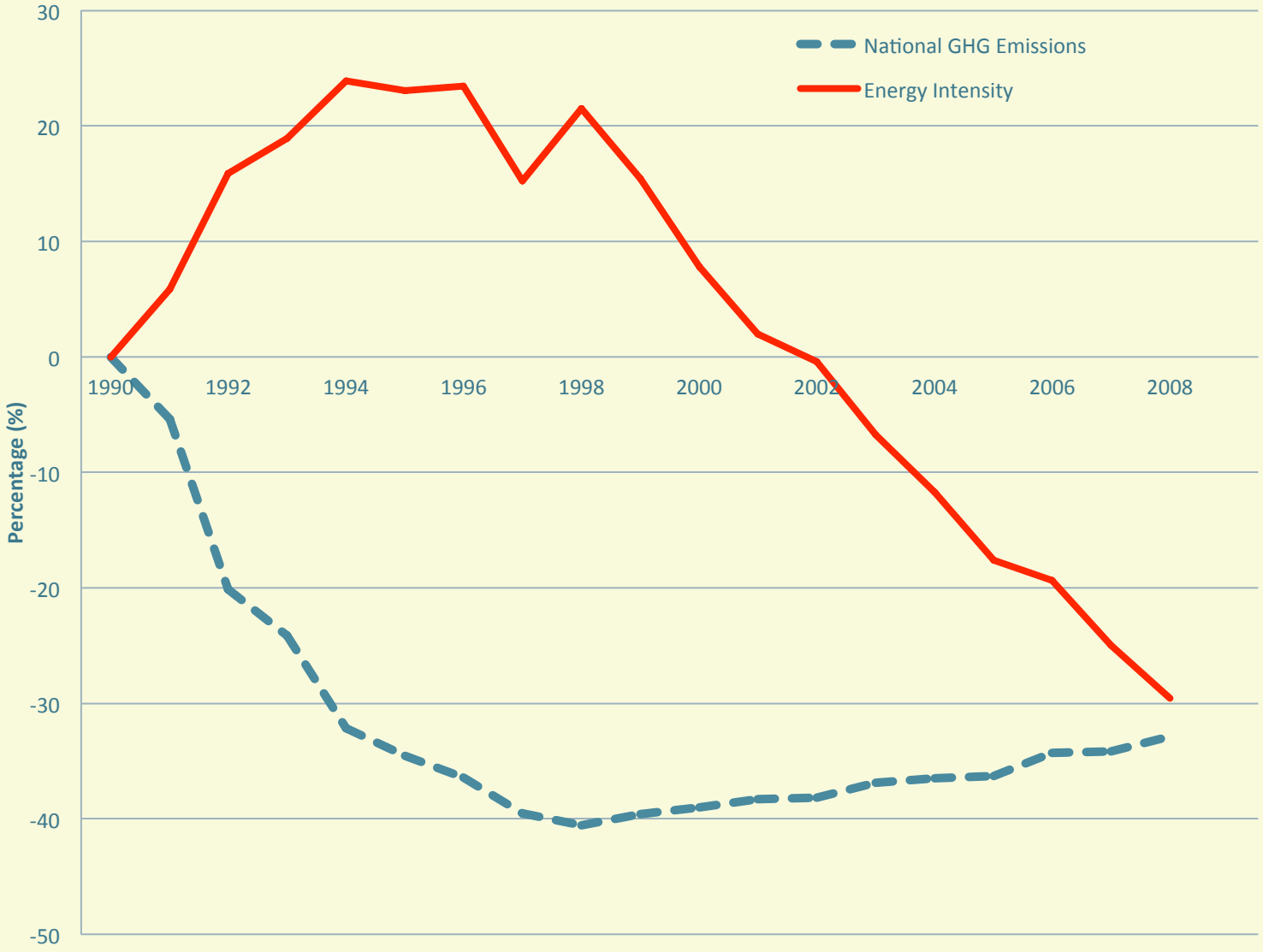
Soviet/Russian Oil and Gas Rent,1950-2011

(billions of $2011)



Source: Clifford G. Gaddy and Barry W. Ickes. "Russia's Dependence on Resources." In *The Oxford Handbook of the Russian Economy*, Michael V. Alexeev and Shlomo Weber, editors. Oxford: Oxford University Press, 2012.

