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# **The ODA UNESCO Project for Promotion of Energy Science Education for Sustainable Development in Asia (Lao PDR)**

# Theme 2

## **Current energy situation and needs to transform toward sustainable system.**

**Lecturer: Ms. Khamporn Moonphumy  
Department of physics, Faculty of Natural Science,  
National University of Laos.**

# Contents

- I. Current energy status, resources and future energy scenarios.**
- II. Social and Environmental cost.**
- III. Ethics and behavioral change issues.**

# **I. Current energy status, resources and future energy scenarios.**

# 1. Introduction

## Energy Definations

**Energy** is a fundamental property of physical system and refers to its Potential to maintain a material system identity or structure.

**“Energy is a resource coming from two main sources:**

➤ **solar energy and geothermal energy”**

- **Solar energy exists in main types:  
solar radiation, bio-energy (biomass), energy occupied in the movement of atmosphere and hydrosphere (wind, wave, sea current, tide, and river)**
- **Geothermal energy includes: thermal energy in volcanoes, hot springs, geysers and radioactive energy (U, Th, Po,...)**

## ➤ Units of Energy:

- 1 electron-volt =  $1.6022 \times 10^{-19}$  J
- $1\text{J} = 1\text{kg (m/s)}^2 = 1 \text{ kg.m}^2 / \text{s}^2$ .
- 1 BTU = 1054 J, kWh =  $3.6 \times 10^6$  J
- 1 cal = 4,186 J, 1 kcal = 4186 J
- Exajoule (EJ): 1 EJ =  $10^{18}$  J
- Quadrillion Btu(quad): 1 quad =  $10^{15}$  Btu = 1.055 EJ
- Terawatt-year (Twyr): 1 Twyr =  $8.76 \times 10^{12}$  kWh = 31.54 EJ = 29.89 quad.
- 1Mw = million ( $10^6$ ) watts;      1Gw = billion = ( $10^9$ ) watts ;  
1 Tw = trillion ( $10^{12}$ ) watts;      1Pw = quadrillion = ( $10^{15}$ ) watts.

## ➤ Energy use:

- Economic development and energy consumption.
- Energy resource and its utilization.
- Last 250 years, powered by fossil fuels.
- Current status : Resources availability, Global warming.
- **Example: Energy consumption and GDP (china)**

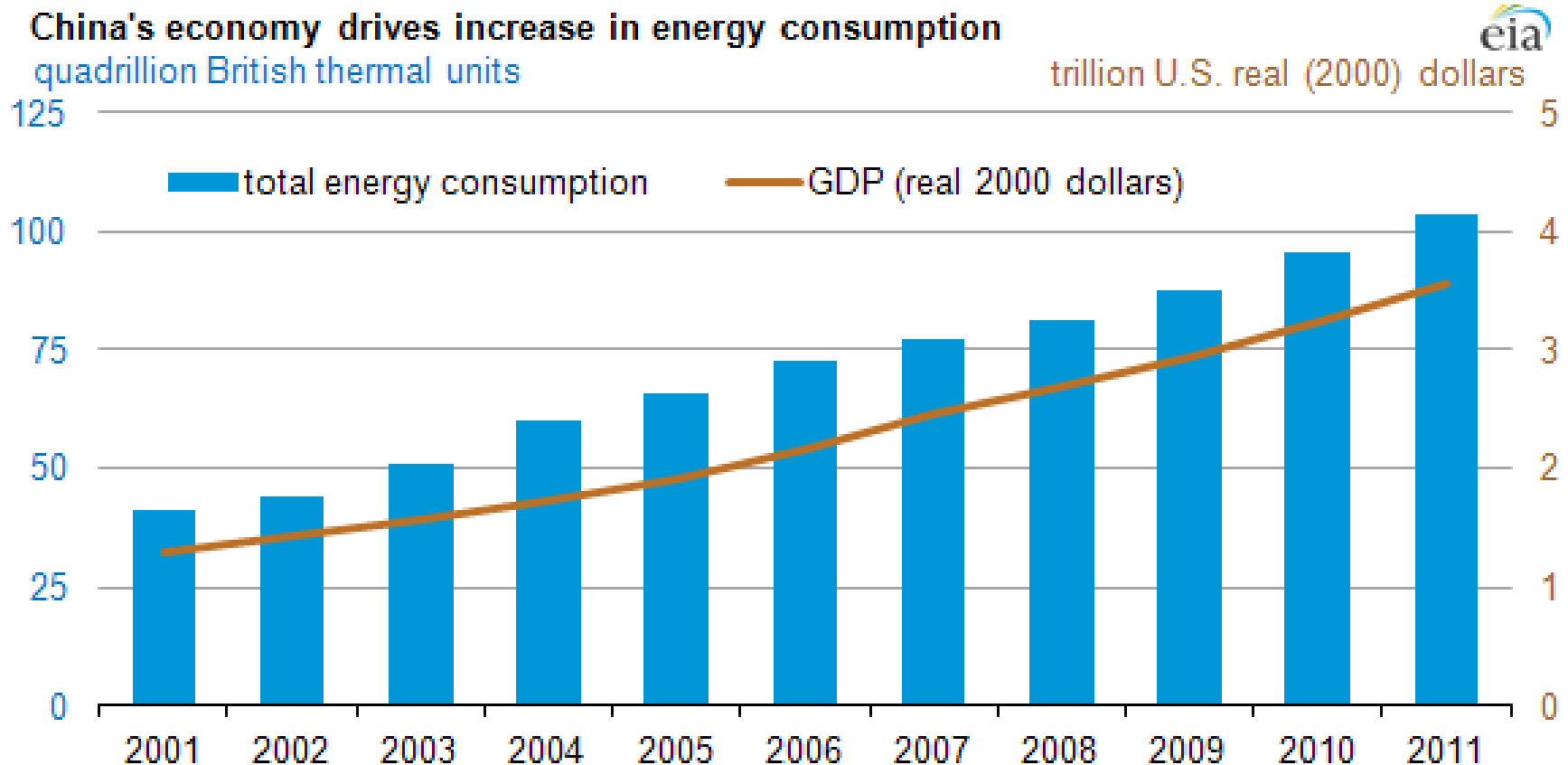
# Example: Energy consumption and GDP (china)

SEPTEMBER 21, 2012

Economic growth continues to drive China's growing need for energy

Source: World Bank, BP Statistical Review of World Energy.

<http://www.eia.gov/todayinenergy/detail.cfm?id=8070>



Gross domestic product, or GDP, is one of the ways for measuring the size of economy.

## Example: Energy consumption (china)

**Source:** [World Bank, BP Statistical Review of World Energy.](http://www.eia.gov/todayinenergy/detail.cfm?id=8070)  
<http://www.eia.gov/todayinenergy/detail.cfm?id=8070>

### Electricity

- China had the most installed generating capacity in the world in 2011, at 1,073 gigawatts, slightly higher than the United States.
- About 80% of China's electricity generation came from conventional thermal sources, primarily coal, in 2011.
- Both China's electric generating capacity and its electricity generation doubled between 2005 and 2011.

### Coal

- China was the largest producer and consumer of coal in the world in 2011, and accounted for almost half the world's coal consumption.
- China became a net coal importer in 2009 for the first time in over 20 years.
- China has the third-largest coal reserves in the world.

### Oil

- China was the world's second-largest consumer of oil and liquids in 2011, as well as second-largest oil importer (trailing the United States in both categories).
- China's total oil consumption is slated to continue increasing; EIA forecasts that growth in China's demand for oil will represent 64% of projected world oil demand growth during 2011-2013.



# Example: Energy consumption (china)

**Source:** [World Bank](#), [BP Statistical Review of World Energy](#).  
<http://www.eia.gov/todayinenergy/detail.cfm?id=8070>

## Natural gas

- China was the fourth-largest global consumer of natural gas in 2011.
- Use and production of natural gas in China is rapidly increasing; natural gas production more than tripled over the last decade.
- Consumption of natural gas in 2011 was nearly 50% higher than in 2009.

## Nuclear

- Nuclear power made up only 2% of total electricity generation in 2010. As of mid-2012, China had 15 operating reactors, with a total capacity of nearly 13 gigawatts, and 26 new reactors under construction, with a capacity of about 29 gigawatts.

## Renewables

- While renewables made up a small fraction of the country's total electricity generation, China was the world's leading producer of hydroelectric power in 2010, and the second-largest producer of electricity from wind power.

# ➤ **Energy resources Definations**

[http://www.ehow.com/about\\_5098677\\_definition-energy-resources.html](http://www.ehow.com/about_5098677_definition-energy-resources.html)

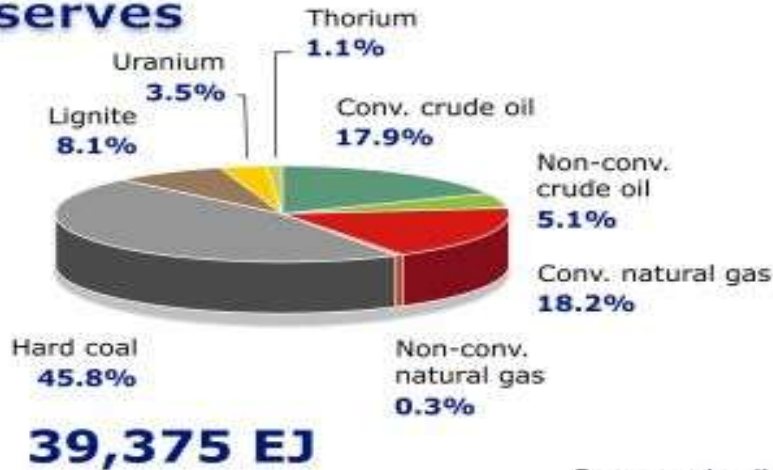
Energy resources are generally defined as anything that can be used as a source of energy. Some important energy resources are oil, natural gas and coal. Access to energy resources is vital to economic development and prosperity. The world's available energy resources threatened to be strained by population growth and rapid economic growth in large countries such as China. At the same time, it's vital that the world develop new energy resources that do not contribute to global warming and other environmental problems.

# ➤ Energy resources (cont)

## Reserves, Resources and Availability of Energy Resources 2011.

[http://www.bgr.bund.de/EN/Themen/Energie/Produkte/annual\\_report\\_2011-summary\\_en.html](http://www.bgr.bund.de/EN/Themen/Energie/Produkte/annual_report_2011-summary_en.html)

