FONDAZIONE ENI ENRICO MATTEI

Is there Enough Energy? an Introduction to Energy Security

NECST Lecture

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Outline

- Introduction
- Reserves and Resources
- Peak oil
- Conventional and unconventional gas and oil
- Measuring energy security
- Conclusions

Introduction: energy and security- worrying about resource scarcity

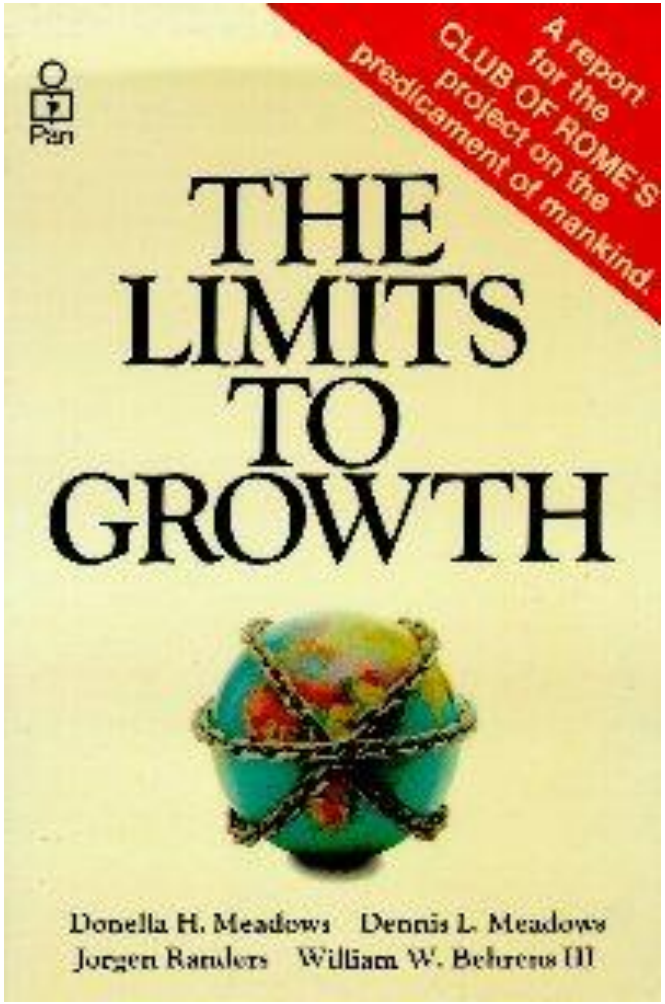
"The power of population is indefinitely greater than the power in the earth to produce subsistence for man."

"Population, when unchecked, increases in a geometrical ratio. Subsistence increases only in an arithmetical ratio".

"The cheapness of labour, the plenty of labourers, and the necessity of an increased industry amongst them, encourage cultivators to employ more labour upon their land, to turn up fresh soil."

THOMAS ROBERT MALTHUS
(1766-1834)

Introduction: energy security - worrying about resource scarcity



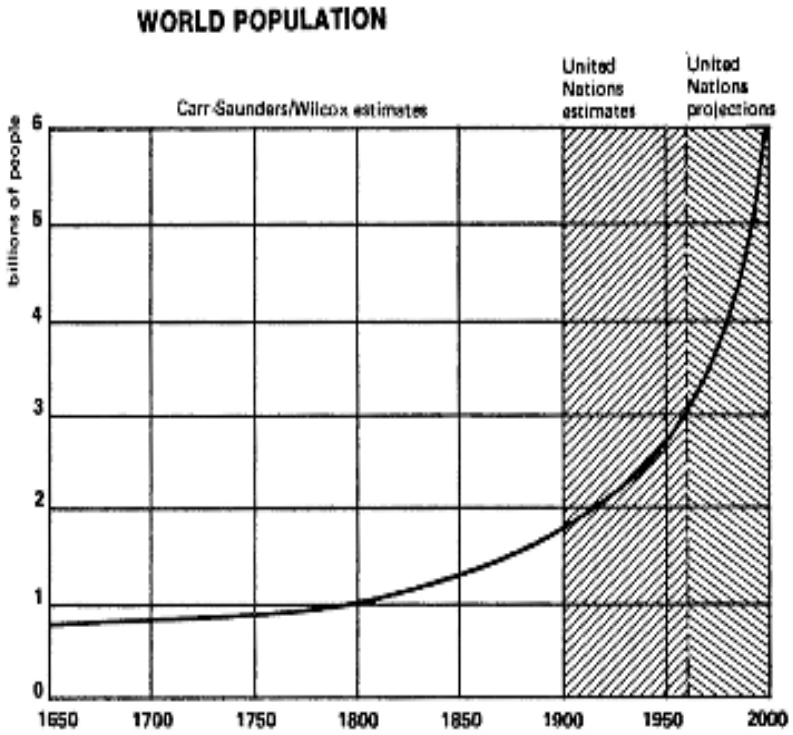
THE CLUB OF ROME

In the 1970's oil price shocks led to sharp price increases for many commodities. At that time many became alarmed at the rate of utilization of natural resources by mankind. It seemed that in just a few years real scarcity would become a major global problem.

A reason for this alarm was the concept that natural resources are inherently limited in nature, and that current rates of use would surely use them all up in the foreseeable future.

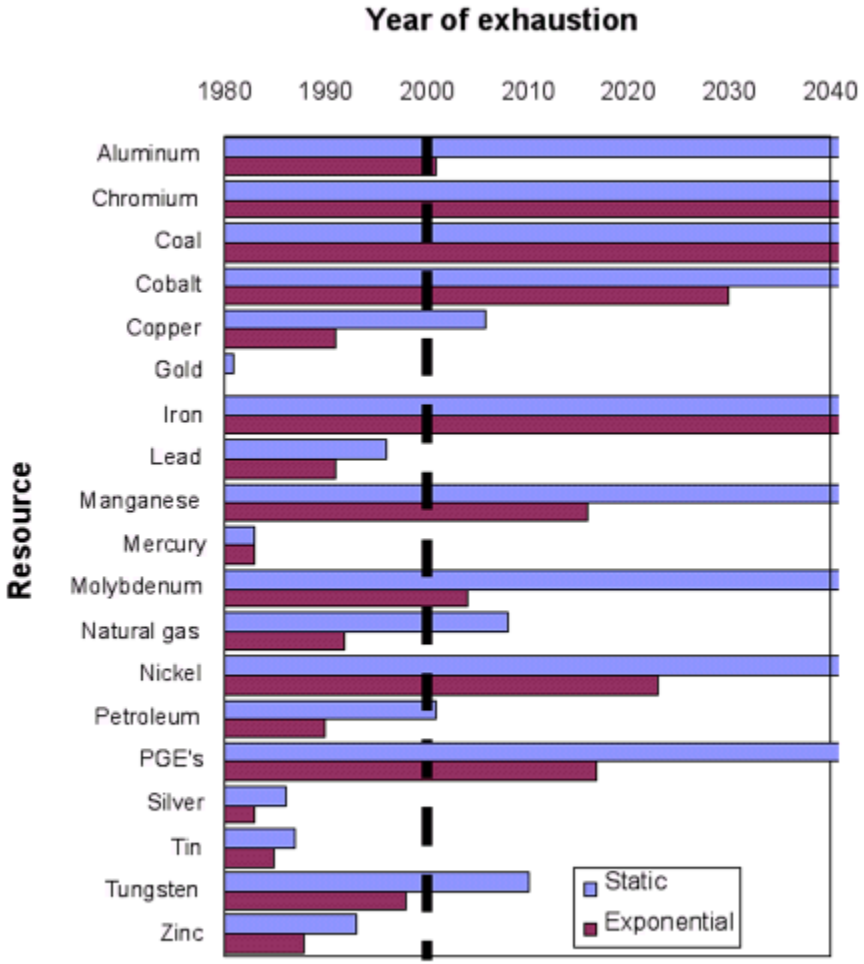
The voice of this movement was the "Club of Rome", so named because they felt that western society, like ancient Rome, was doomed.

Introduction: energy security - worrying about resource scarcity



World population since 1650 has been growing exponentially at an increasing rate. Estimated population in 1970 is already slightly higher than the projection illustrated here (which was made in 1958). The present world population growth rate is about 2.1 percent per year, corresponding to a doubling time of 33 years.

SOURCE: Donald J. Bogue, *Principles of Demography* (New York: John Wiley and Sons, 1969).



Population growth and resource depletion according to the predictions of the Club of Rome