Russian energy intensity and GHG emissions: 1990-2008



In 2009 the energy sector accounted for 82.4% of Russia's GHG emissions.

Russia's Kyoto target is a 0% reduction in emissions.

Current pledge is a 25% reduction in 2020 over 1990 levels.

By 2009 Russian emissions had fallen by 38.9% relative to 1990.

Source: CAIT, UNFCCC and UNDP Russia, 2010

The Oil and Gas Balance

Russia's Exportable Surplus =

Total Domestic Production (+ Central Asian Gas)	Minus	Domestic consumption

Plan A: Invest in expensive new oil and gas production

Plan B: Invest in renewable energy and improving energy efficiency

Plan A: Geography is not destiny (but in Russia it matters!)

% of Russian total	2008 (Actual)	Phase 1 (2008-12)	Phase 2 (2013-20)	Phase 3 (2020-30)
The Share of East Siberia & the Far East in Oil Production	3	10-12	12-14	18-19
The share of the eastern direction in the total volume of oil and oil products exports	8	10-11	14-15	22-25
The share of new regions in total gas production Including: Yamal East Siberia & the Far East	2 - 2	13-14 6 7-8	21-23 9 12-14	38-39 23-34 15
Share of independent gas producers and vertically integrated oil companies in total gas production	17	20	25-26	27
Share of the Asia-Pacific Region in gas exports	-	11-12	16-17	19-20
Share of LNG in export structure	-	4-5	10-11	14-15

Source: *Energy Strategy of Russia for the period up to 2030*

Figure 8.9 ● Major oil fields and supply infrastructure in Russia

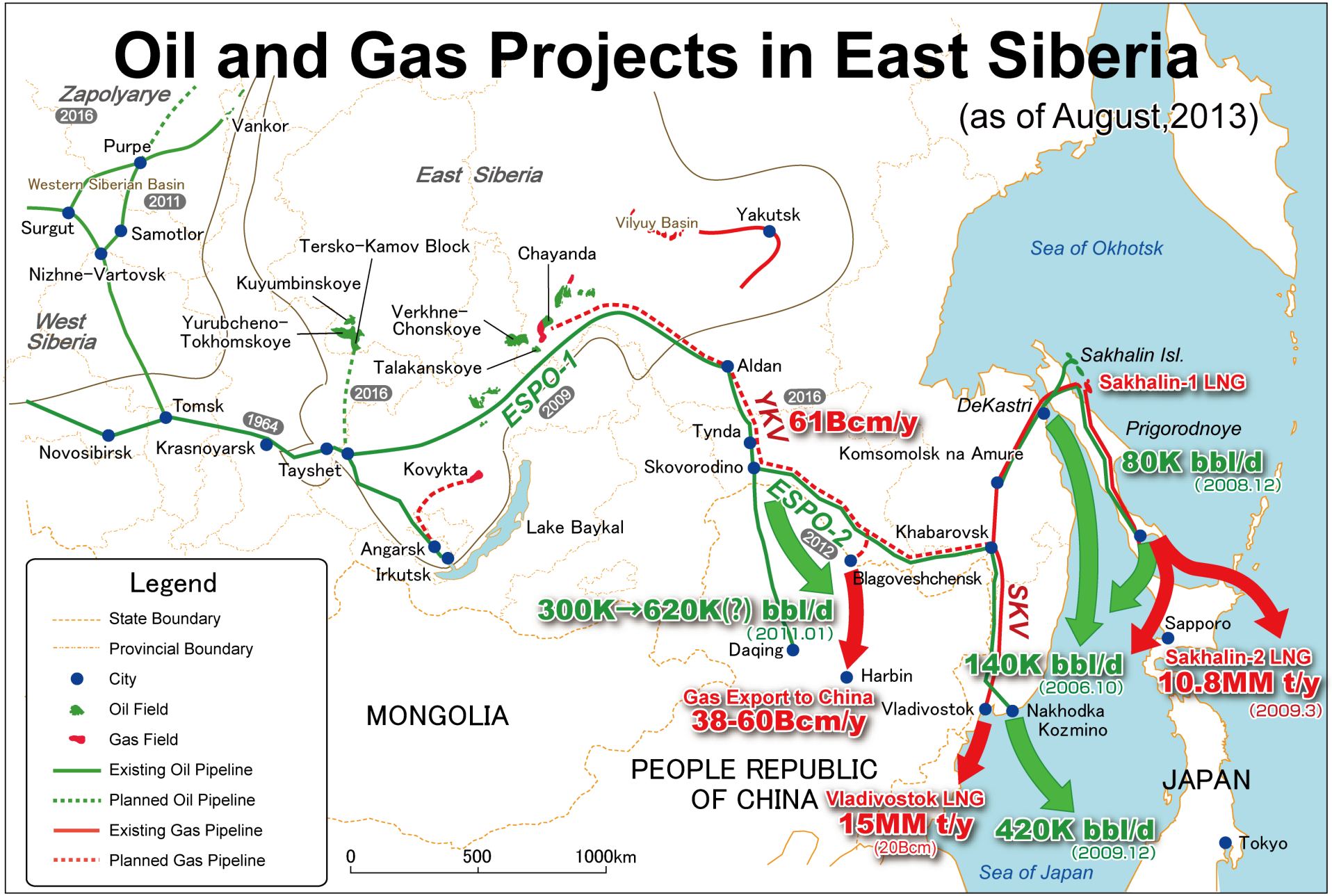
This map is for illustrative purposes and is without prejudice to the status of or sovereignty over any territory covered by this map.