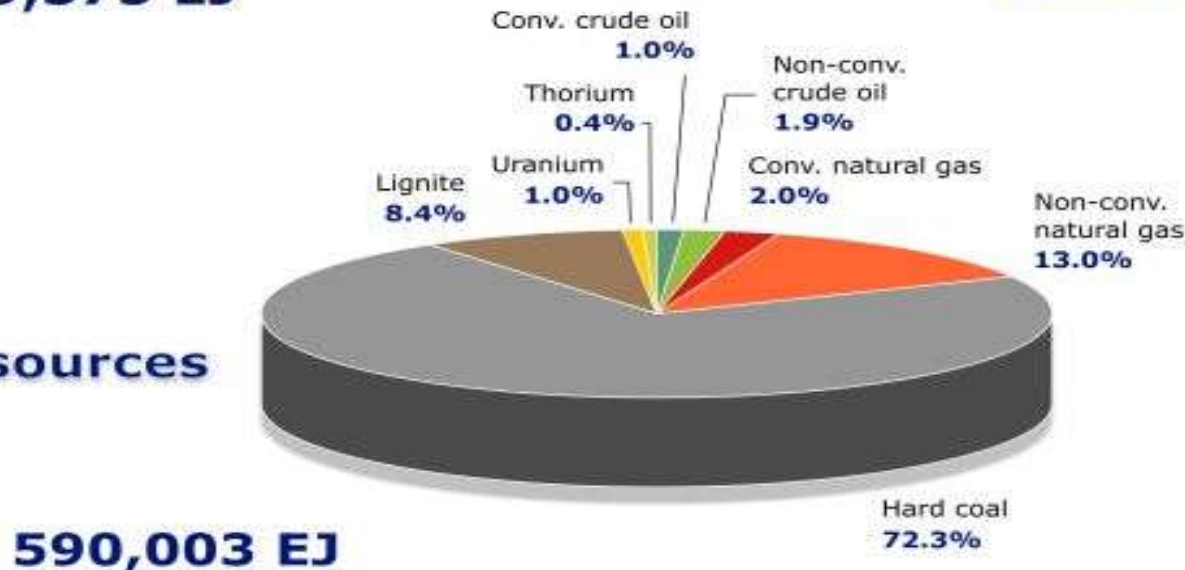
### Reserves



### Production 2010



### Resources

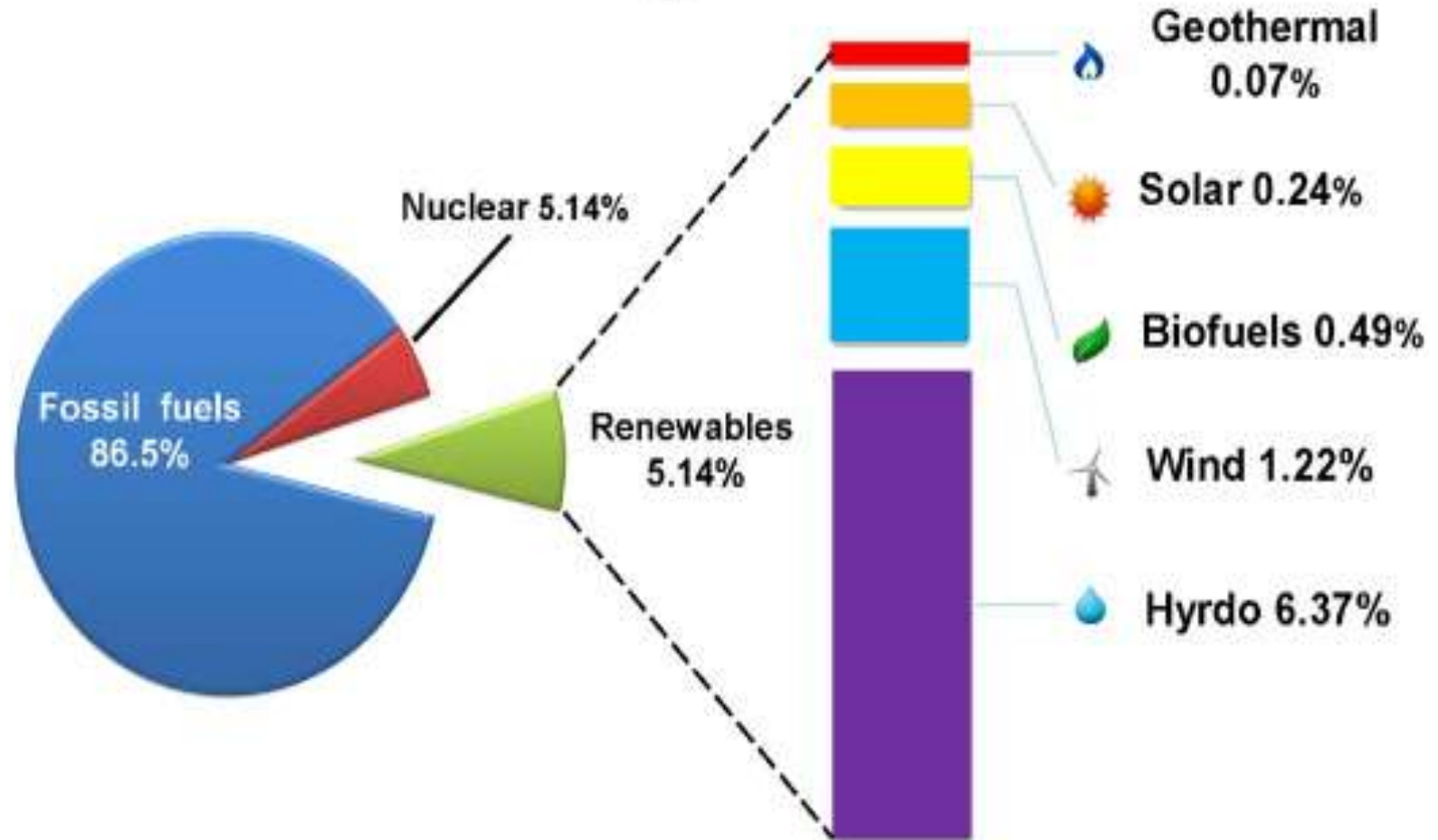


## ➤ World Energy production

journal homepage: [www.elsevier.com/locate/nanoenergy](http://www.elsevier.com/locate/nanoenergy)

Nano Energy (2012) 1, page 259–272

### World Energy Production Oct. 2011



# 1.1 Energy consumption of the world.

## Energy source Definitions

<http://www.businessdictionary.com/definition/energy-source.html>

Material such as coal, gas, oil, and wood consumed in generation of power.

### **Coal Definition**

Mineral deposit containing combustible substances which is considered to be a fossil fuel. Coal is formed from plants that have been fossilized through oxidation. The end result is a black hard substance that gives off carbon dioxide when burned. Coal is currently the most widely used substance to generate electricity and heat. Due to the harmful gases that it releases into the environment.

### **Oil Definition**

A hydrocarbon liquid substance that is greasy to the touch and is formed by natural resources or the breakdown of fats. Oil comes in many forms as diverse as crude oil and vegetable oil, which serve very different purposes. Products consisting of oil are insoluble when added to water, but will dissolve in organic substances such as those acquired from living organisms.



# Consumption of energy sources

<http://gregor.us/coal/my-quick-preview-of-the-2011-bp-statistical-review/>

Global Energy Use by Source 2010

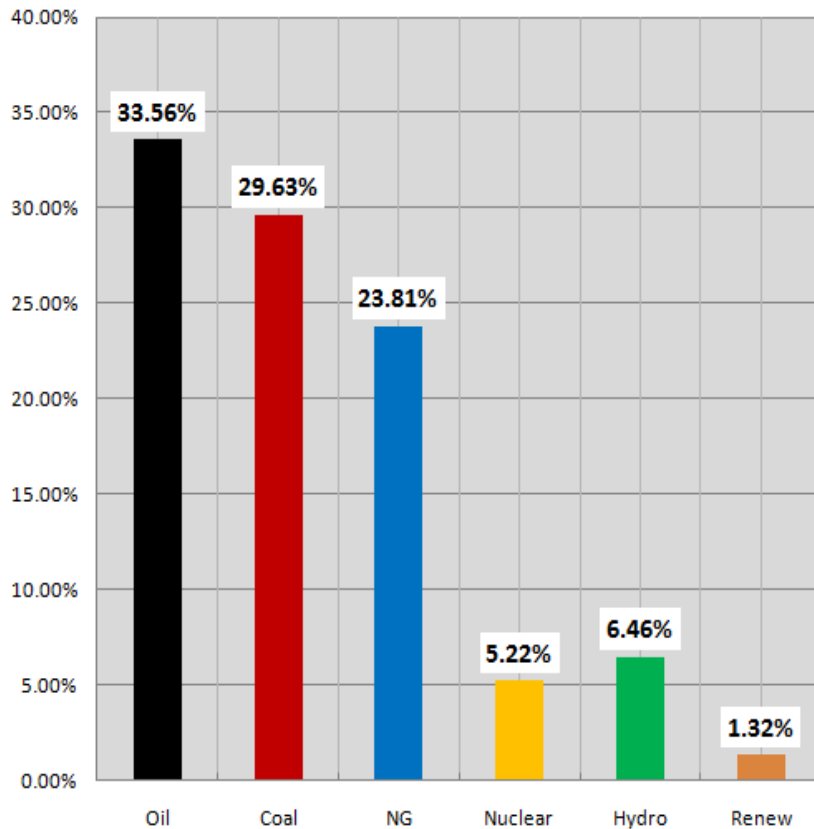


chart: [www.gregor.us](http://www.gregor.us) | data: bp statistical review

Global Energy Use by Source 2011

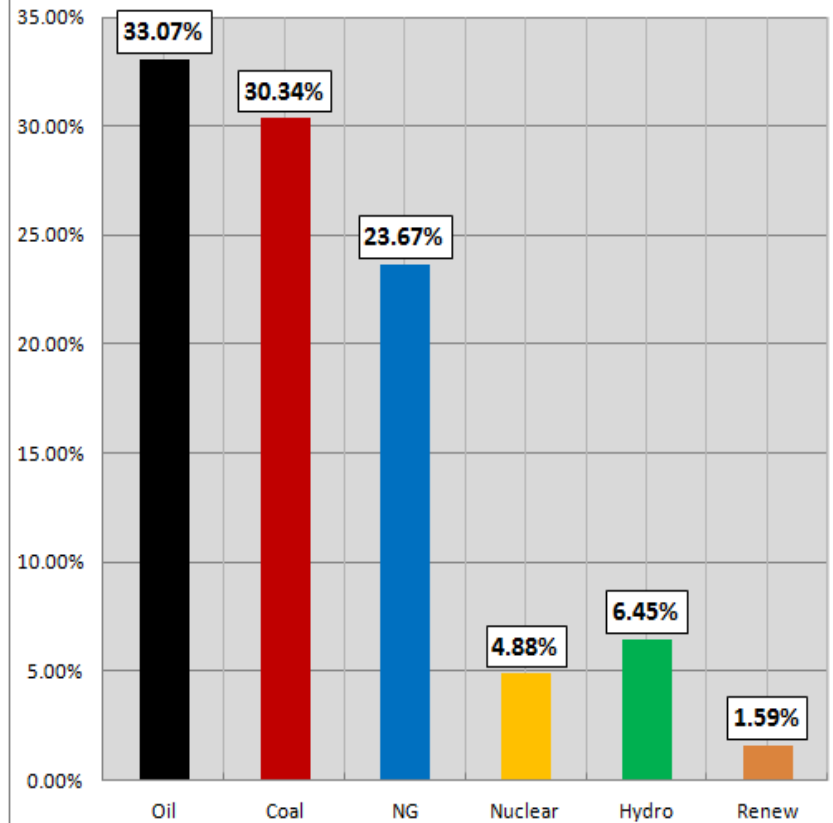
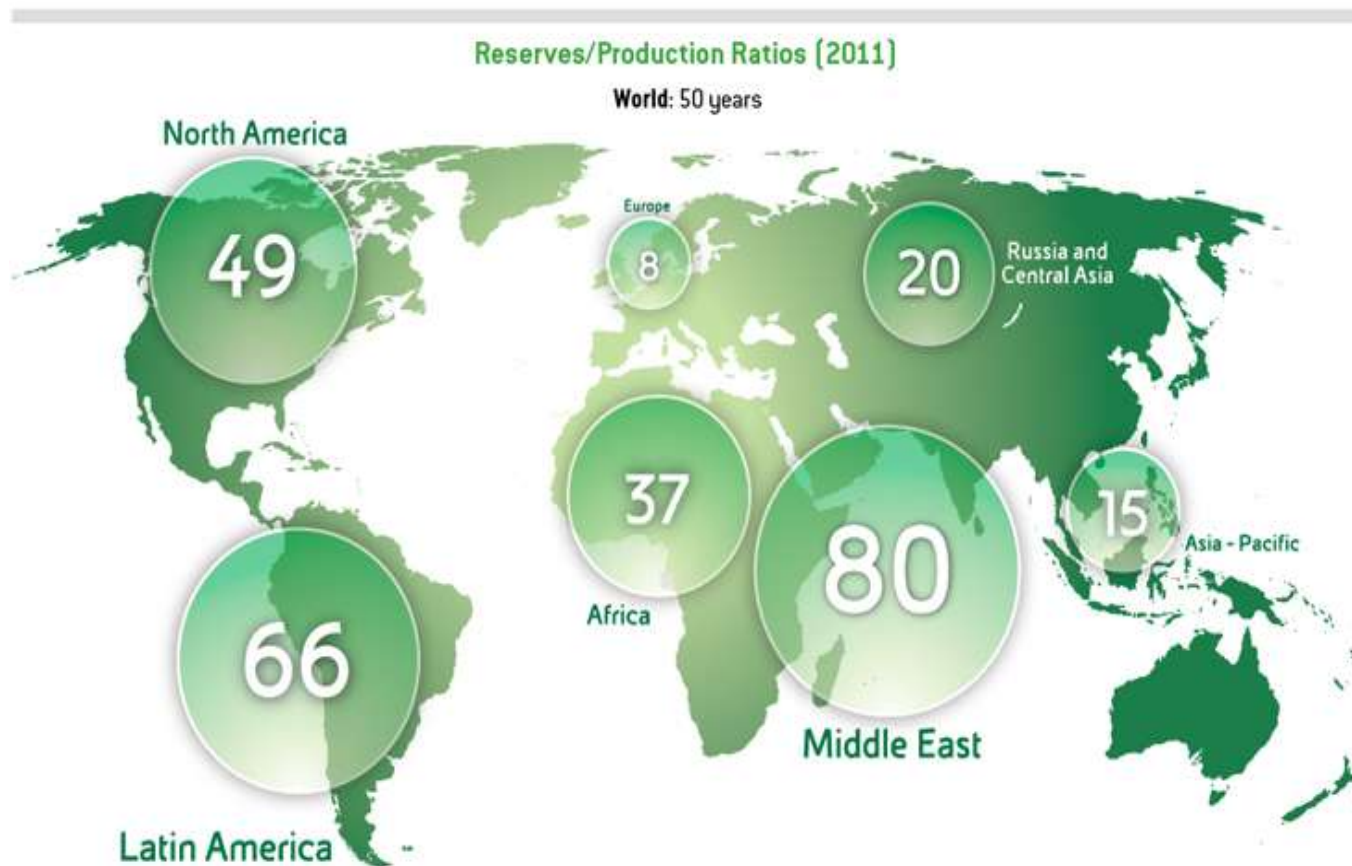