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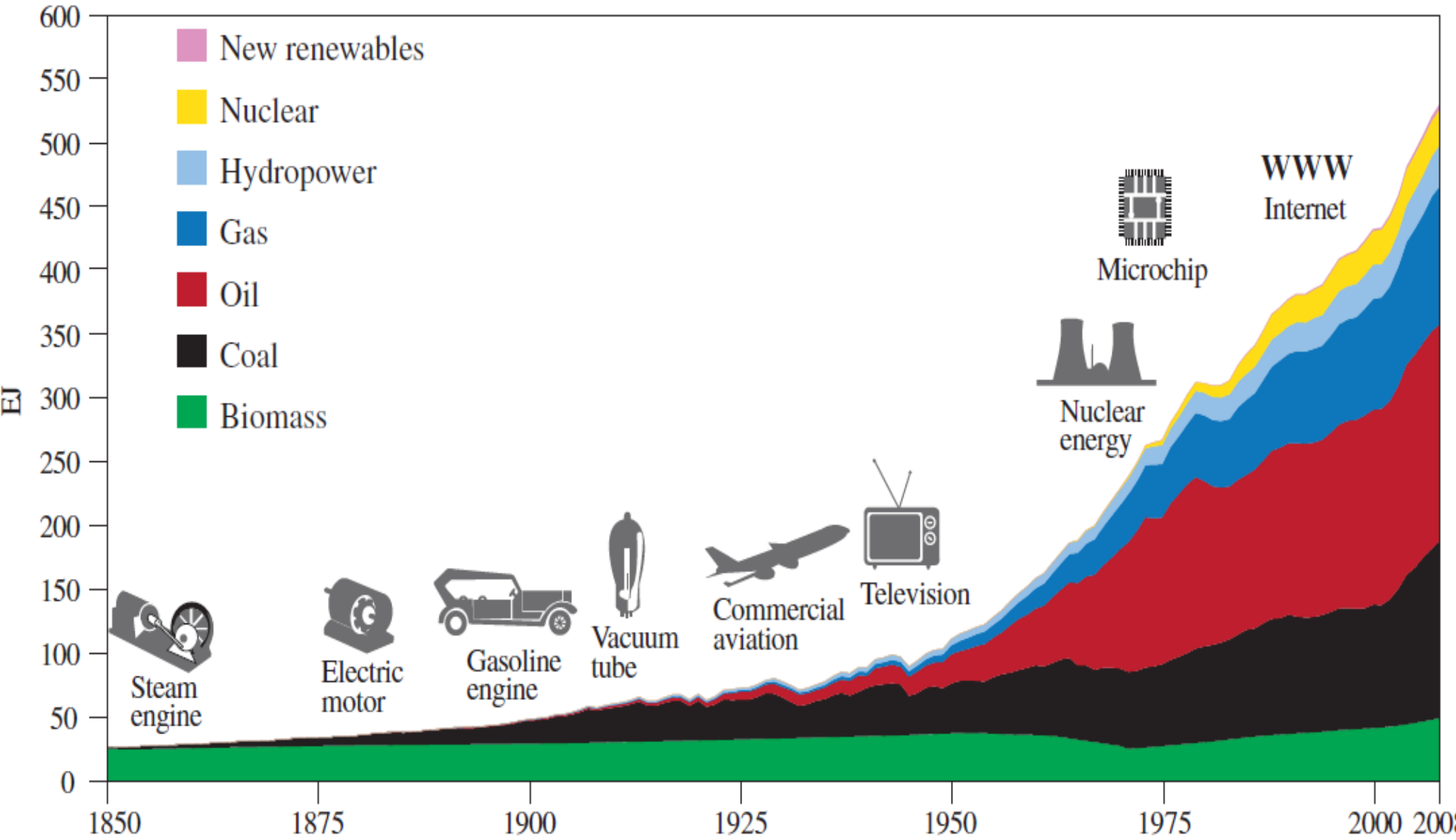
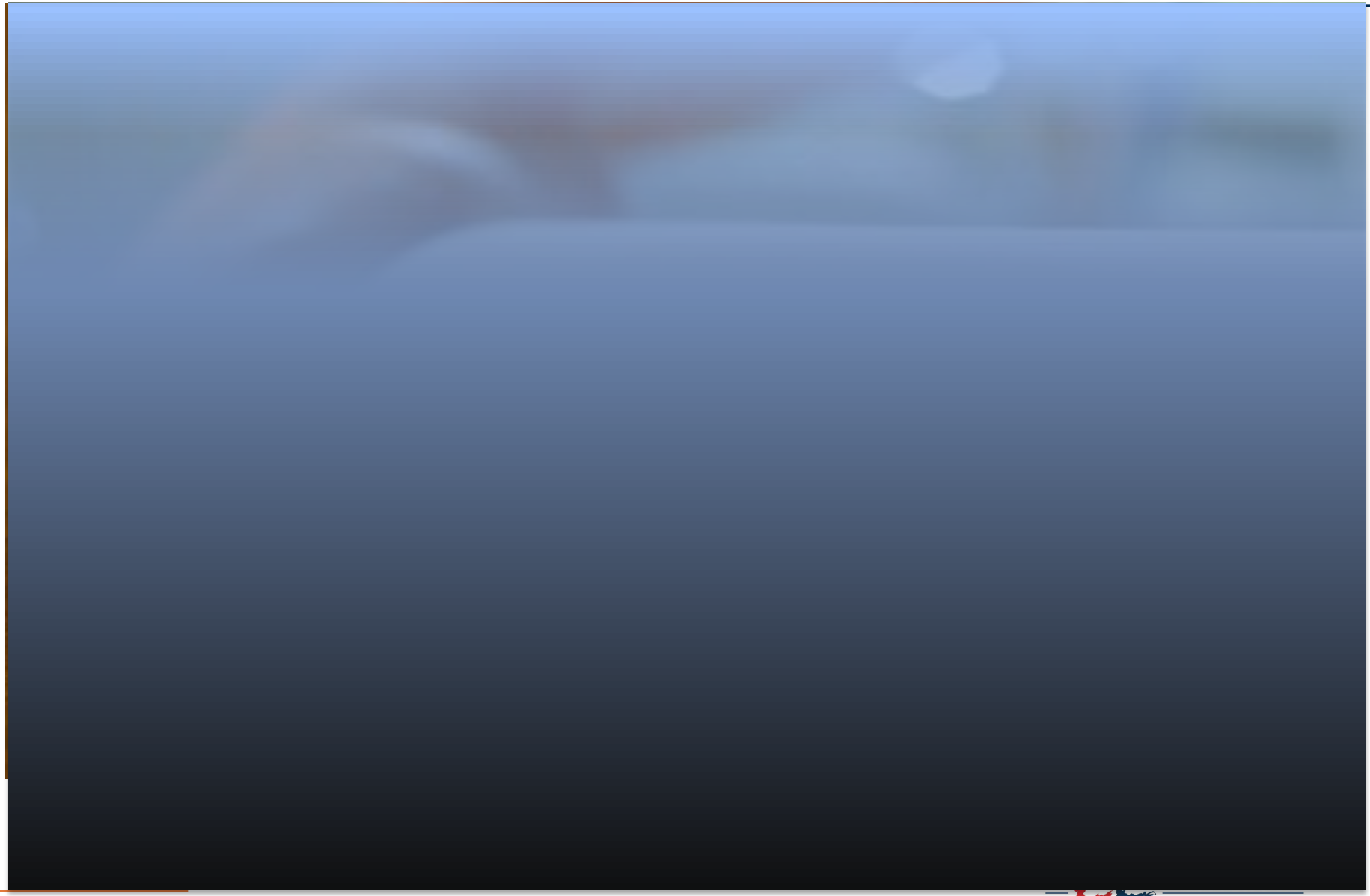
History of world primary energy use, by source (in EJ).



Source: Grubler et al .(2012) Global Energy Assessment - Toward a Sustainable Future - Chapter 1

Reserves and Resources



Defining reserves and resources

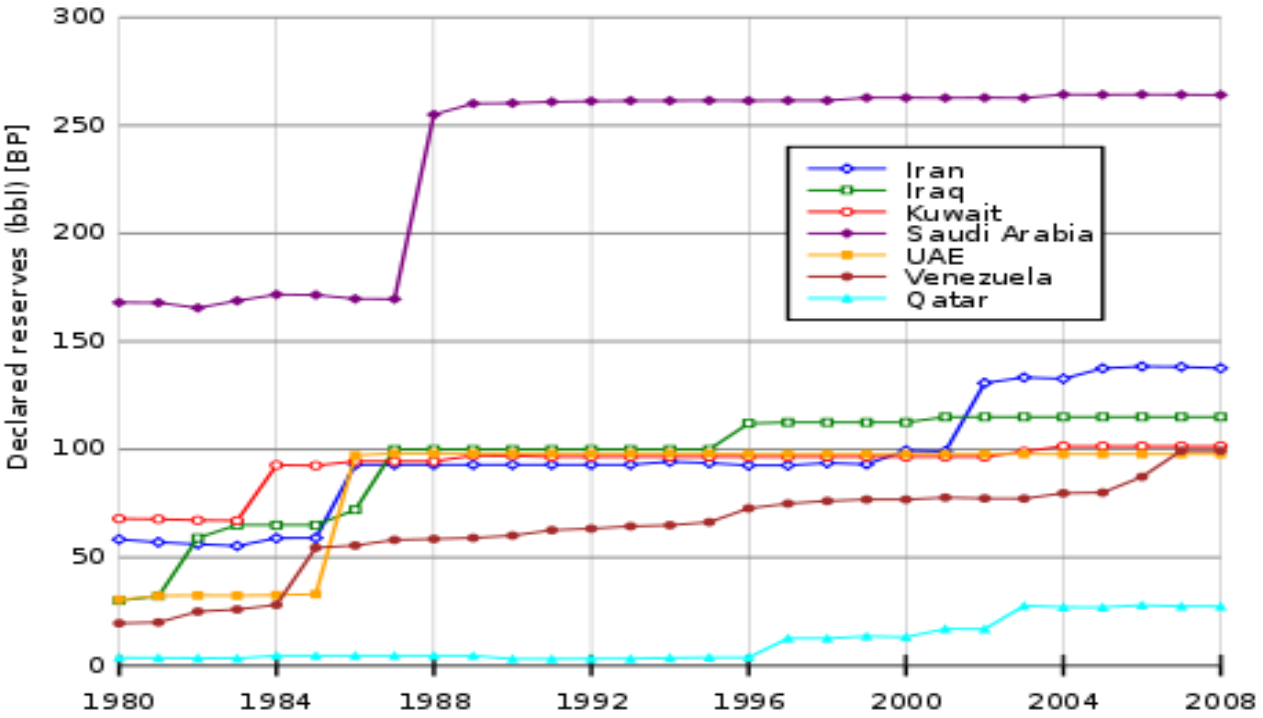
Proven Reserves: "the estimated quantities of resources which geological and engineering data demonstrate with reasonable certainty to be recoverable in future years from known reservoirs under current economic and operating conditions."

Resources

Estimated Ultimately Recoverable Resources. Resources that is infeasible to recover for reasons that are either economic or technical.

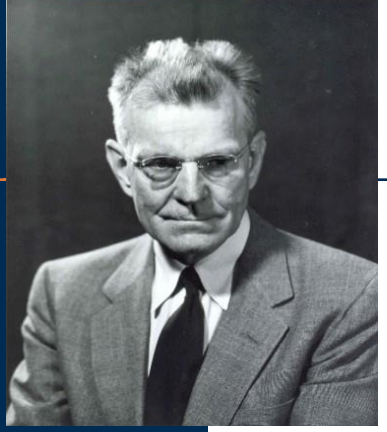
Non Conventional: oil from coal, oil shale, oil sands, tar sands, bitumen, heavy and extra heavy oil, deep water oil, polar oil and natural gas condensates. Shale gas

«Proven» Reserves?

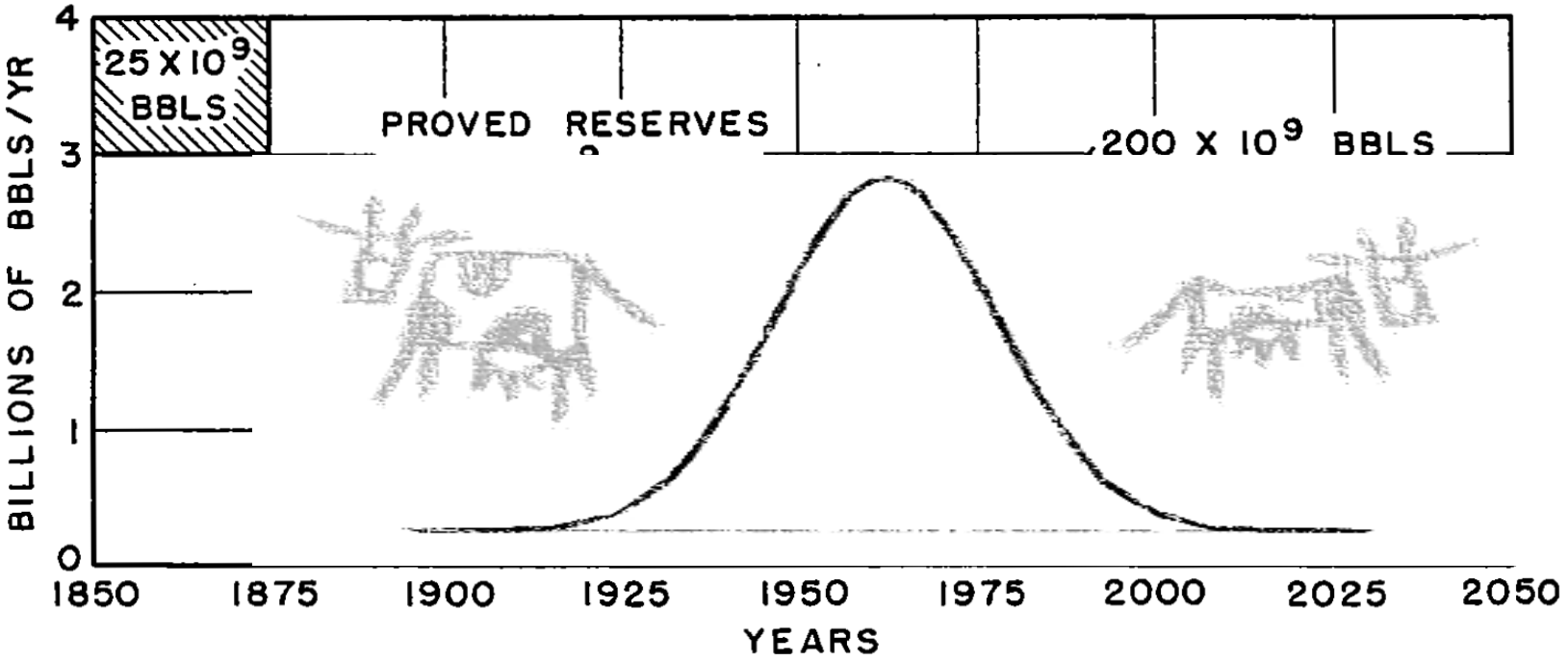


	World	OPEC
2003	1213	819
2002	1031	819
2001	1028	814
2000	1016	802
1999	1034	800
1998	1019	797
1997	1019	789
1996	1007	777
1995	1000	770
1994	999	772