Source: IEA 2011

Figure 8.15 • Major gas fields and supply infrastructure in Russia

This map is for illustrative purposes and is without prejudice to the status of or sovereignty over any territory covered by this map.

Source: IEA 2011


Oil and Gas Projects in East Siberia
(as of August,2013)
Zapolyarye
2016
Purpe
Vankor
Western Siberian Basin
2011
Surgut
Samotlor
Nizhne-Vartovsk
West Siberia
East Siberia
Tersko-Kamov Block
Kuyumbinskoye
Yurubcheno-Tokhomskoye
Verkhne-Chonskoye
Talakanskoye
Chayanda
Vilyuy Basin
Yakutsk
Sea of Okhotsk
Sakhalin Isl.
Sakhalin-1 LNG
DeKastri
Prigorodnoye
80K bbl/d
(2008.12)
Komsomolsk na Amure
Aldan
2016
YKV
61Bcm/y
Tynda
Skovorodino
ESPO-1
2009
ESPO-2
2012
2016
1964
Tomsk
Novosibirsk
Krasnoyarsk
Tayshet
Kovykta
Lake Baykal
Angarsk
Irkutsk
Khabarovsk
Blagoveshchensk
SKV
300K→620K(?) bbl/d
(2011.01)
Daqing
Harbin
Gas Export to China
38-60Bcm/y
MONGOLIA
PEOPLE REPUBLIC OF CHINA
Vladivostok
Nakhodka
Kozmino
140K bbl/d
(2006.10)
Sapporo
Sakhalin-2 LNG
10.8MM t/y
(2009.3)
JAPAN
Vladivostok LNG
15MM t/y
(20Bcm)
420K bbl/d
(2009.12)
Tokyo
Sea of Japan
Legend
State Boundary
Provincial Boundary
City
Oil Field
Gas Field
Existing Oil Pipeline
Planned Oil Pipeline
Existing Gas Pipeline
Planned Gas Pipeline
0
500
1000km

Plan B: Demand Reduction and energy efficiency

- According to a World Bank/IFC (2008) study Russia could save 45% of its total primary energy consumption if it implemented economy wide energy efficiency savings.
- Russia's own Energy Strategy to 2030 suggests that technical and organizational savings could reduce energy consumption by 40%.
- Improved energy efficiency and demand reduction sits well with modernization strategy.
- Investment in renewable energy would reduce carbon intensity as well as domestic demand for fossil fuels.