chart: [www.gregor.us](http://www.gregor.us) | data: bp statistical review

# 1.2 Type and source energy now situation

## ➤ World oil - reserves/production Ratio

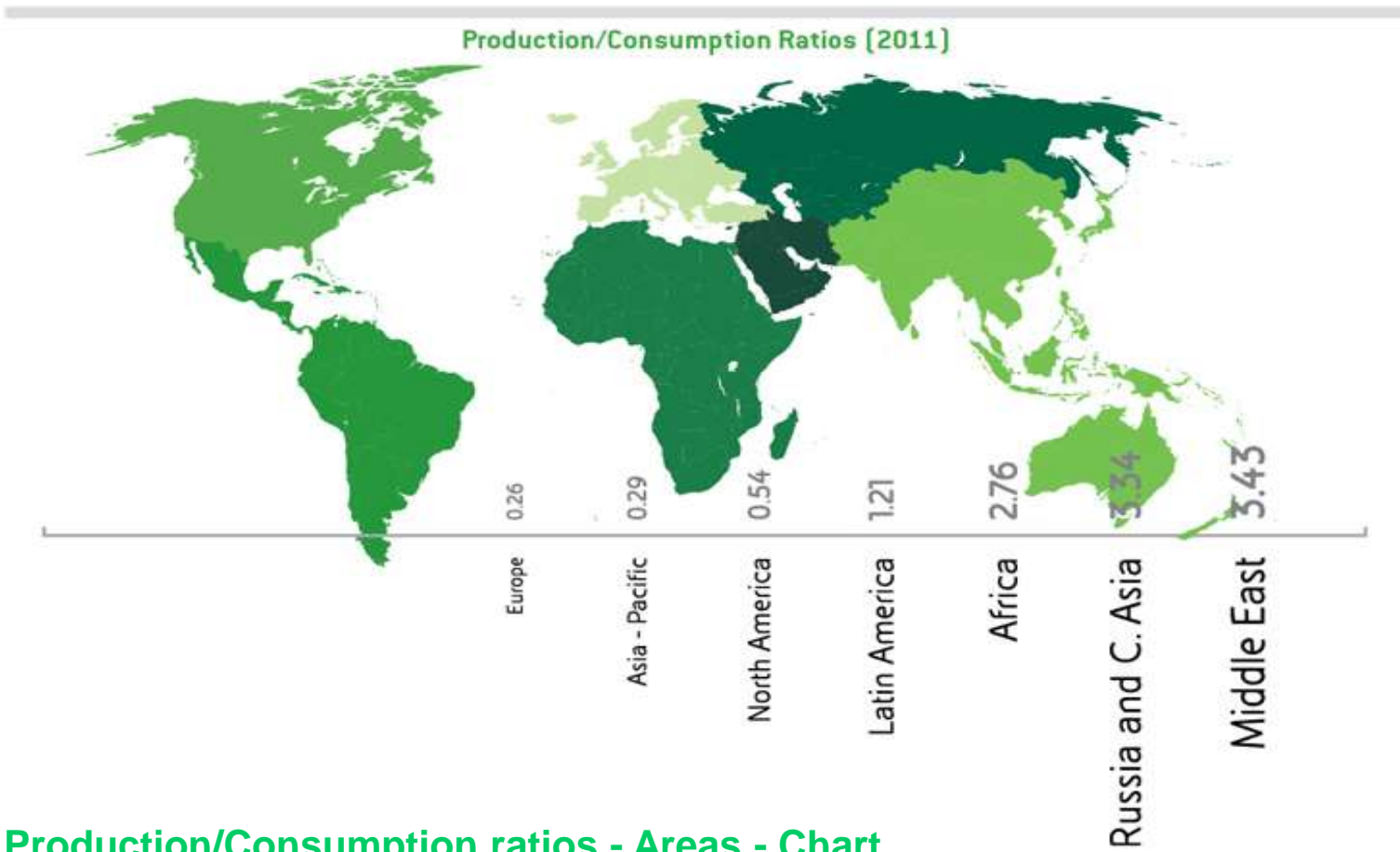
<http://www.eni.com/world-oil-gas-review-2012/oil/Oil--Areas-Chart+4-2.shtml>





# ➤ World Oil- Production/Consumption ratios

<http://www.eni.com/world-oil-gas-review-2012/oil/Oil--Areas-Chart+7-2.shtml>

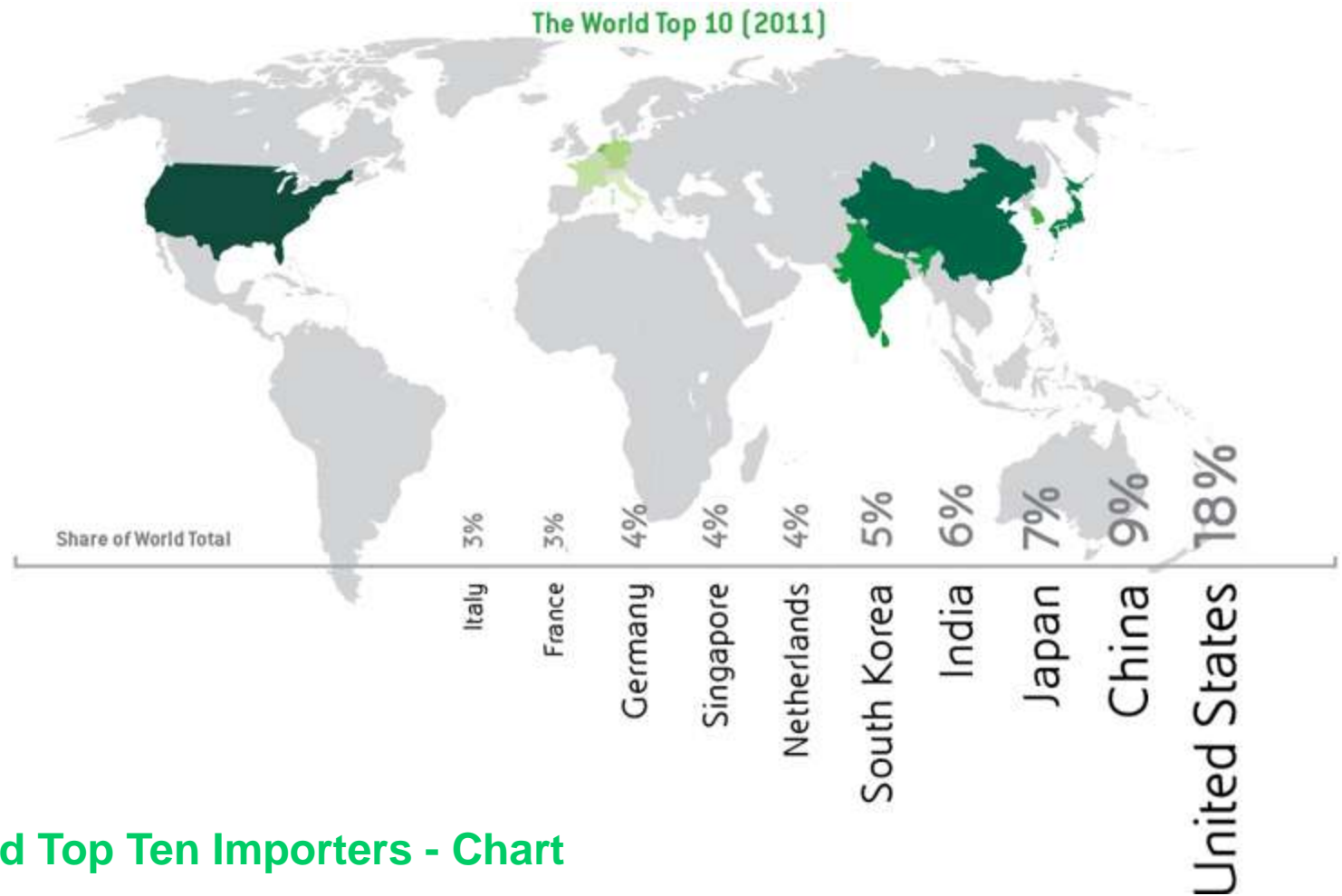


Production/Consumption ratios - Areas - Chart



# ➤ World oil trade-Importers

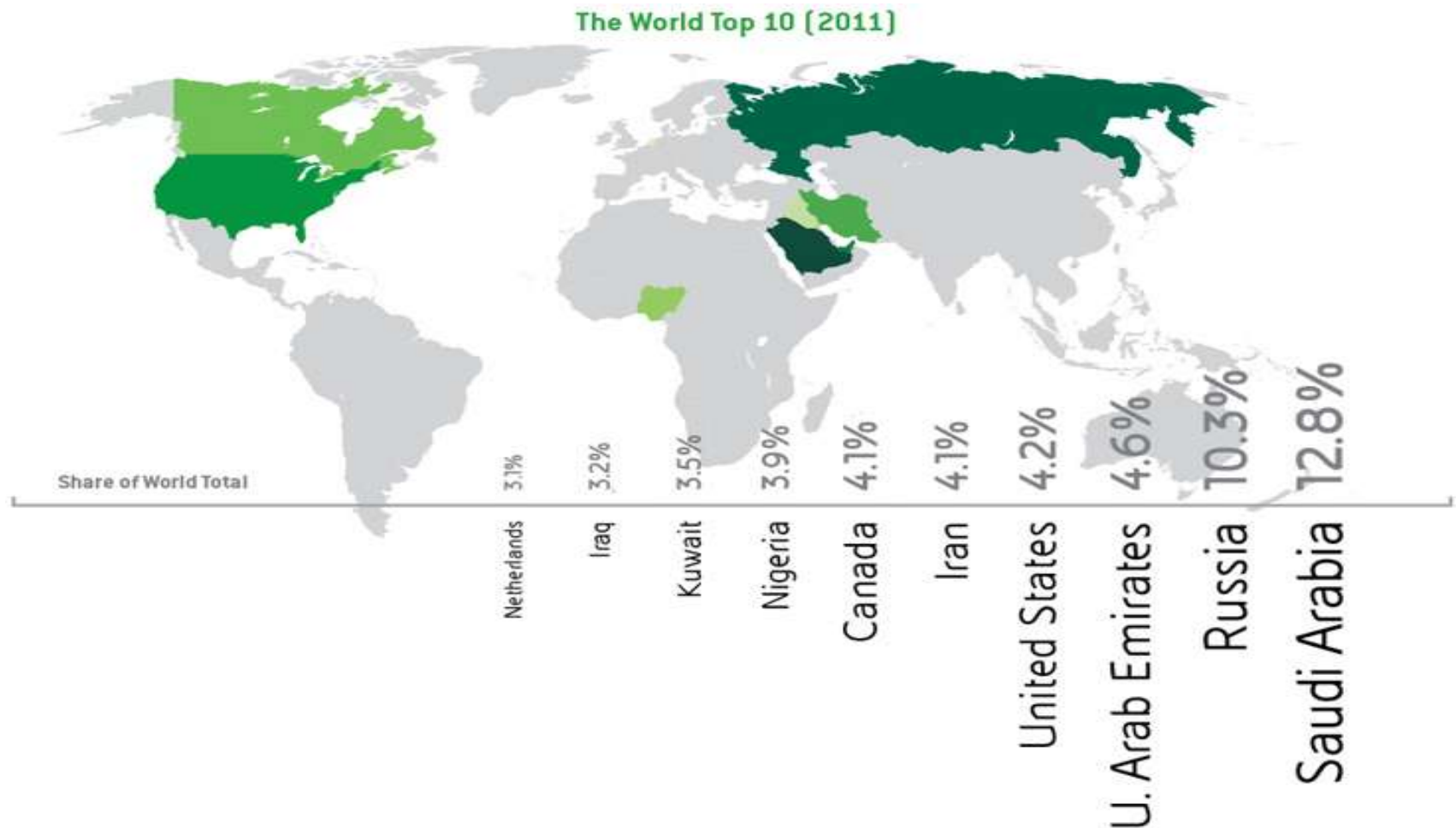
<http://www.eni.com/world-oil-gas-review-2012/oil/Oil--The-World-Top-Ten-Importers-Chart+9-2.shtml>



The World Top Ten Importers - Chart

# ➤ World oil trade-Exporters

<http://www.eni.com/world-oil-gas-review-2012/oil/Oil--The-World-Top-Ten-Exporters-Chart+8-2.shtml>