There is some arbitrariness in the classification, and the access to the real data is often considered a business critical information. The strategic use of reserves information is typical of OPEC countries



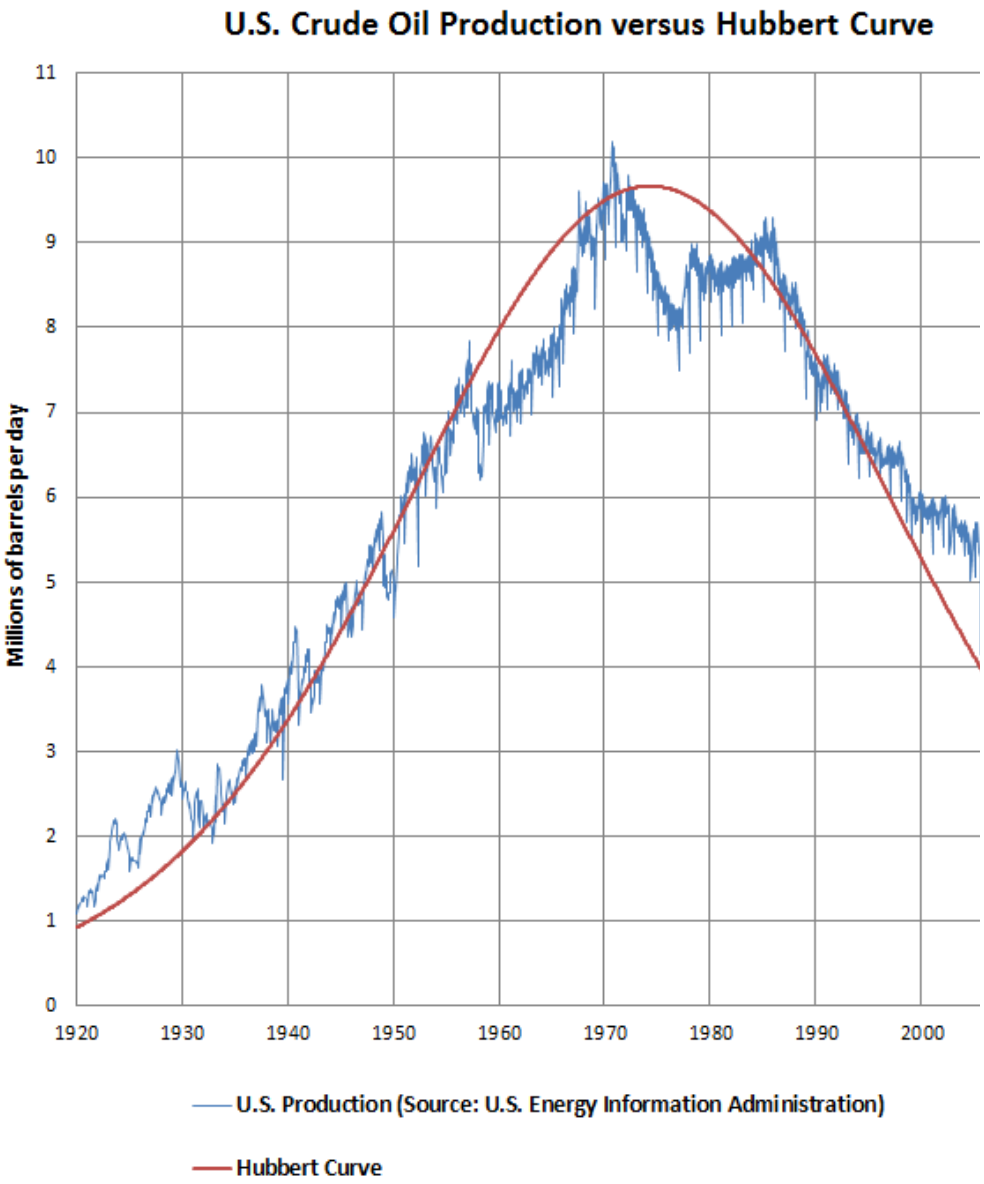
Hubbert's curve



M.K. Hubbert's 1956 graph

Source: Nuclear Energy and the Fossil Fuels" Publication No. 95. Houston: Shell Development Company, Exploration and Production Research Division, 1956

Oil - Hubbert's curve



Hubbert was right about the US…

…at least for a long while

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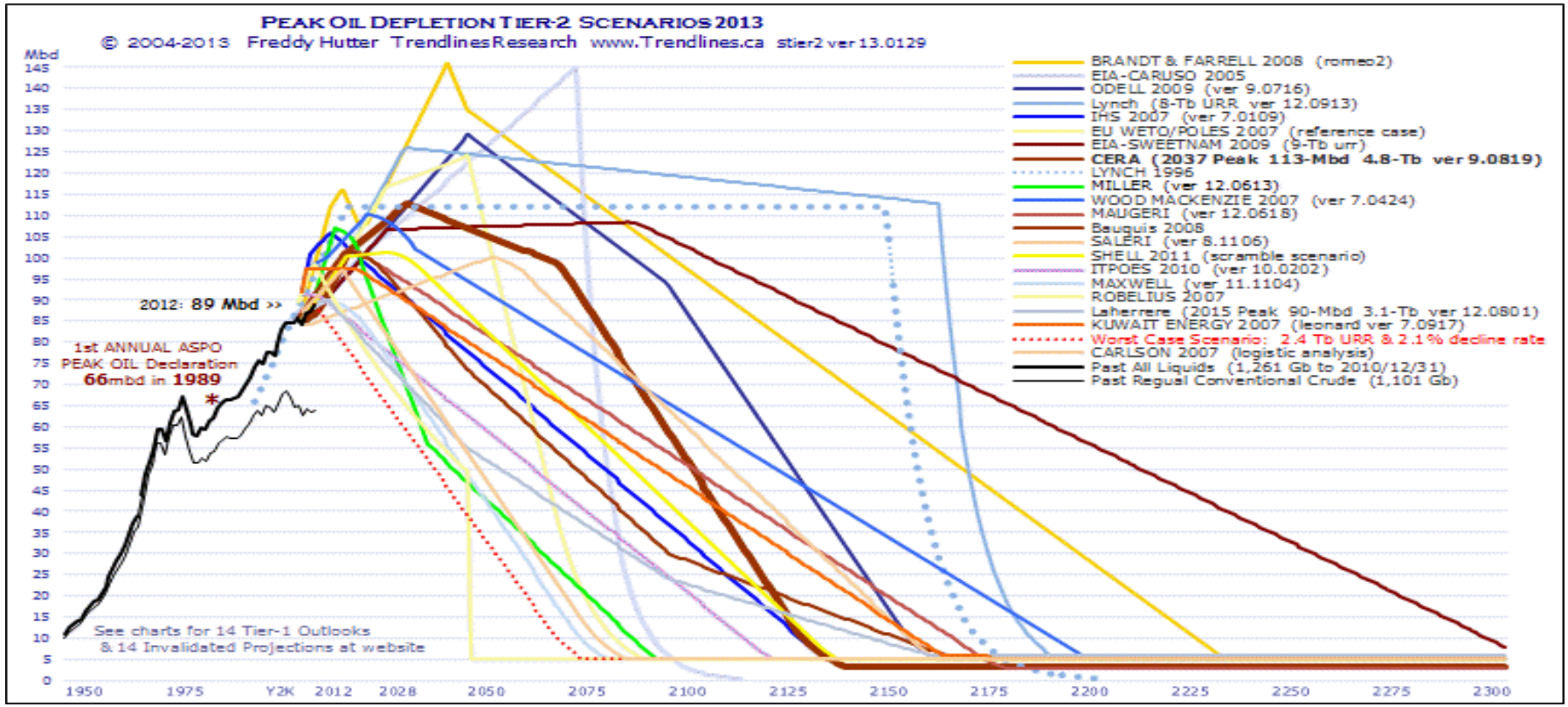
The peak oil puzzle

…Globally there is uncertainty about when or (if) oil production will peak



Uncertainty stems from:

- reserves: how much oil is there in the ground, really?
- no major new discoveries, but
- recoverability: is it feasible and how much does it cost to recover unconventional oil? now it looks easier and cheaper.
- oil producers' behaviour: a single world market , but an oligopolistic one

A different peak: climate and energy security - twin problems

Between now and 2050, humanity have to face a twin problem:

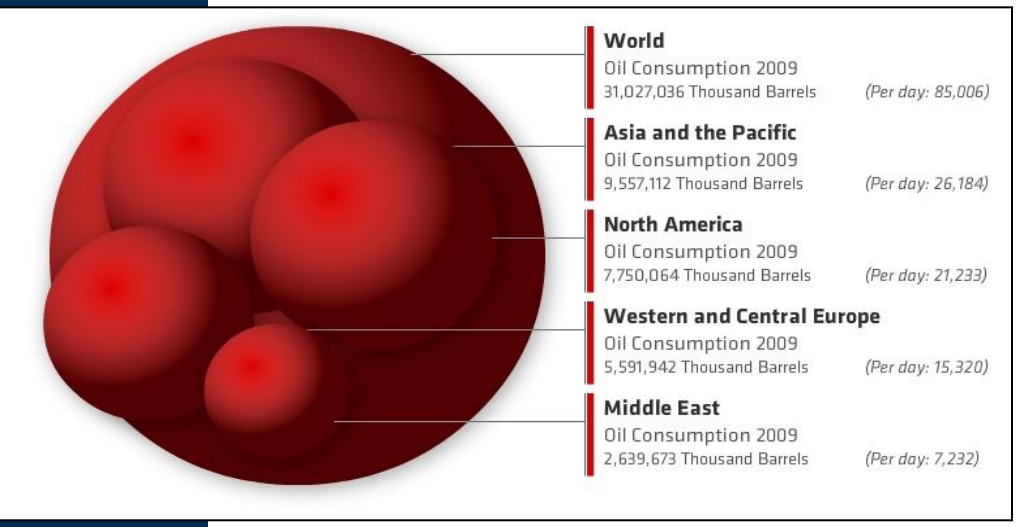
- The growing scarcity for (conventional) oil and gas
- The accumulation of GHGs in the atmosphere