Demand Reduction and energy efficiency

- UNDP Russia (2010) calculate that to improve Russia's energy efficiency by 45% compared to 2005 would cost $324-57 billion.
- However, they also point out that if all the oil and gas saved was exported it would raise $80-90 billion a year.
- Russia also flares huge amounts of natural gas, estimates for 2010 are 35 bcms, about 25% of the volume Gazprom exports to Europe (138.6 bcm in 2011).
- The IEA (2010) calculates the total cost of natural gas subsidies in 2009 in Russia to be $34 billion, $ 238 per person or 2.7% of GDP.
- Lots of low hanging fruit when it comes to efficiency savings, what is missing is the incentive.

The bottom line

The IEA (2011) suggests that through increased efficiency, a reduction in flaring and demand reduction, Russia could realise savings of almost 180 bcms of gas, which is the equivalent of the three new fields Gazprom needs to develop on the Yamal Peninsula and also close to Russia's net exports of natural gas in 2010 [such an approach would also yield significant reductions in GHG emissions.]

The Russian Energy Dilemmas Nexus

'Russia must face two key issues: ensuring that its workers are employed in a diverse range of globally competitive jobs and maintaining export capacity through greater domestic energy efficiency, as oil and gas production volumes will not grow much in the future.'

Sutela, 2010, 4.

Dimension	External Global/regional	Internal National/local
Energy Security	Security of demand Security of transit	Resource nationalism Sustainability of oil and gas production and exports
Economic Globalization	Russia's role in the global economy	Diversification Modernization Innovation
Climate Change Policy	Energy efficiency Low carbon transition Climate change policy	Energy intensity Carbon intensity Climate change impacts

Source: Bradshaw, 2012, 217.

Russia: standing at the Crossroads

- Russia could continue on its current path of energy profligacy and this would result in huge investments being made in the energy sector at the expense of the modernization of the economy and the environment.

Or,

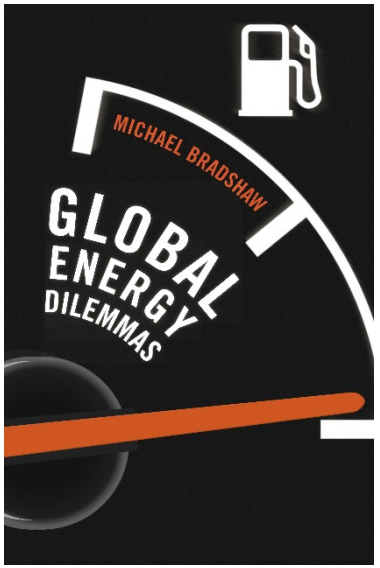
- Russia could invest in renewable energy, demand reduction and efficiency and modernization and by so-doing reduce the need to develop frontier oil and gas to the same degree, which would also reduce energy intensity and GHG emissions.

Conclusions: the Carbon Paradox and Russia's Energy Dilemma

"The best that we can hope for is that we don't run out of cheap oil, and the worst we have to fear is that we will continue to burn fossil fuels, including oil, as we have burned them in the past." (Homer-Dixon and Garrison 2009)

- We can only afford to burn half of proven economically recoverable oil. gas and coal reserves and still have a chance of constraining global warming to 2° C (Meinhausen et al. 2009).
- Yet the IEA New Policies Scenario suggests that fossil fuels will account for 76% of world primary energy demand in 2035 (450 scenario = 64%; EIA 80% in 2040).
- If the world gets serious about GHG reductions, what will this mean for Russia?

Thank you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low-carbon
sustainability
globalization
greenhouse
anthropogenic
revolution
consequences
production
services
hydrocarbons
research
reliable
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making
element
challenges
human
oil
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