The World Top Ten Exporters - Chart

# What is natural gas

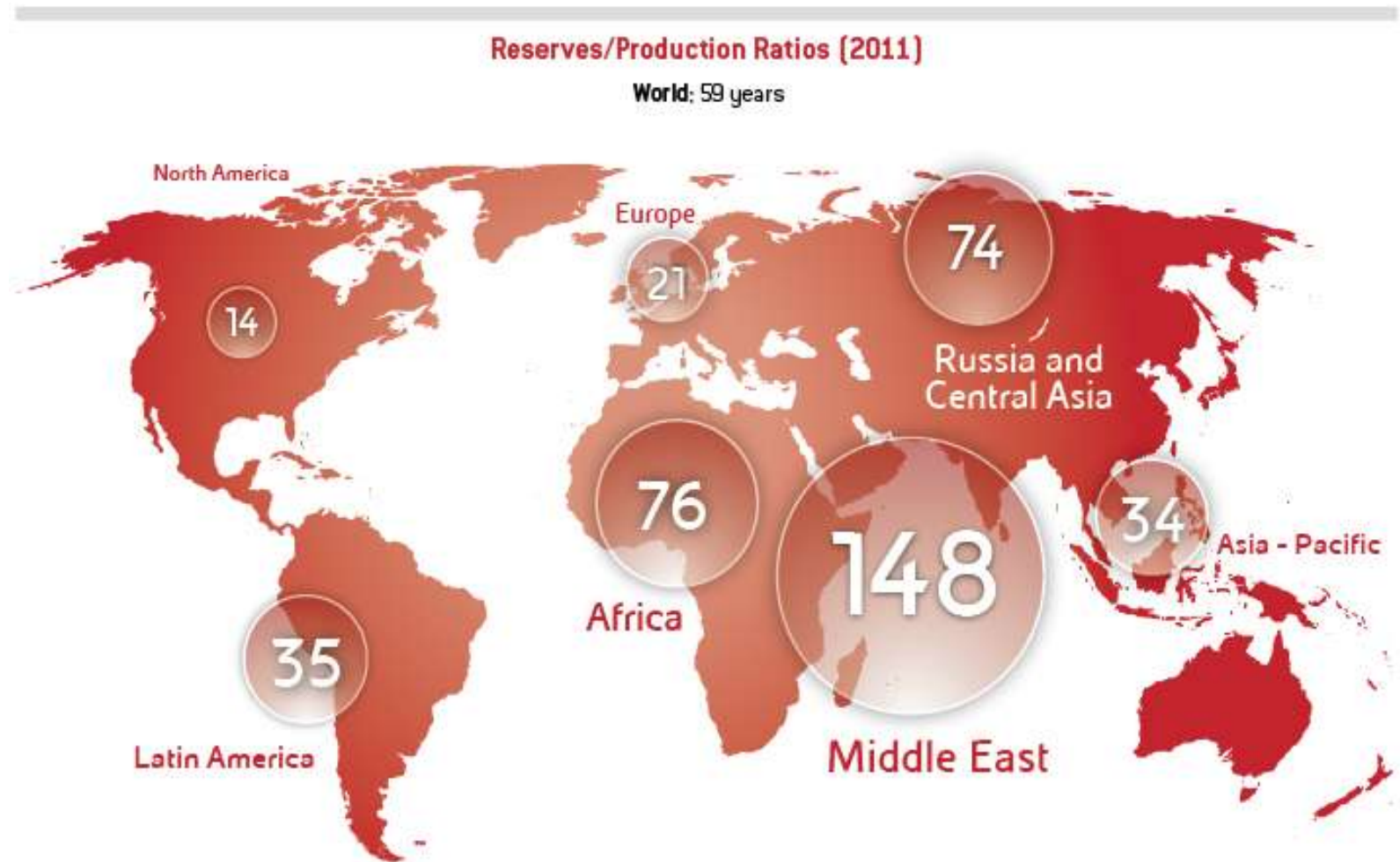
<http://www.natgas.info/html/whatisnaturalgas.html>

Natural gas, crude oil, and coal are collectively known as hydrocarbons. Also called petroleum compounds, hydrocarbons are made up of the elements hydrogen and carbon, plus impurities. A wide variety of distinctly different hydrocarbon compounds, each with a different proportion of these two main elements, is encompassed within the general terms natural gas and crude oil. Methane is the main component of natural gas, usually accounting for 70%–90% of the total volume produced.

# ➤ World natural gas—Reserves/Production Ratio

## Natural Gas Reserves/Production Ratios - Areas - Chart

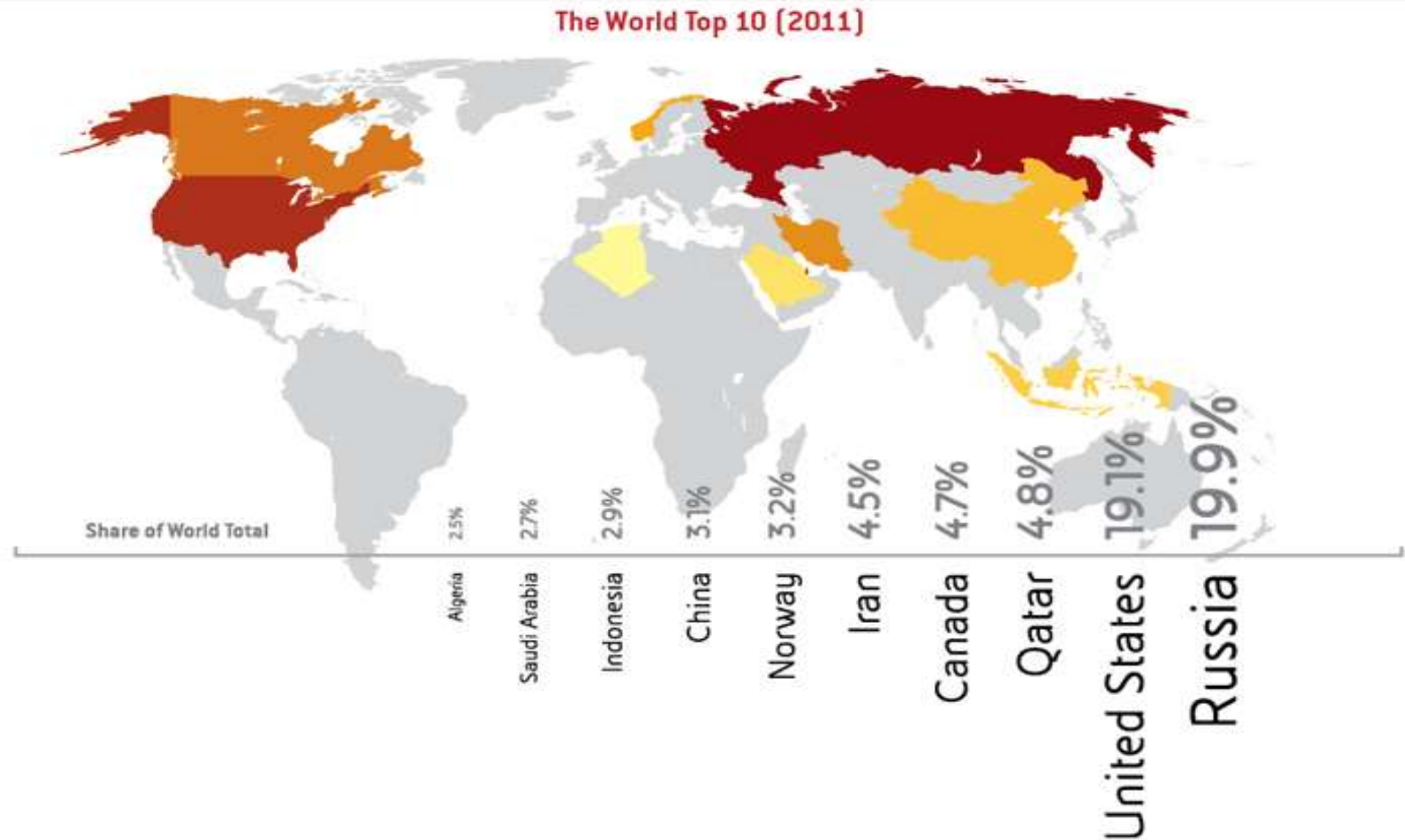
<http://www.eni.com/world-oil-gas-review-2012/gas/Gas--Areas-Chart+4-2.shtml>



# ➤ World natural gas production

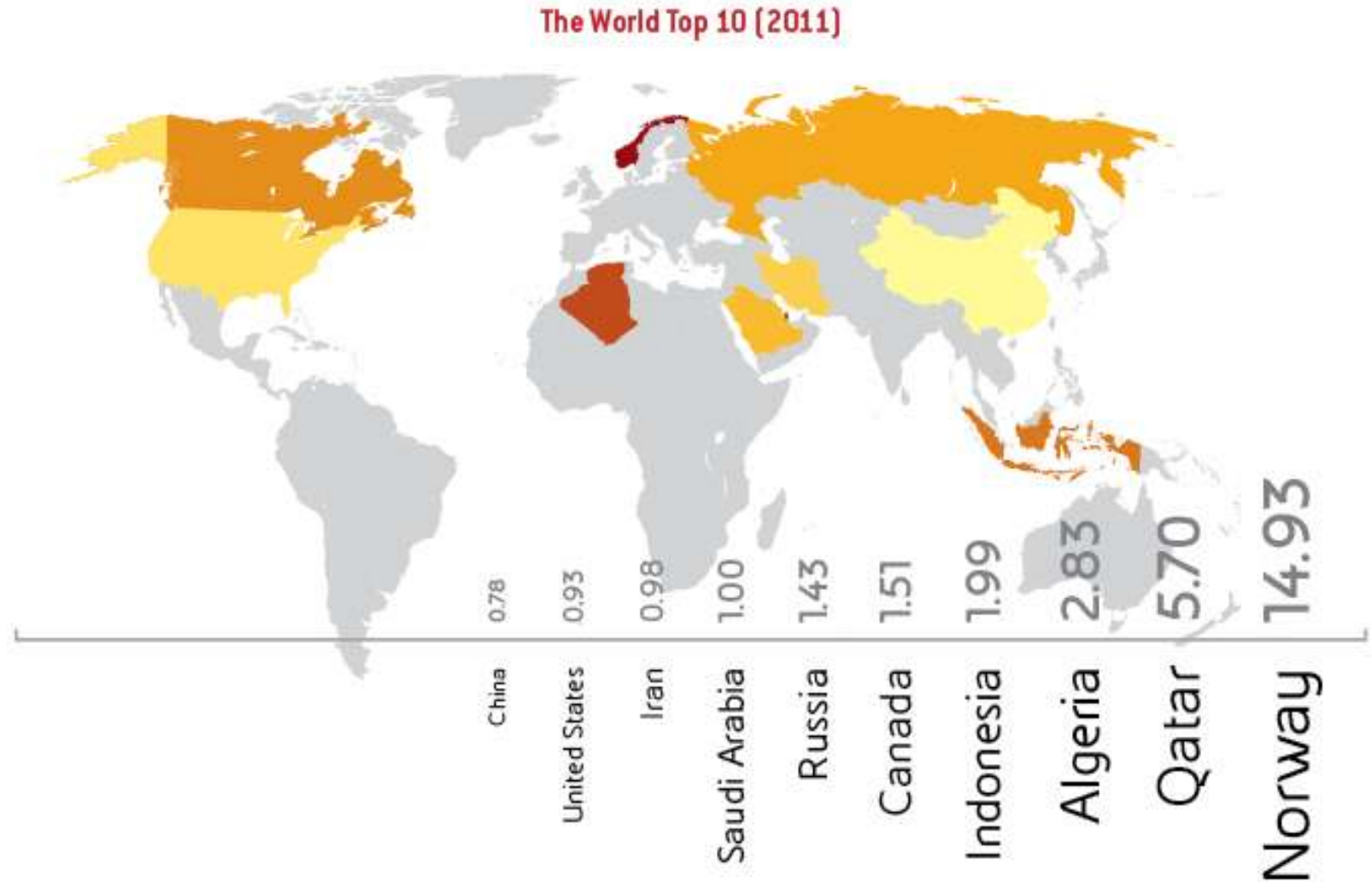
## Natural Gas Production - The World Top Ten Producers - Charts

<http://www.eni.com/world-oil-gas-review-2012/gas/Gas--The-World-Top-Ten-Producers-Chart+2-4.shtml>



# ➤ Natural Gas - Production/Consumption ratios

<http://www.eni.com/world-oil-gas-review-2012/gas/Gas--The-World-Top-Ten-Producers-ranked-by-Production-Consumption-Chart+7-4.shtml>