These « twin problems » cannot be considered independently as:

- Hydrocarbon scarcity paves the way to coal and unconventional oil and gas, and thus to increasing carbon emissions
- Conversely, climate policies open the path to low carbon societies, and to different ways to deal with energy needs

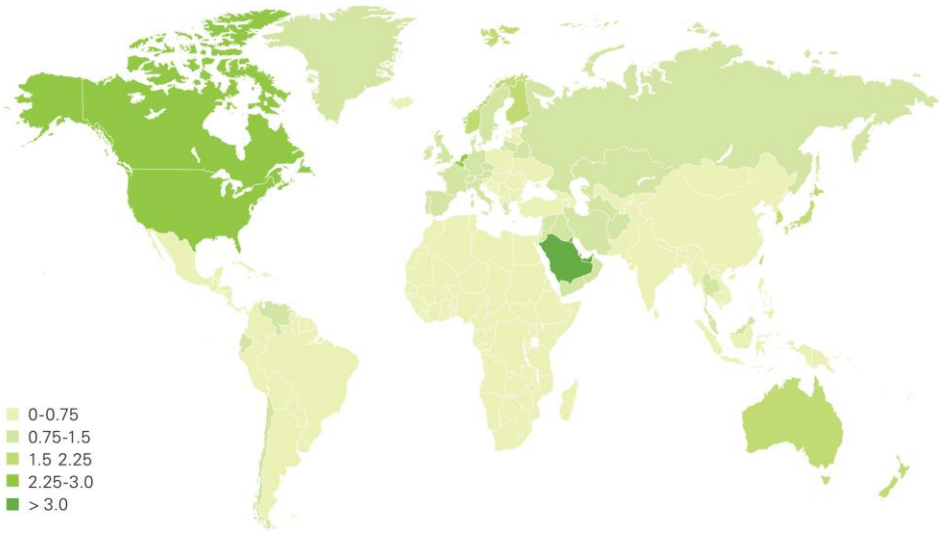
« Smart energy policies » thus have to deal with the two sides of the problem.

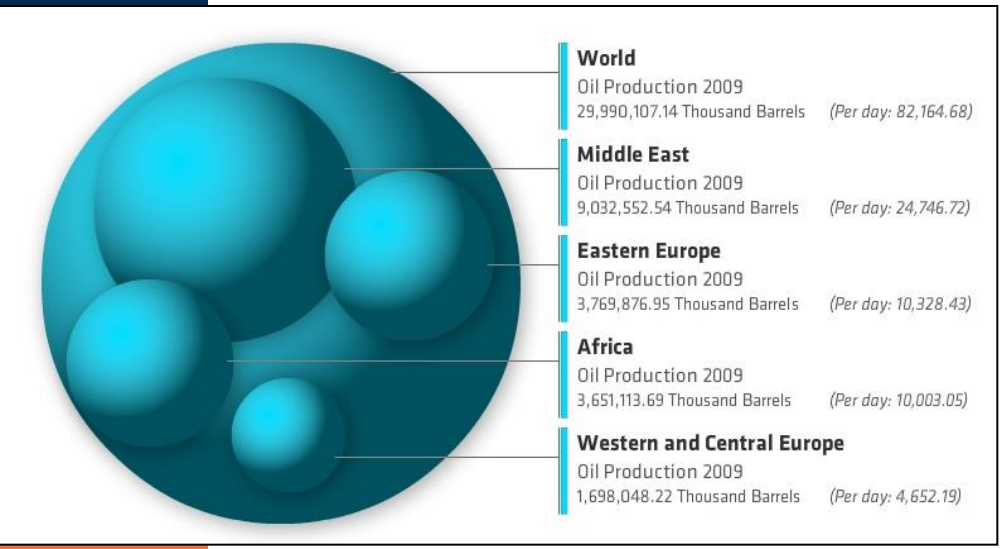
Oil: consumption, proven reserves and production 2009

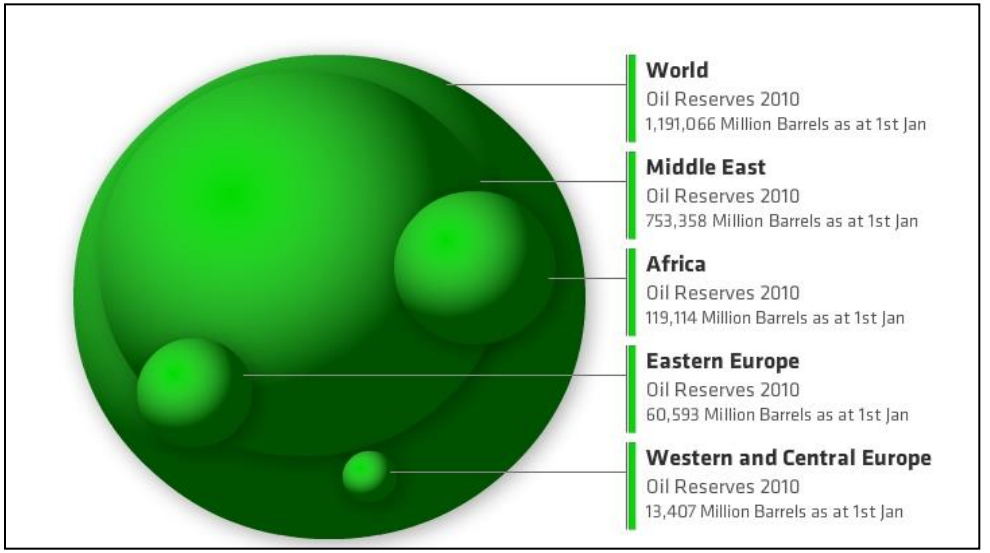


source ENI Oil & Gas Review 2011

source BP Statistical Review 2014

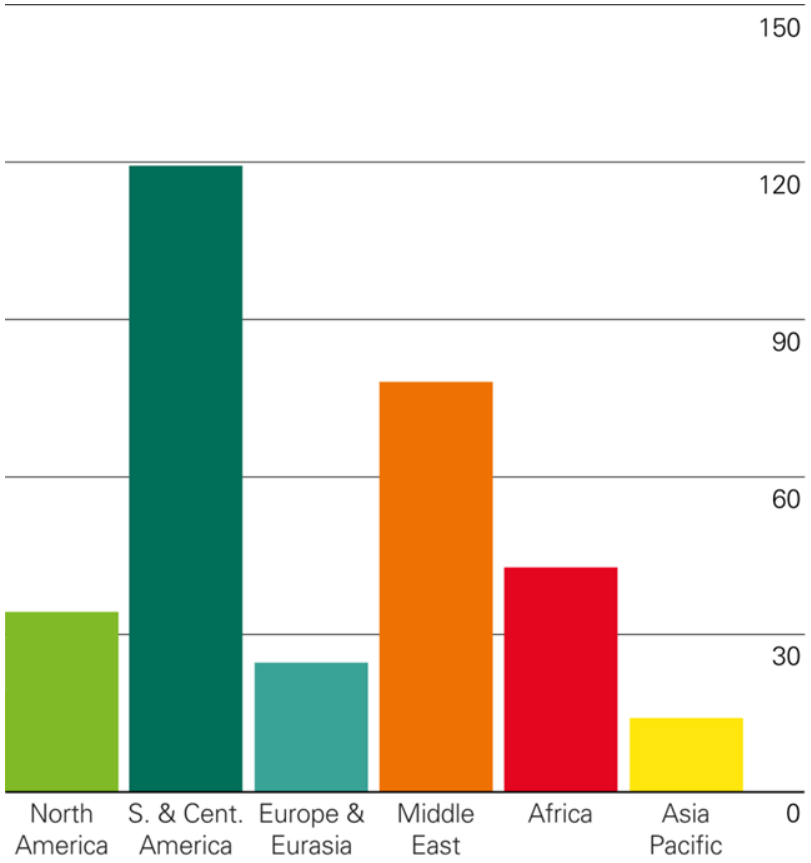


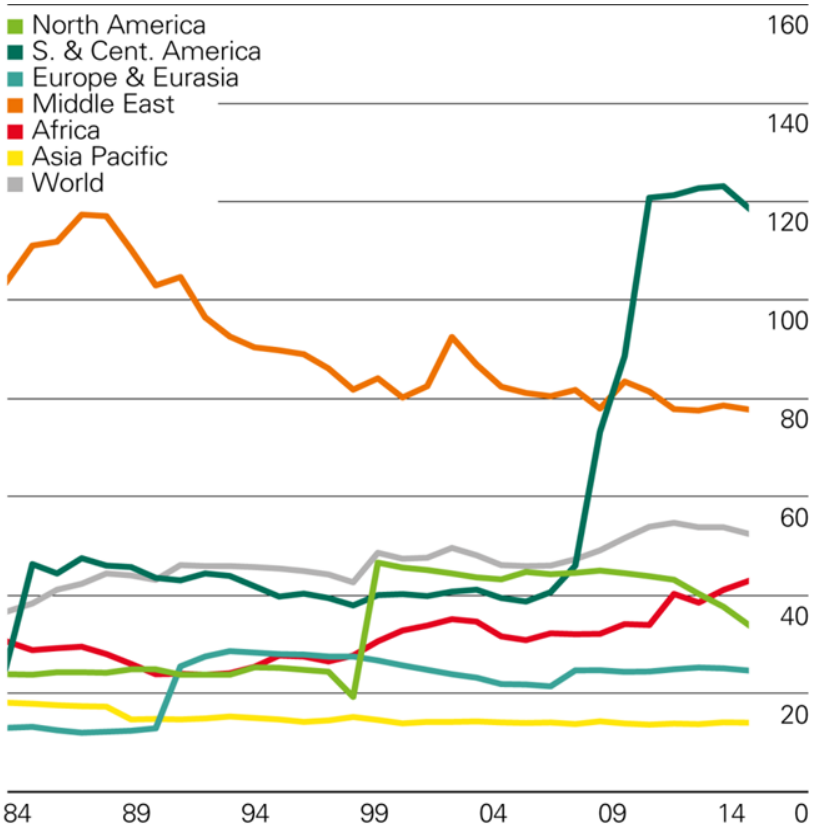




5 years after…

Production/reserve ratio (years)





"Total world proved oil reserves reached 1700.1 billion barrels at the end of 2014 sufficient to meet 52.5 years of global production"