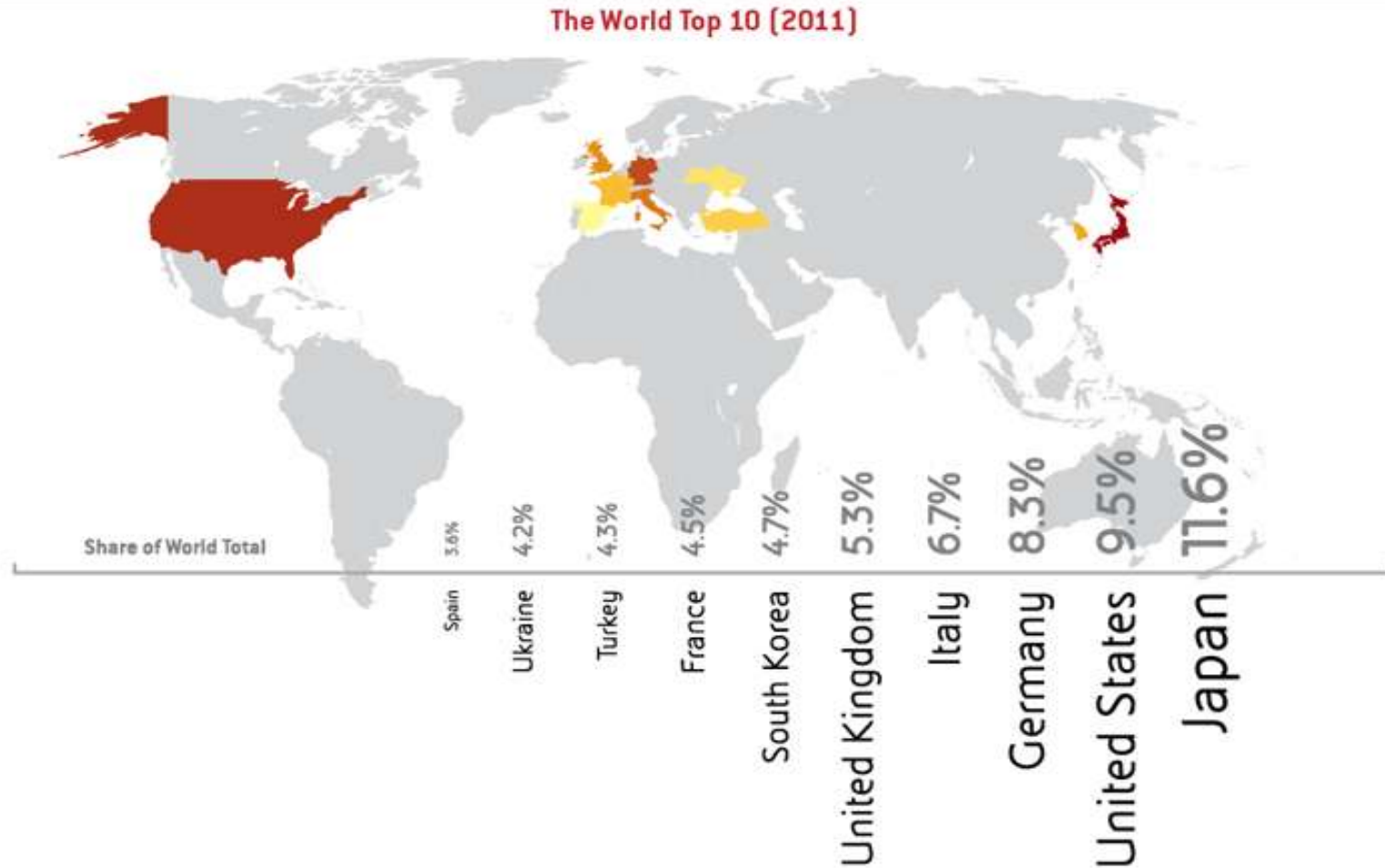




# ➤ World Natural gas trade-Importers

## The World Top Ten Importers - Chart

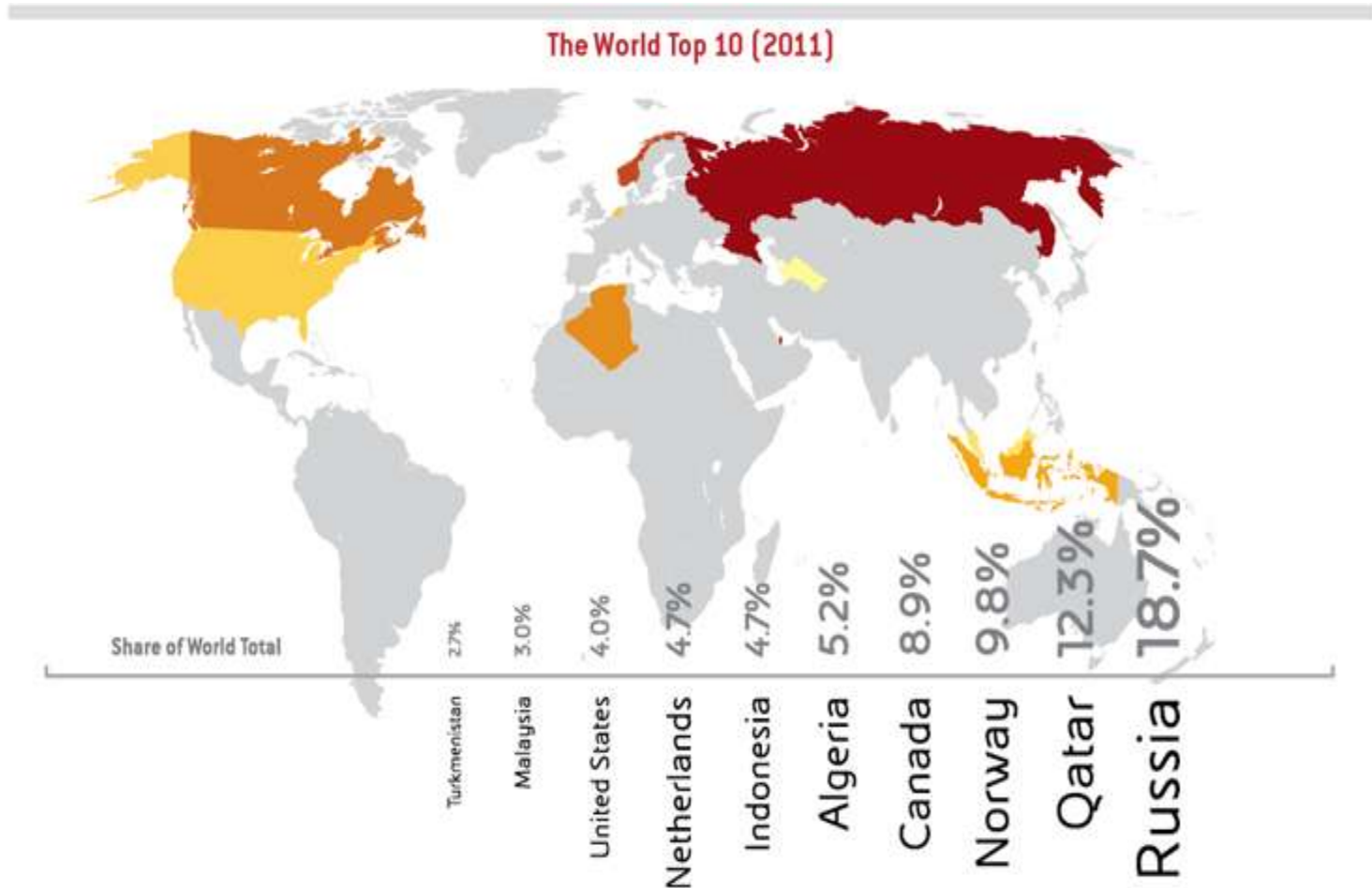
<http://www.eni.com/world-oil-gas-review-2012/gas/Gas--The-World-Top-Ten-Importers-Chart+9-2.shtml>



# ➤ World Natural gas trade-Exporters

## The World Top Ten Exporters - Chart

<http://www.eni.com/world-oil-gas-review-2012/gas/Gas--The-World-Top-Ten-Exporters-Chart+8-2.shtml>





# ➤ World coal – reserves

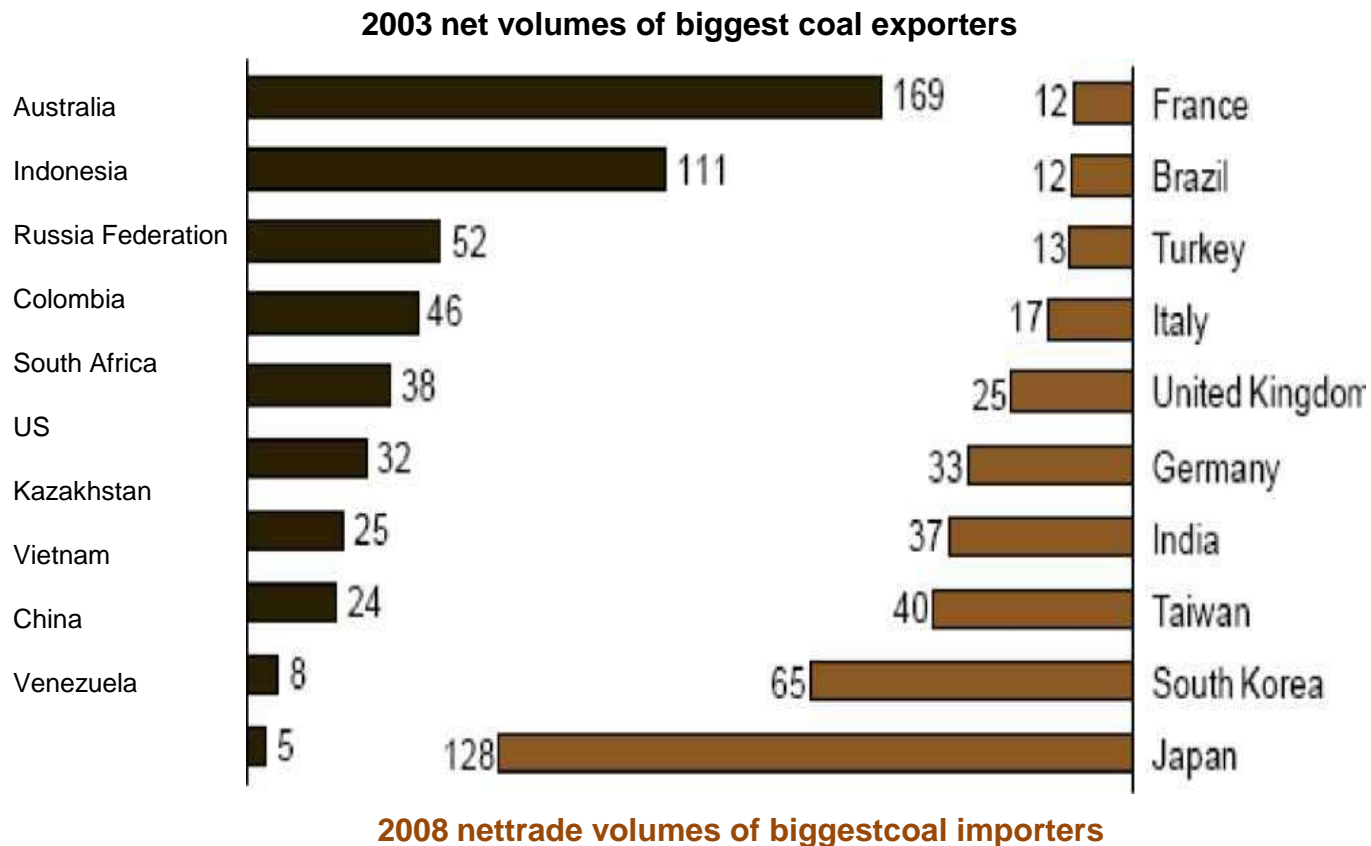
Source: 2010 Survey of Energy Resources

<http://bizjournalonline.com/?p=1741>



## ➤ World Coal - imports-exports

- Coal - Proved reserves at end 2009 (Thousand million tones) and largest coal
- exporters and importers (2008) and their net trade volumes (million tones)
- Top 10 coal net-exporters and importers, 2008



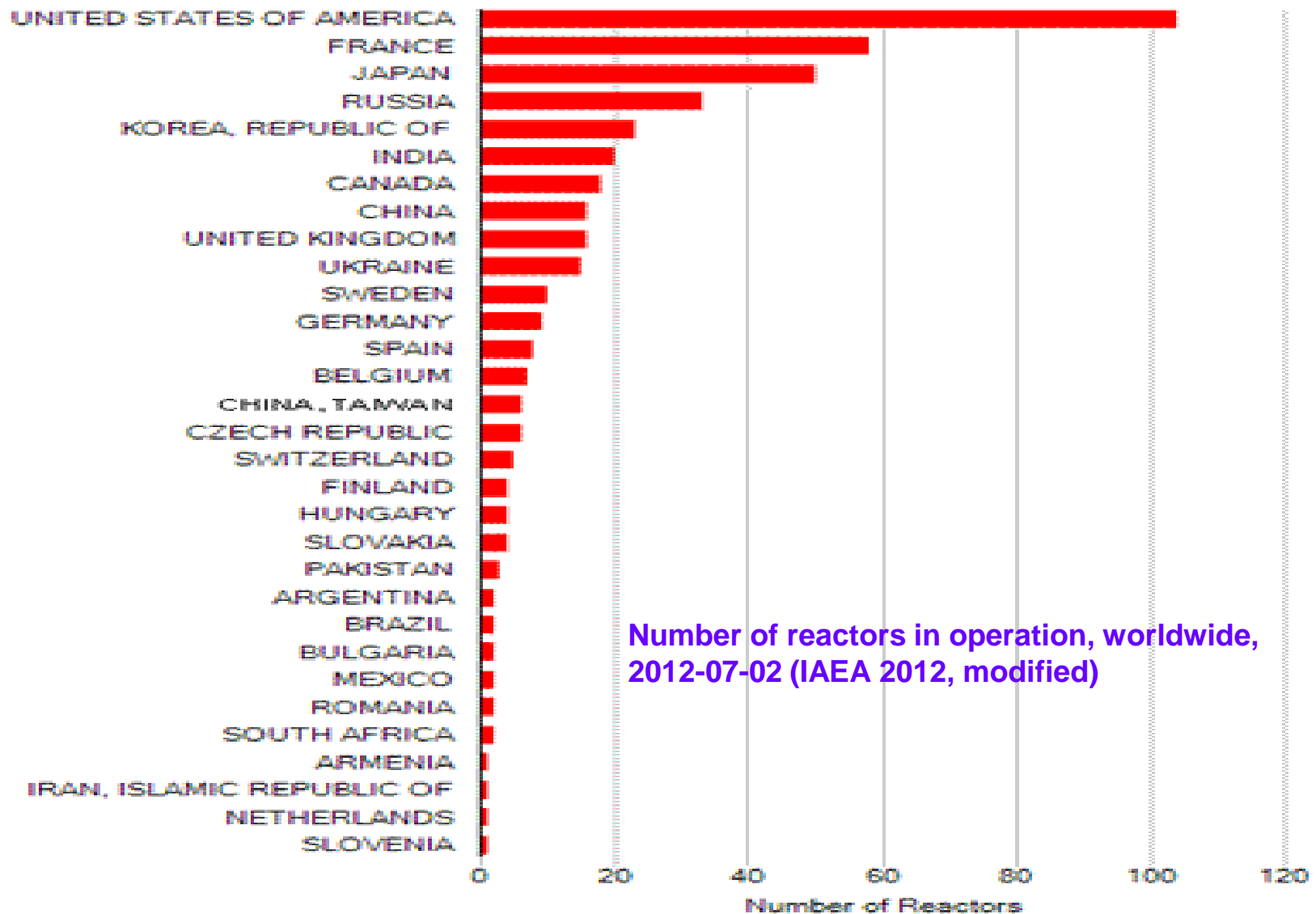
## ➤ World coal consumption for power generation:

Coal used in electricity generation, 2008	
Country	%
South Africa	94
Poland	93
China	81
Australia	76
Israel	71
Kazakhstan	70
Lidia	68
Czech Republic	62
Morocco	57
Greece	55
USA	49
Germany	49



# World nuclear power plant

<http://www.euronuclear.org/info/encyclopedia/n/nuclear-power-plant-world-wide.htm>



# ➤ World- Nuclear Generation

<https://www.e-education.psu.edu/eme444/node/265>

## Top 10 Nuclear Generating Countries 2011, Billion kWh



Source: International Atomic Energy Agency

Updated: 3/12

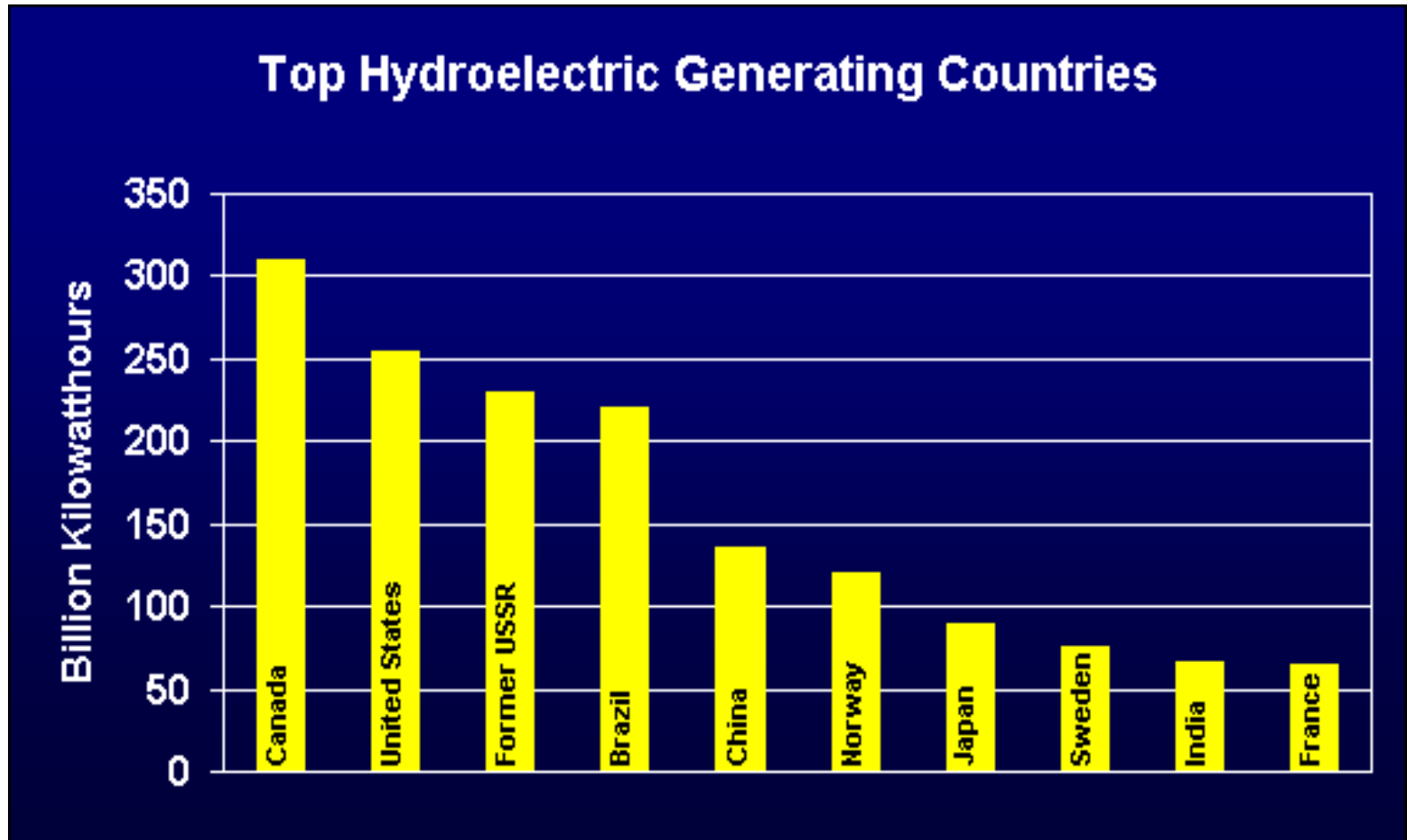
# ➤ Hydropower

<http://www.circleofblue.org/waternews/2010/world/africa/drought-climate-change-jeopardize-and-complicate-hydropower-policies-around-the-world/>

Countries with Hydropower as the Largest Share of National Electricity Generation	
Country	% of Total Generation
Bhutan	100
DR Congo	100
Lesotho	100
Mozambique	100
Paraguay	100
Uganda	100
Ethiopia	99
Nepal	99
Norway	99
Zambia	99
Burundi	98
Albania	98
Tajikistan	98
Laos	97
Malawi	97
Namibia	97
Rwanda	97
Source: Energy Information Administration, 2006	

# ➤ World hydropower electrics

[http://new.wvic.com/index.php?option=com\\_content&task=view&id=7&Itemid=44](http://new.wvic.com/index.php?option=com_content&task=view&id=7&Itemid=44)



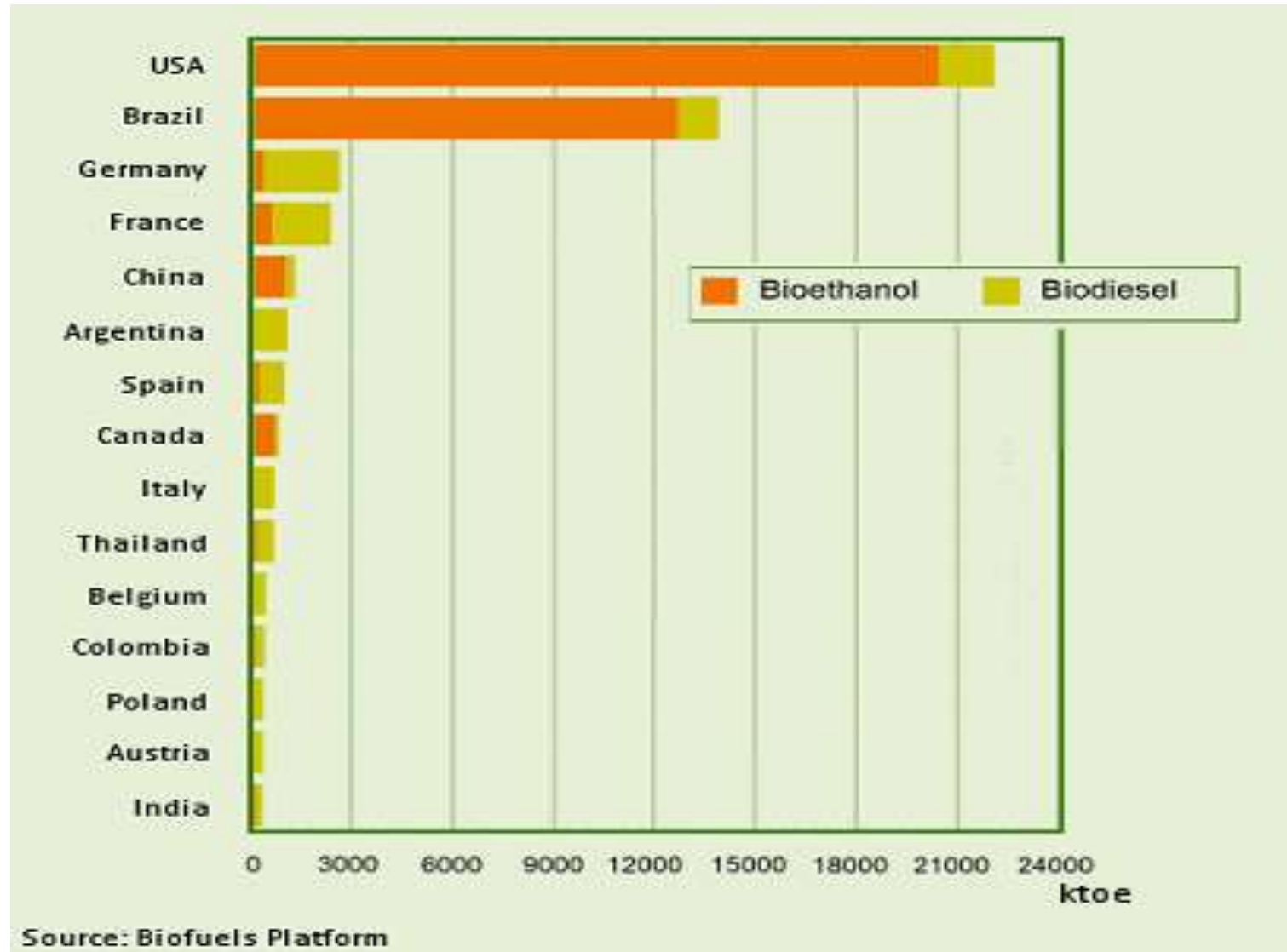
The United States is the second largest producer of hydropower in the world.  
Canada is number one.



# World bio fuels

**Top 15 Countries by Bio fuel Production, 2009 . in kiloton of oil equivalent (ktoe)**

[http://www.chemistryviews.org/details/ezone/1439487/Renewable\\_Energies\\_Wind\\_Solar\\_Biomass.html](http://www.chemistryviews.org/details/ezone/1439487/Renewable_Energies_Wind_Solar_Biomass.html)