BP Statistical Review

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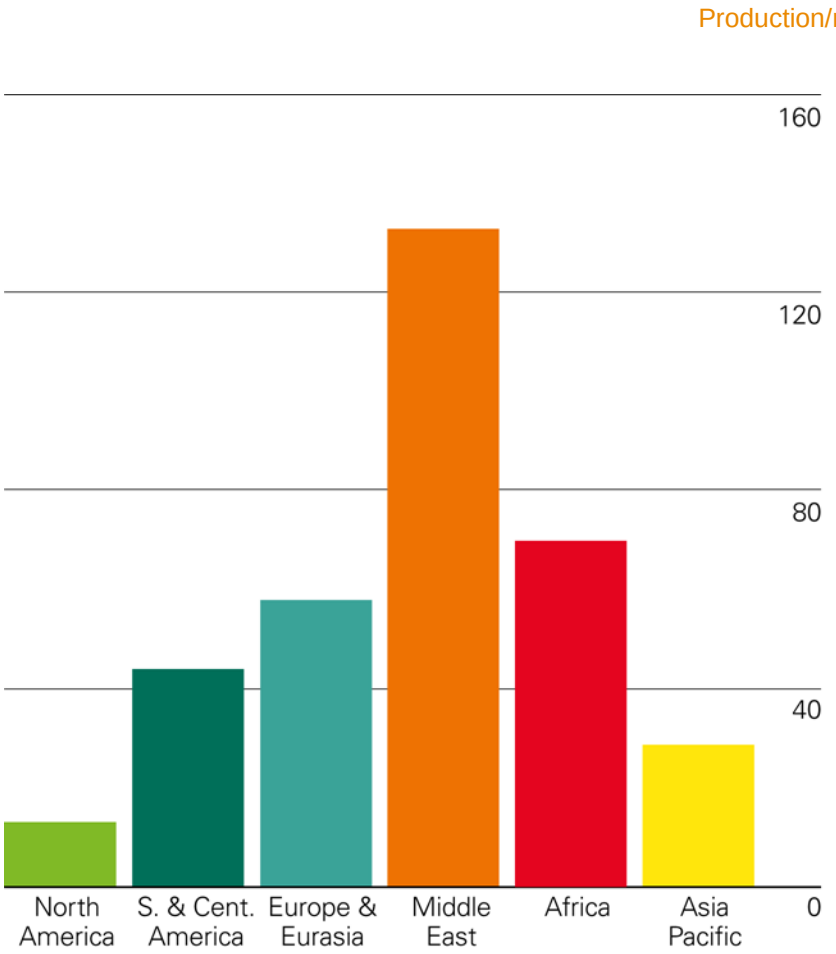
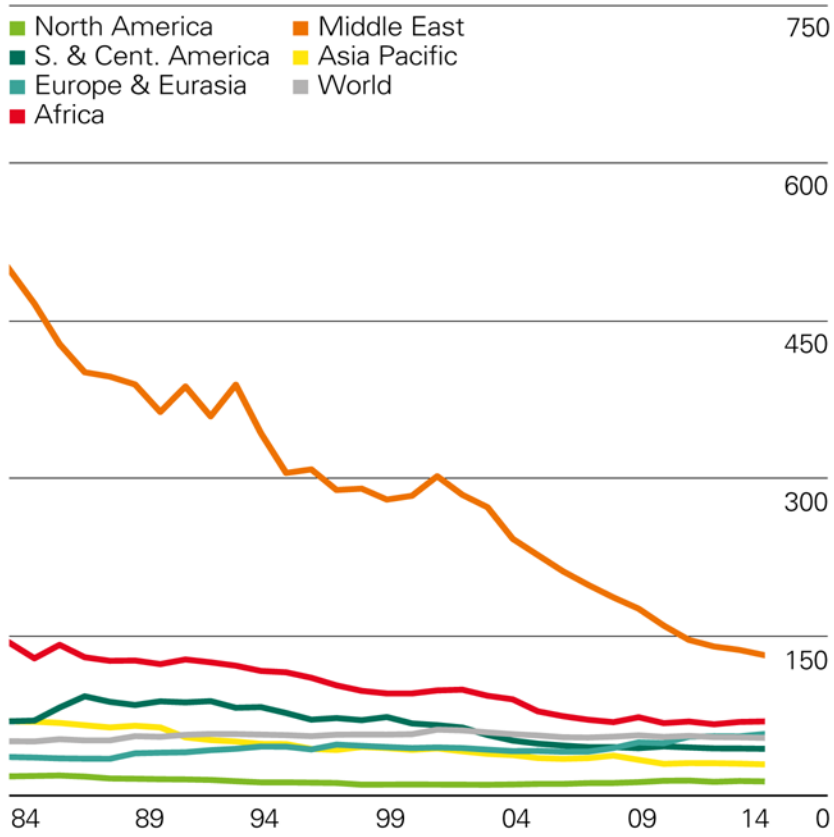
Gas production and reserves in 2014



Production/reserves ratio (years)



"World total proven natural gas reserves at end-2014 stood at 187.1 trillion cubic metres (tcm), sufficient to meet 54.1 years of global production"

BP Statistical Review

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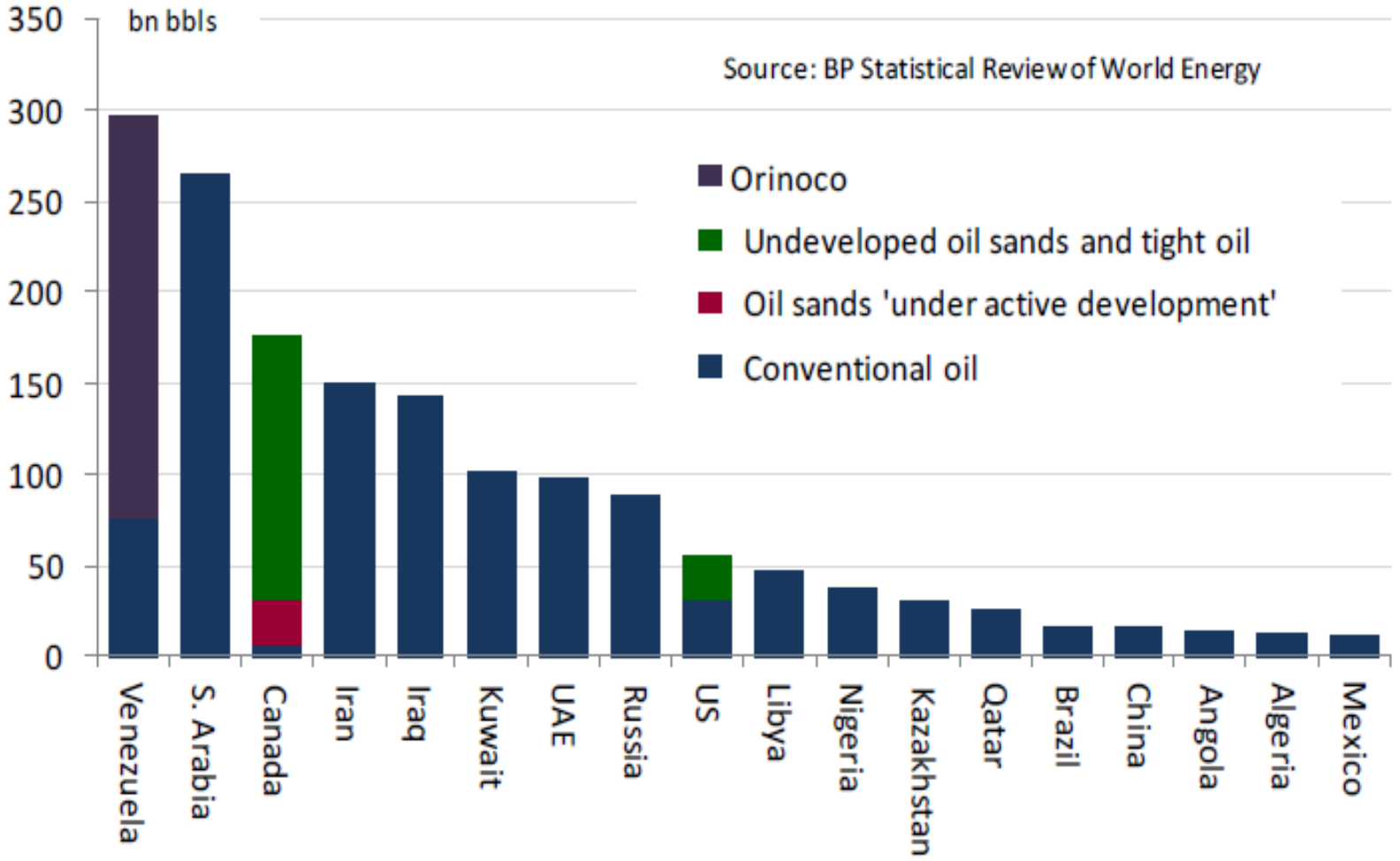
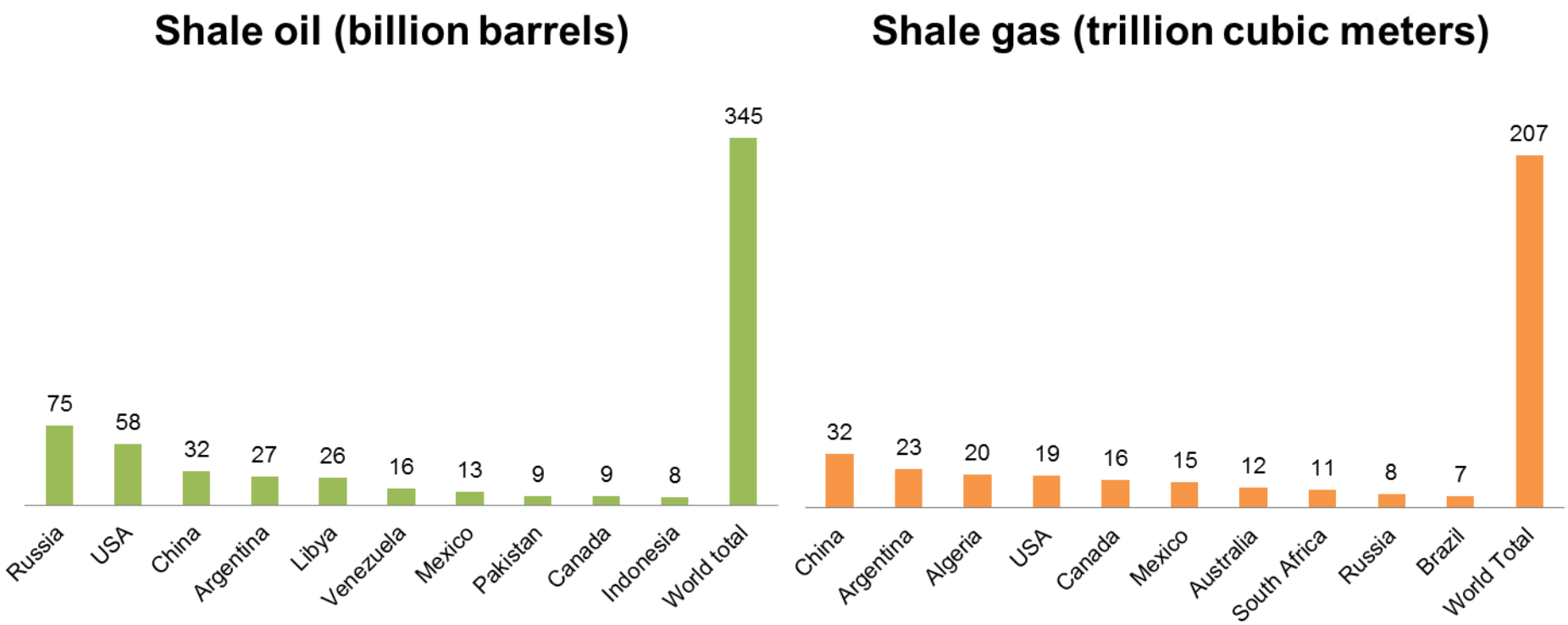
Unconventional vs. Conventional Oil Reserves



Source: Julian Lee, (2012) Moscow School of Management SKOLKOVO

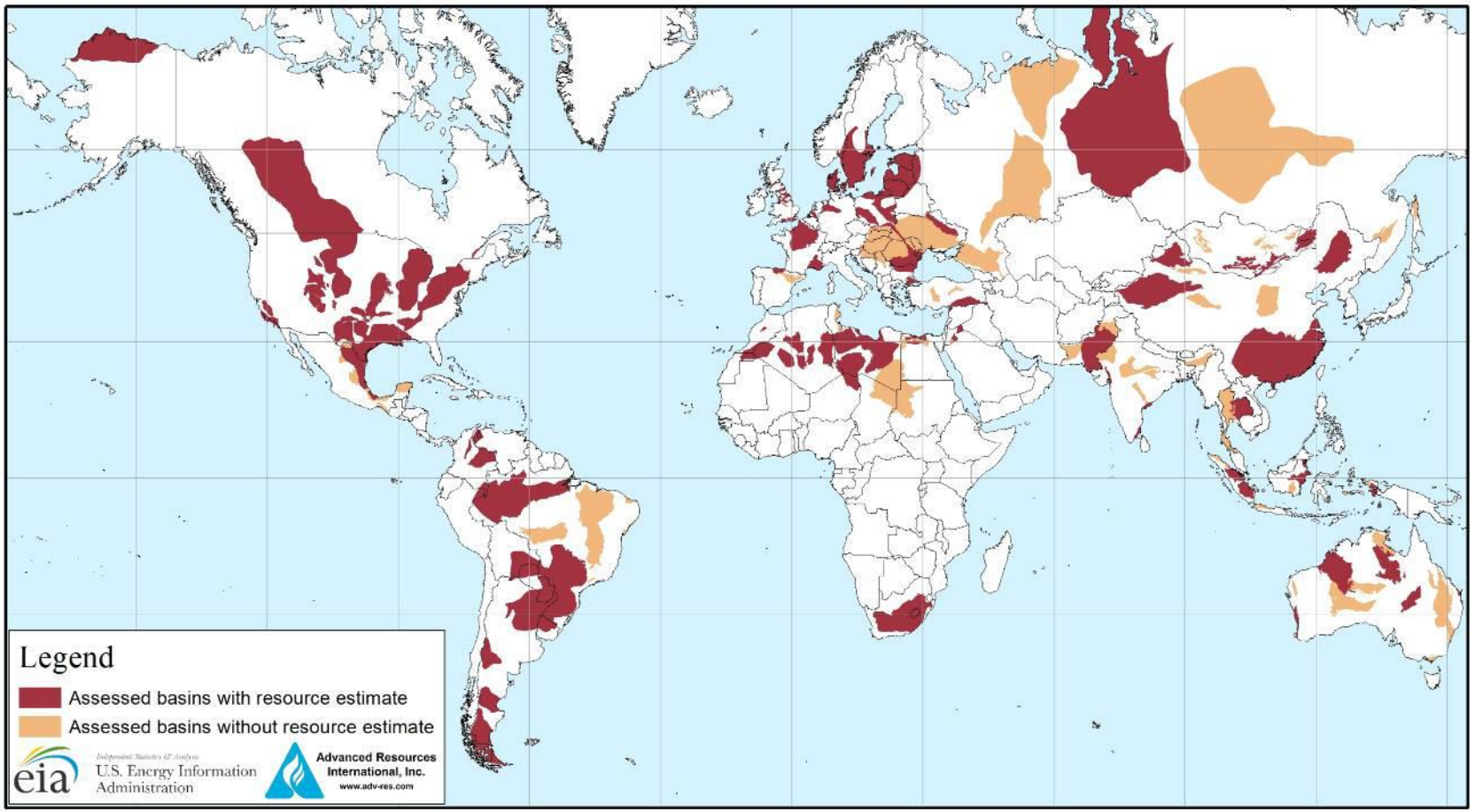
Unconventional resources



Top 10 countries with technically recoverable shale resources

Source: EIA 2013

Unconventional (shale) gas resources



Source: EIA 2013

Is it “secure”?

- What ultimately matters is not how much fossil energy is there in Earth’ crust, but how much of it can get safely to us.
- IEA’s define Security of Supply (SoS) as “*the availability of a regular supply of energy at an affordable price*”
- Many disciplines have traditionally dealt with the issue of security of supply (economics, geopolitics, and engineering) so that under the label of “security of supply” many different visions and concerns need to be accommodated and a common ground established in order to arrive at a consistent, interdisciplinary framework.
- Security of supply is more than the availability of enough energy. Many indicators have been used to quantify security of supply, mainly in negative sense (in terms of of “dependency “ and vulnerability”).

Dependency and Vulnerability

Dependence is a measure of how much the domestic economy relies on sources of energy that are not under its control. Physical measures of dependence include:

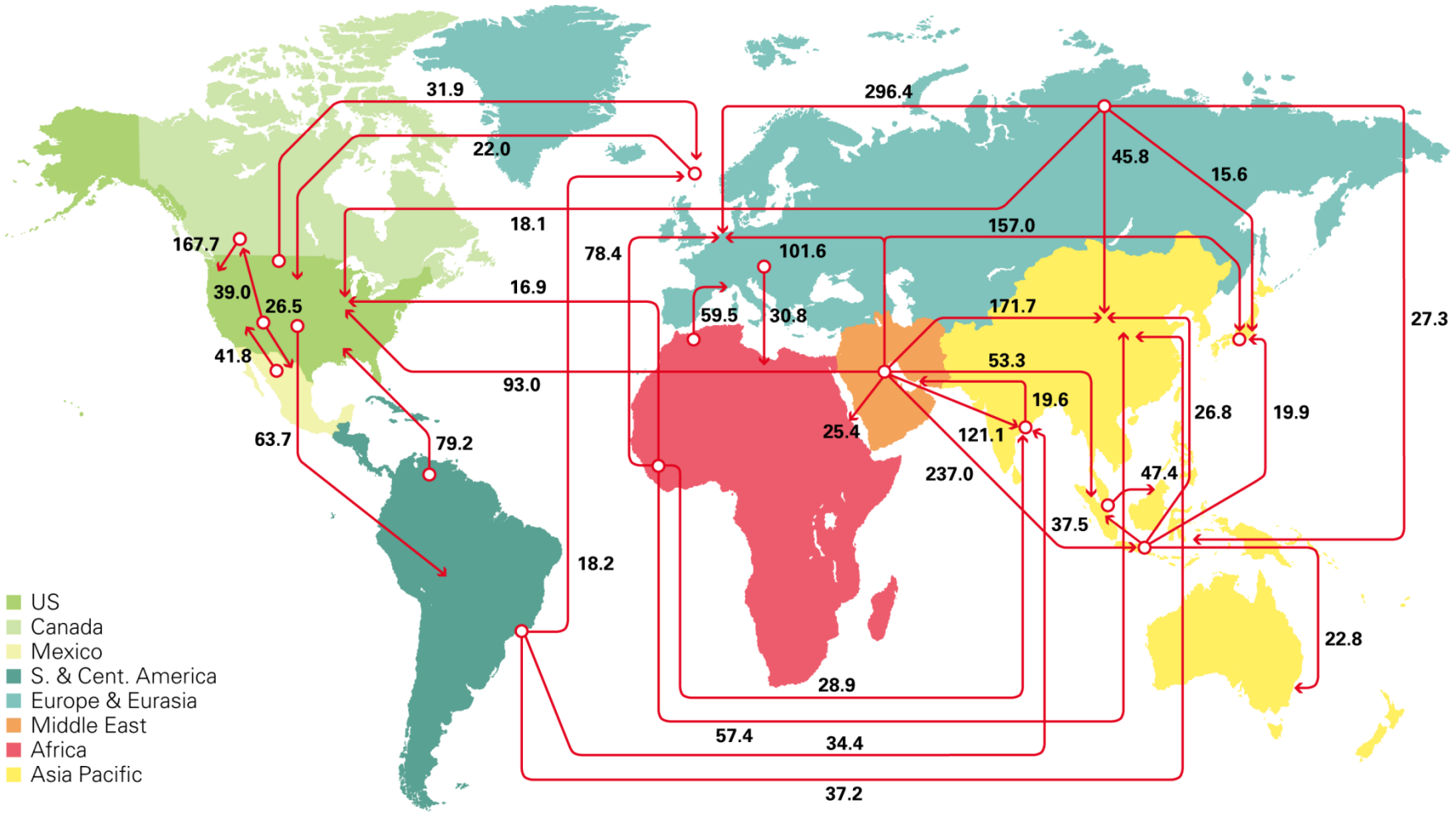
- imports of energy as a percent of total imports,
- oil imports as a percent of total oil consumption,
- gas imports as a percent of total gas consumption.

Economic measures of dependence are oil and gas consumption in physical units per $ of real GDP.

Vulnerability is a measure of the likelihood of domestic disruption in case some external energy source is reduced or cut off. Physical measures of vulnerability include

- the amount of imported oil used in transportation relative to total energy used in transportation,
- amounts of imported oil and gas fired electricity generation relative to total electricity generation,
- degree of supply concentration and
- the Shannon-Weiner diversity index.