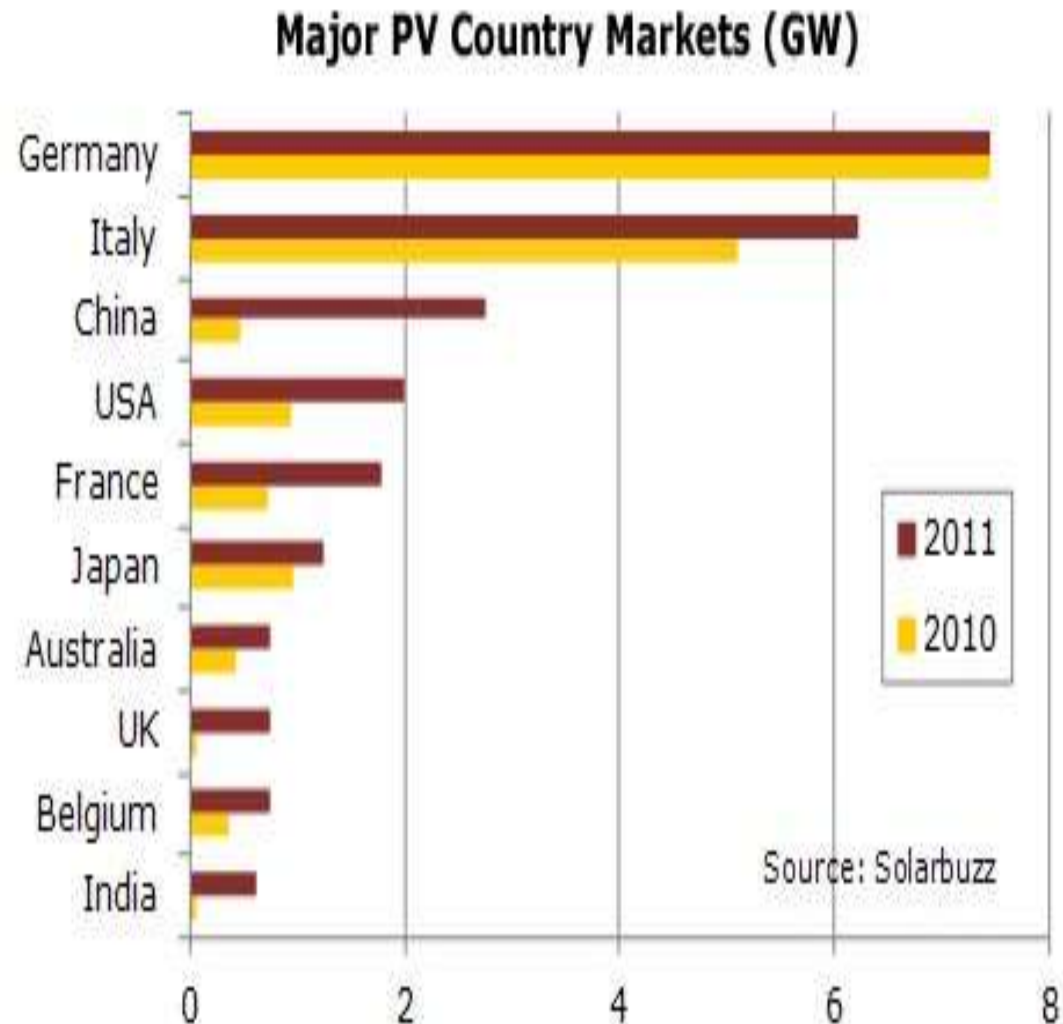




# SOLAR PHOTOVOLTAICS

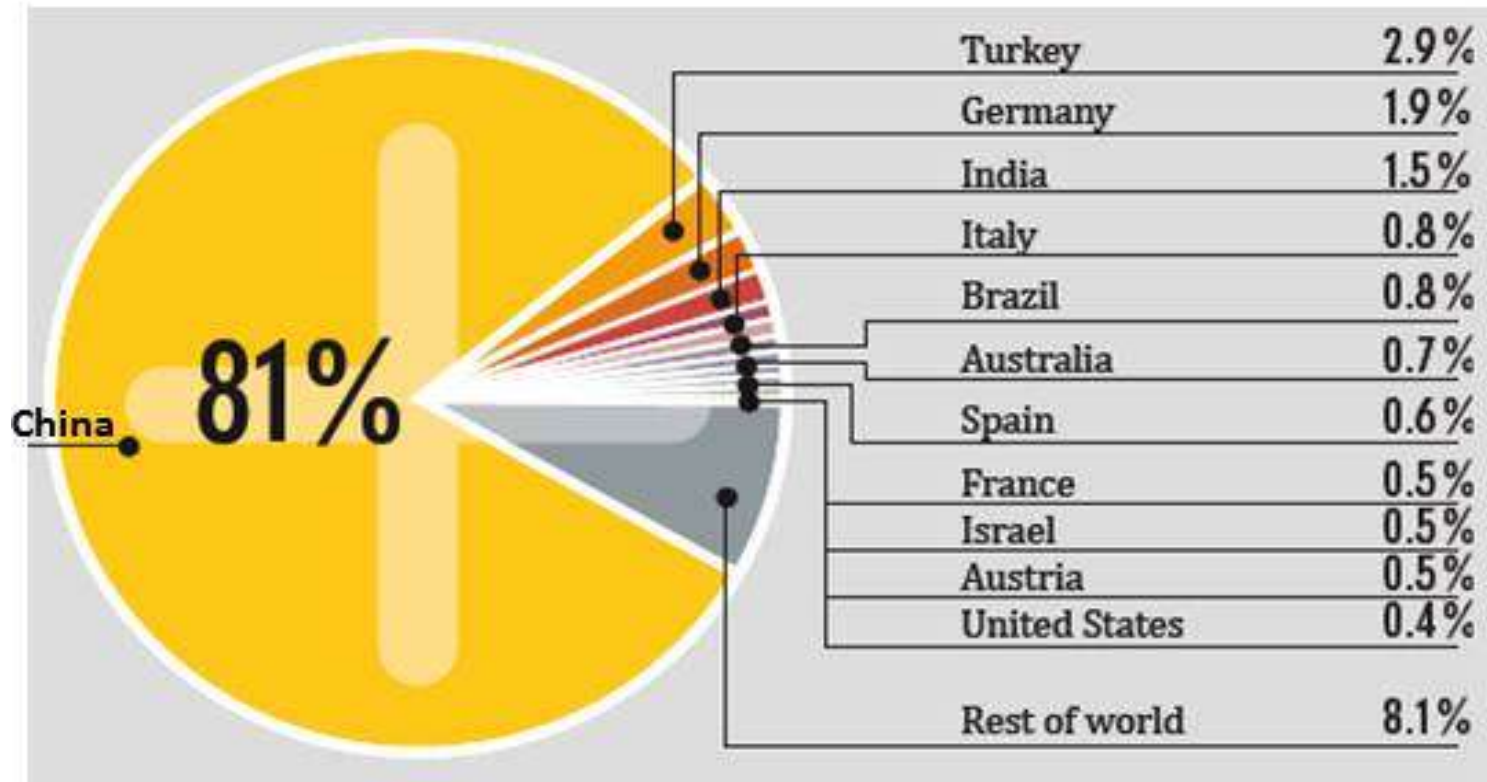
<http://cleantechnica.com/2012/03/19/worldwide-solar-pv-market-grew-in-2011/>

- By the end of 2009, nearly 23,000 megawatts of PV had been installed worldwide.
- Germany installed 3,800 MW of PV in 2009, bringing Germany's overall PV generating capacity to 9,800 MW.
- 10,700 MW PV cells were produced globally in 2009 - 51% increase from 2008.
- China produced 3,800 MW of PV in 2009.



## ➤ SOLAR WATER HEATERS

SOLAR HEATING ADDED CAPACITY, TOP 12 COUNTRIES, 2010



<http://www.eai.in/club/users/aathmika/blogs/551>

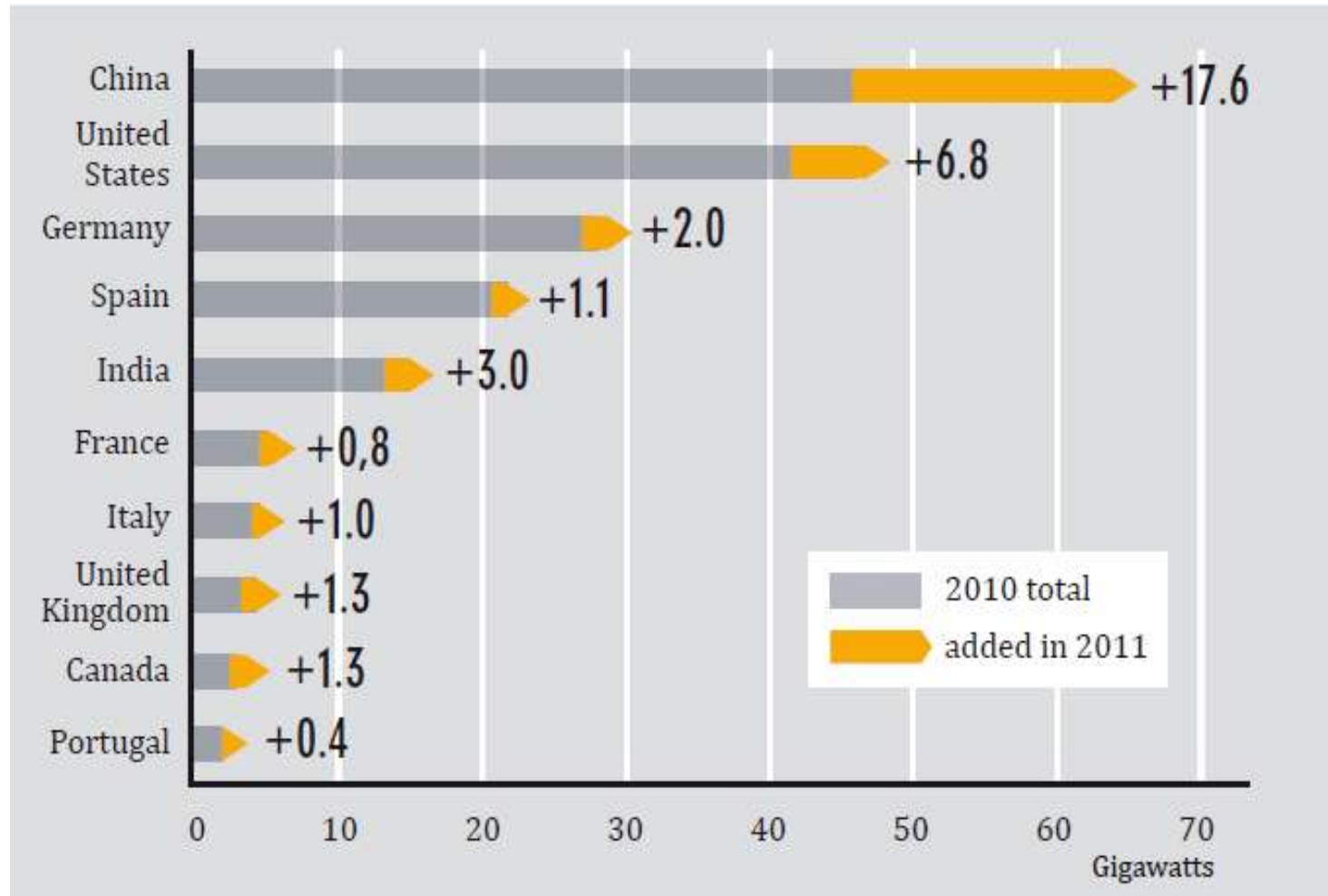
(from the REN21 2012 report)



# WIND POWER – TOP 10 IN 2012

<http://www.cleanenergyworldnews.com/wind-energy-2/>

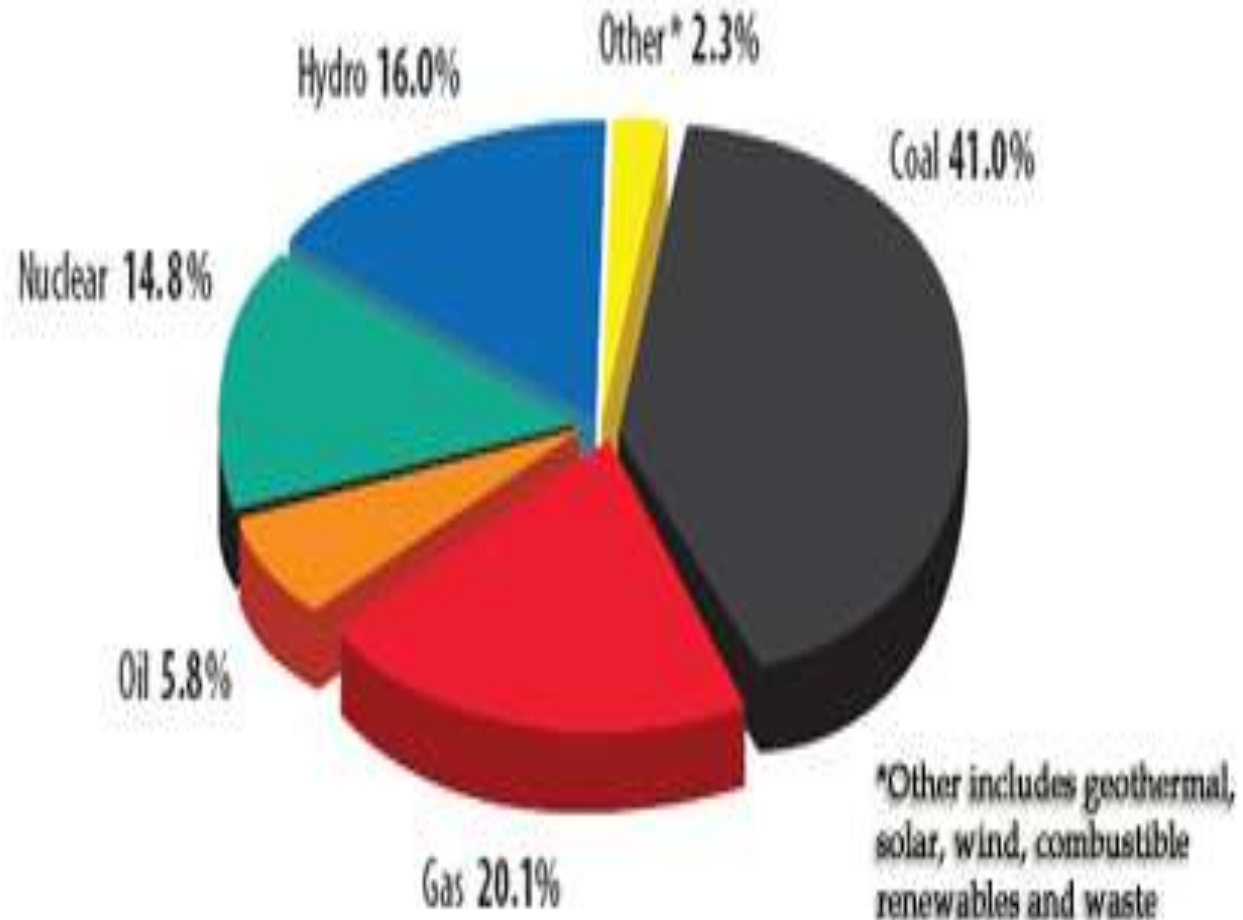
## Worldwide Wind Power Capacity at the Beginning of 2012



# ➤ Global Electricity Generation

[http://www.cna.ca/how\\_works/electricity\\_generation/](http://www.cna.ca/how_works/electricity_generation/)

Global demand for electricity will continue to rise, especially in those large developing countries such as China, India and Brazil with rapidly-growing economies.