Oil trade, 2014



BP Statistical Review of World Energy 2015

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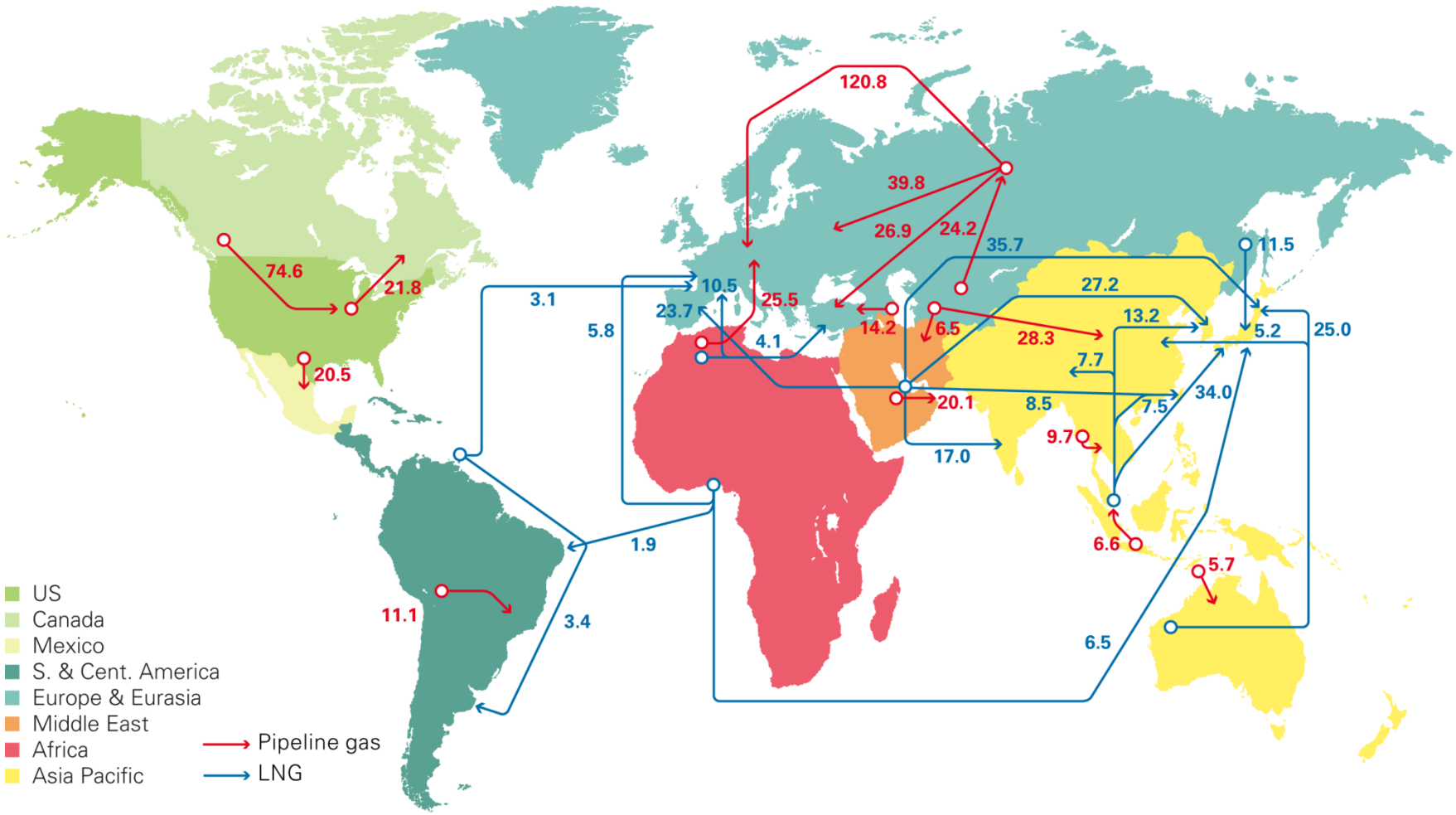
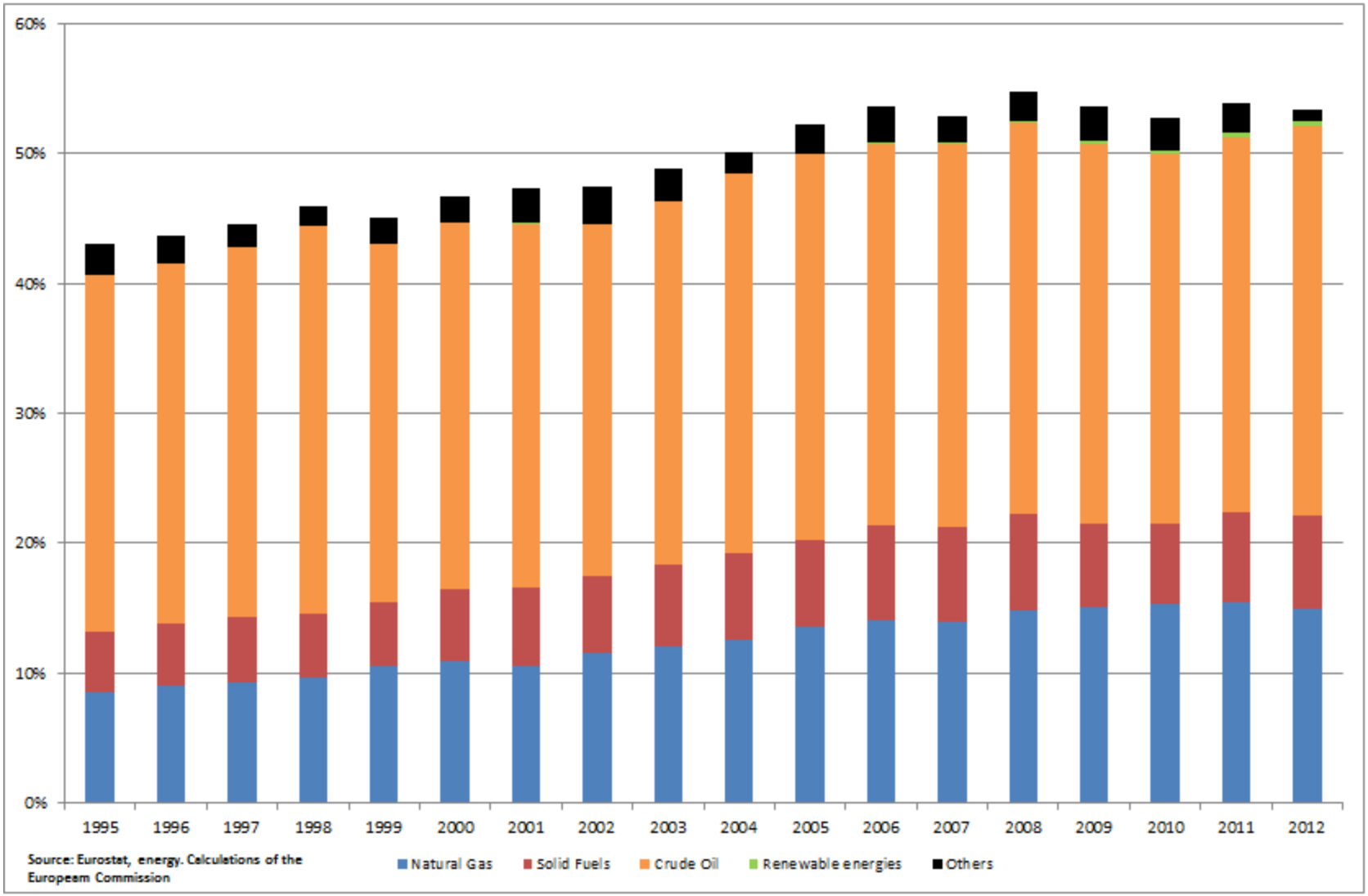
Natural gas trade, 2014



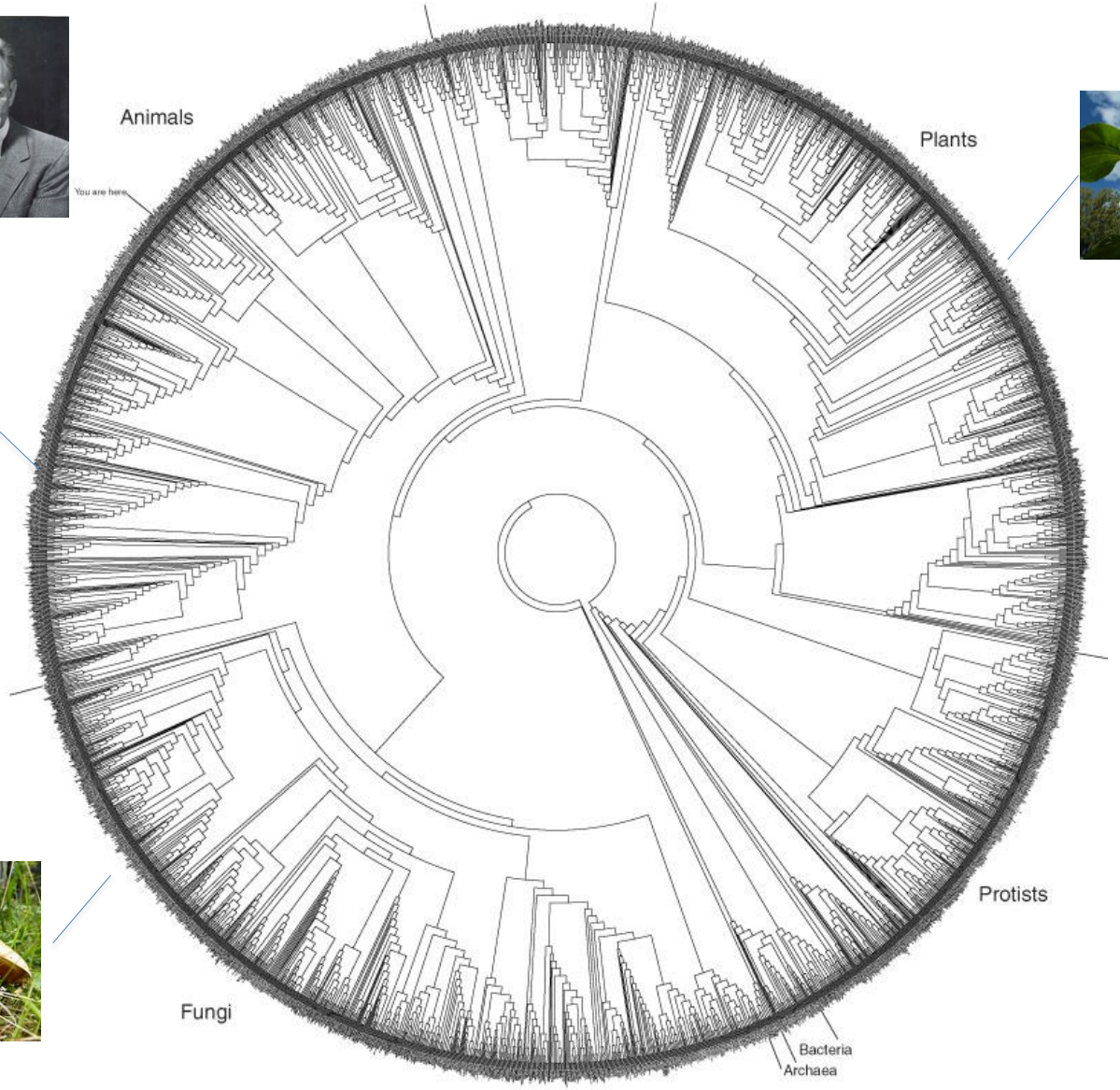
BP Statistical Review of World Energy 2015

Dependency - Net Imports/ total demand by energy product, EU28

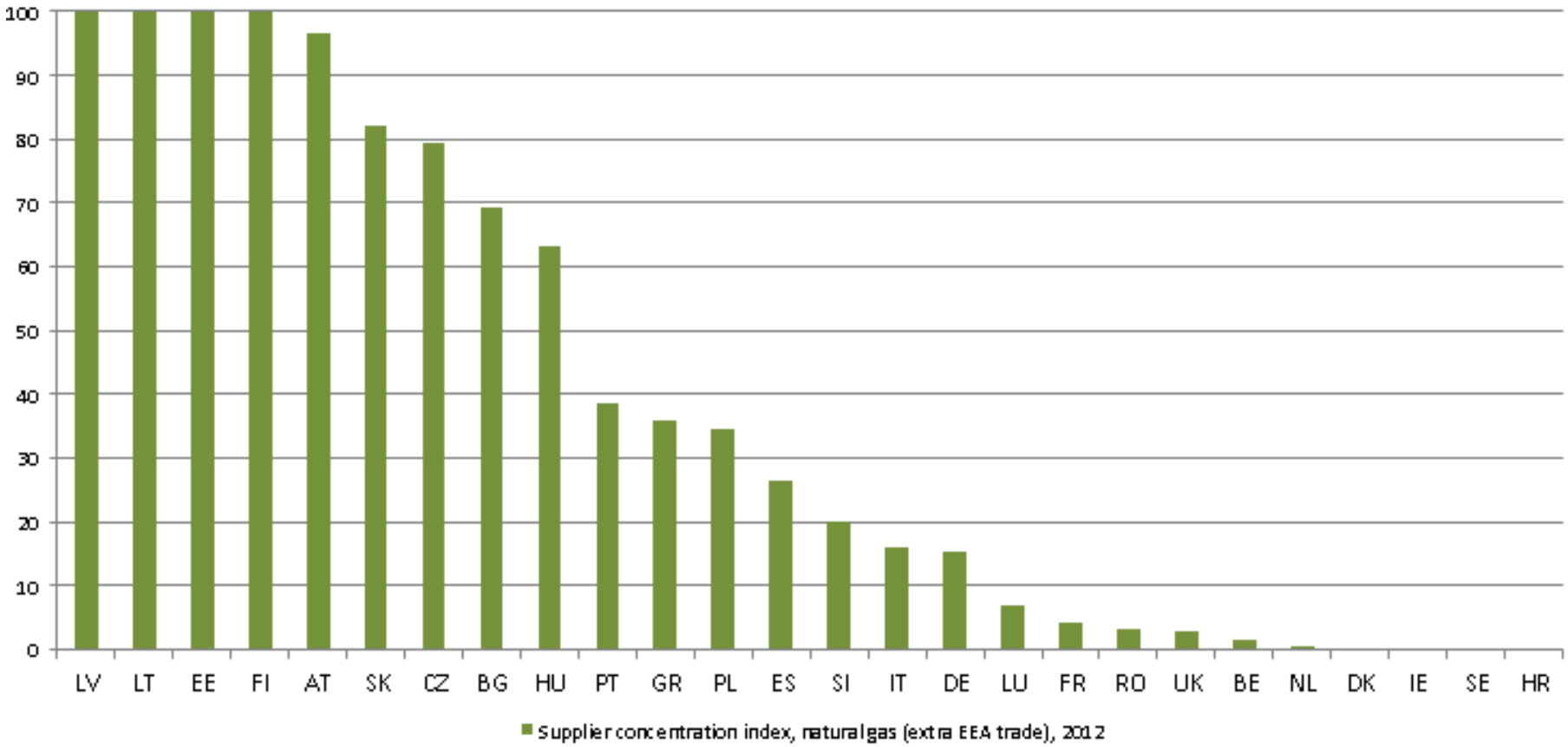


Source European Commission (2014), In-depth study of European Energy Security

Vulnerability- Shannon Weiner index

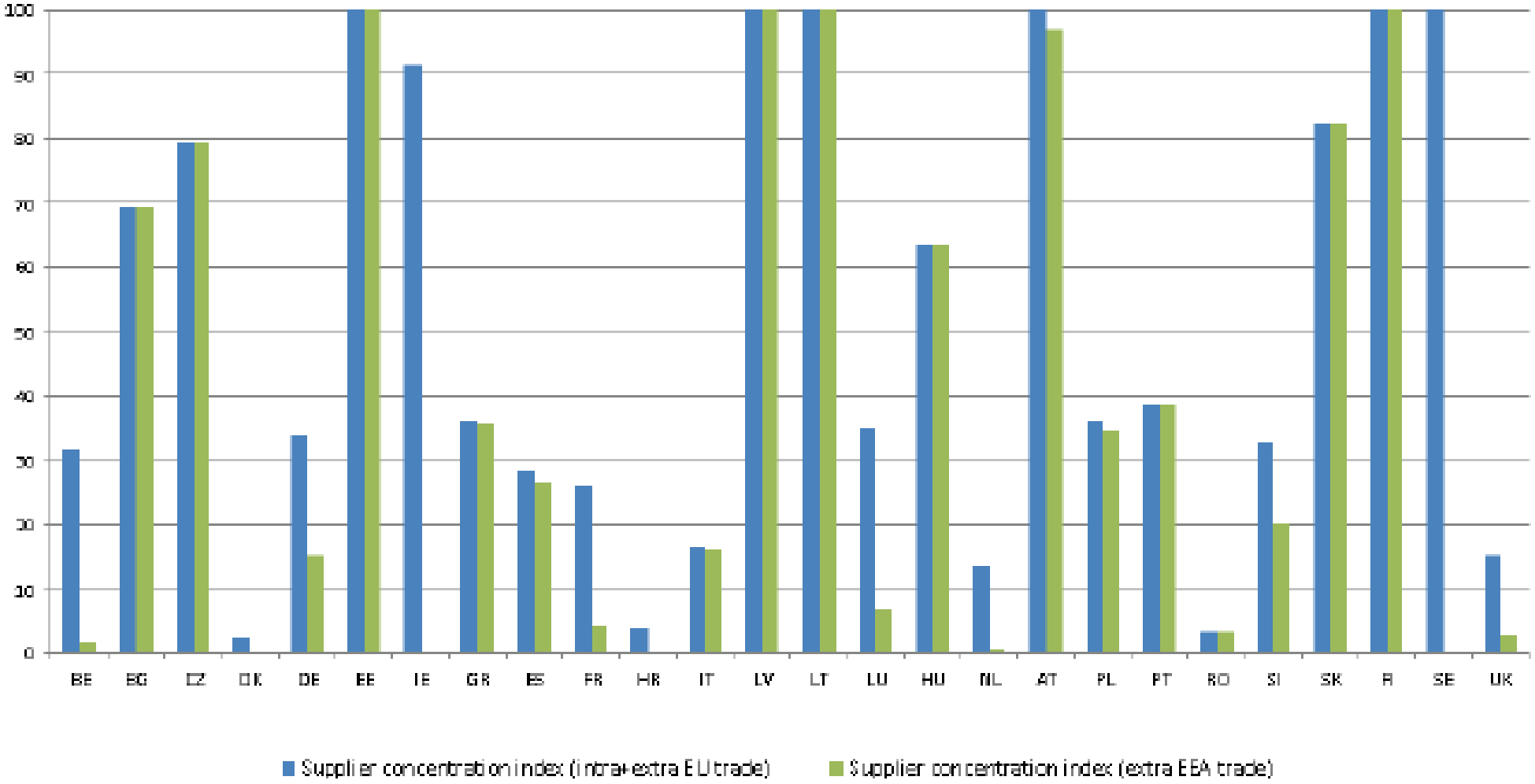


Vulnerability: Supplier concentration, natural gas, 2012



Source European Commission (2014), In-depth study of European Energy Security

Vulnerability: Supplier concentration within and outside EEA, natural gas, 2012



Source European Commission (2014), In-depth study of European Energy Security

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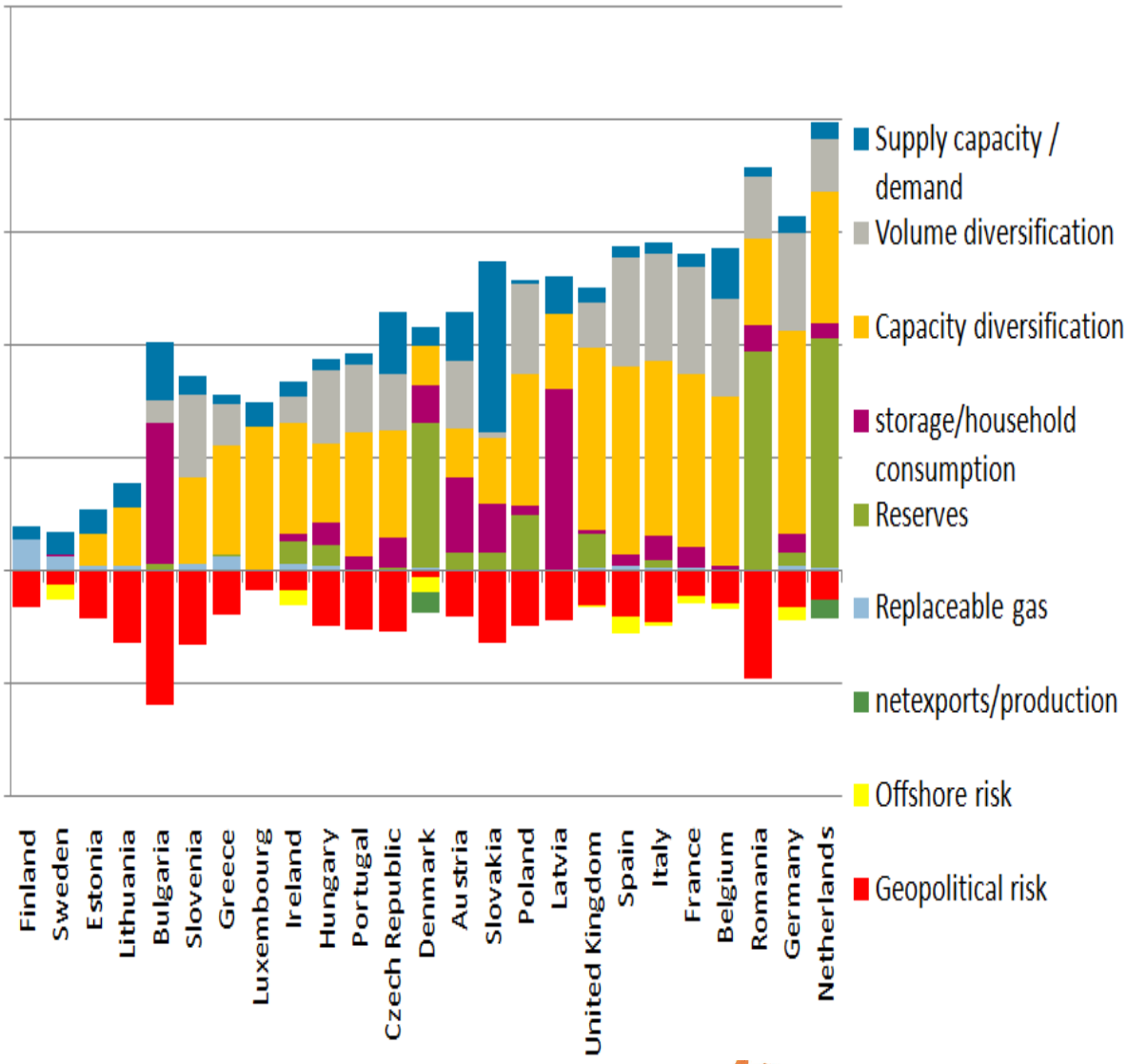
Natural Gas

- Natural gas security is not only a question of the external dimension such as diversification of supply sources and routes. Demand side and internal factors are as important.
- Many parameters are at play – and these parameters can change over time e.g. as the consequence of policy
- Thus securing supply is a mix of measures and forward looking policies.



Source: Ramboll Secure SoS index

Take home messages

- Our economies depend on finite energy sources
- Finite do not mean necessarily scarce
- Scarcity is a matter of definition
- Availability at the source is not enough for energy security: what ultimately matters is not how much fossil energy is there in Earth' crust, but how much of it can get safely to us.
- Measuring this is not univocal, and it is a matter of dependence and of vulnerability, but also of demand patterns and of policy measures

Thank you!

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