Source: OECD/IEA Key World Energy Statistics (2008)

## 1.3 FUTURE ENERGY SCENARIOS

- IEO 2010 Reference case, IEA Reference Scenario– 2008.
- IEA New Policies Scenario –2010, IEA 450 Scenario– 2010.
- WEC Energy Policy Scenario for 2050.

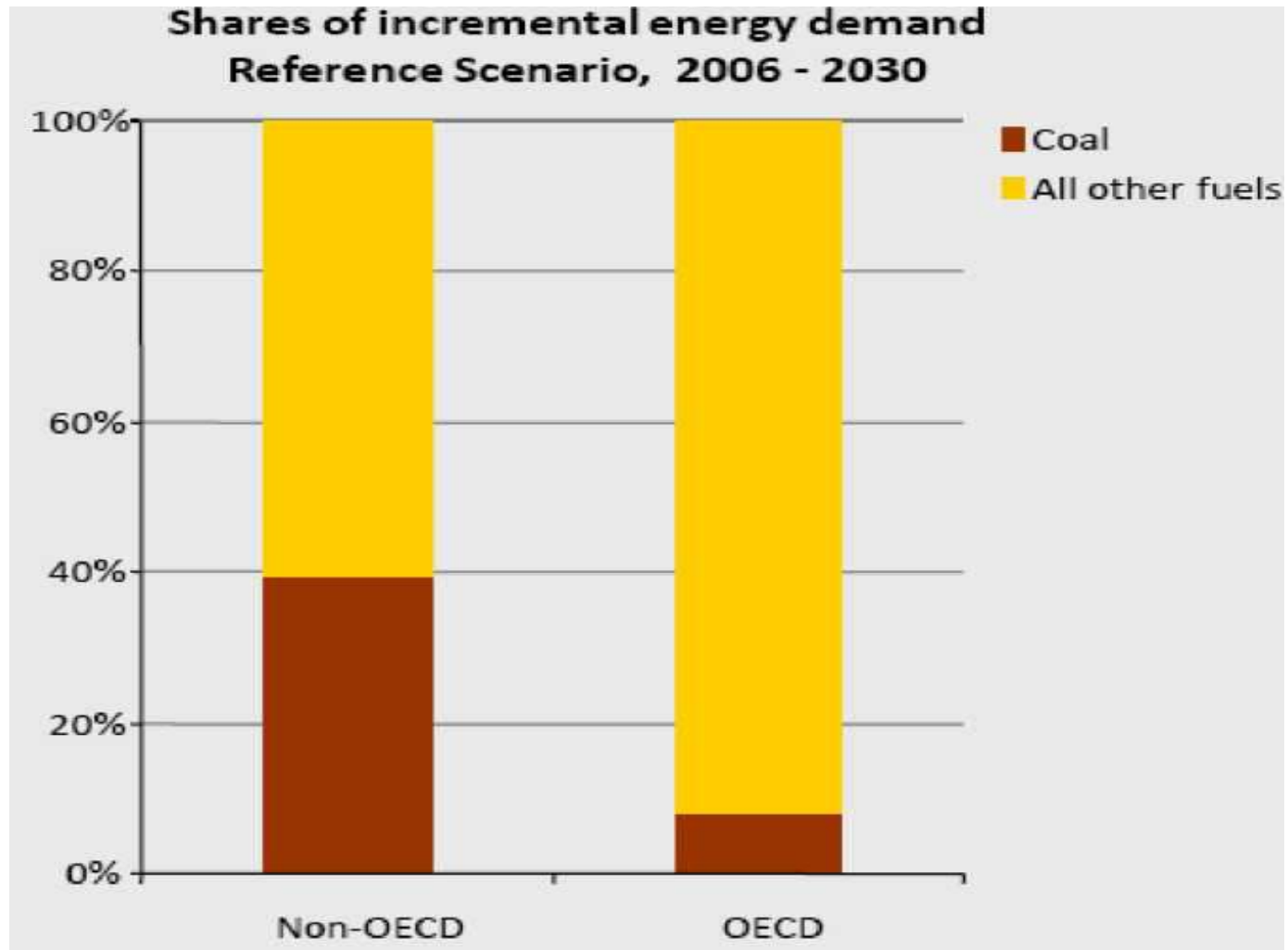
IEO, International Energy Outlook, ແນວໂນ້ມໃນອານາຄົດ

IEA, International Energy Agency, ສຳນັກງານ

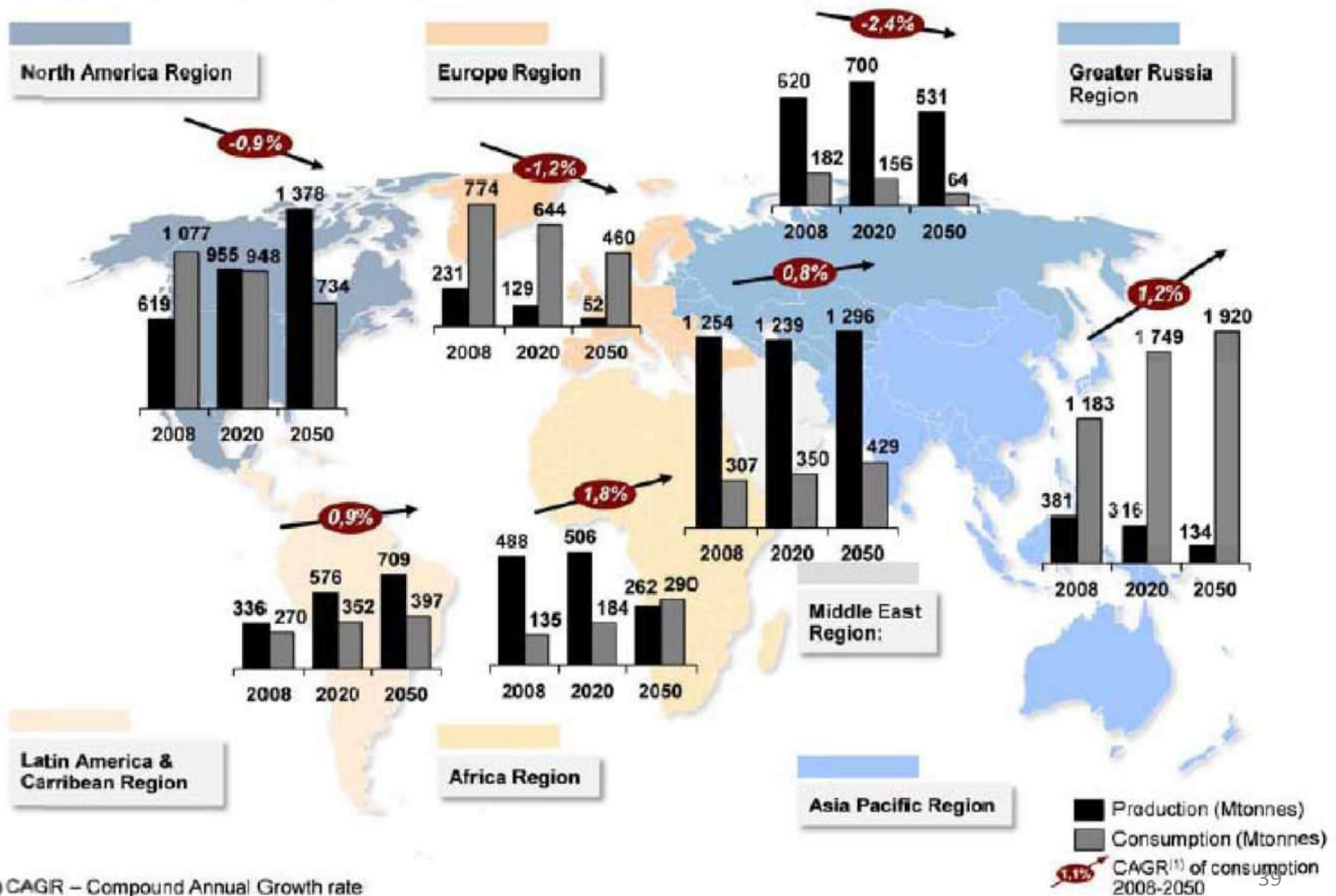
WEC, World Energy Council, ສະພາ

OECD: Organisation for Economic Co-operation and Development.

# ➤ IEO 2010 REFERENCE CASE-COAL DEMAND BY REGION (2007-2030):

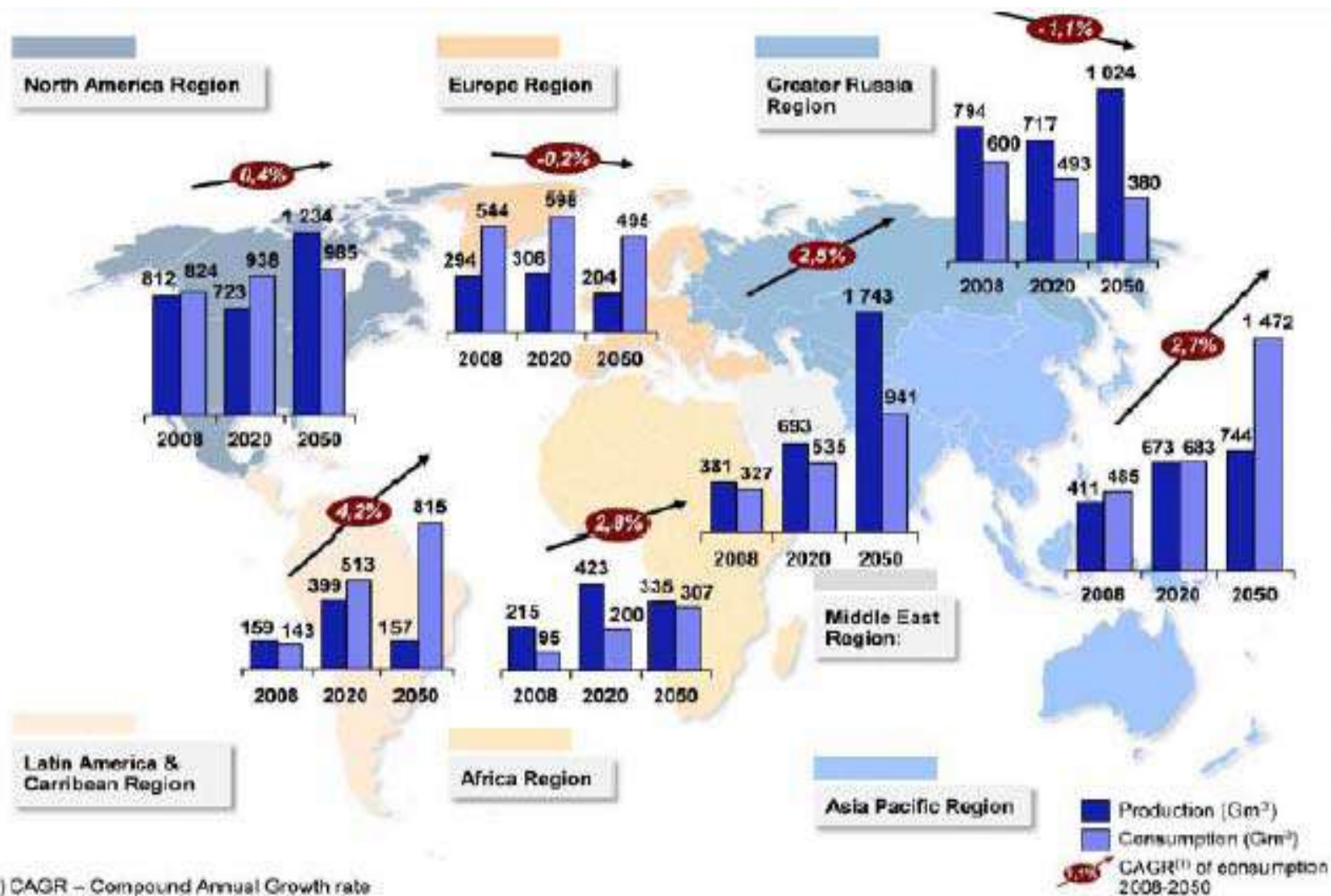


# ➤ **WEC POLICY SCENARIO (2050) - OIL DEMAND BY REGION:** **CAGR-Compound Annual Growth rate.** Source: WEC, 2010c



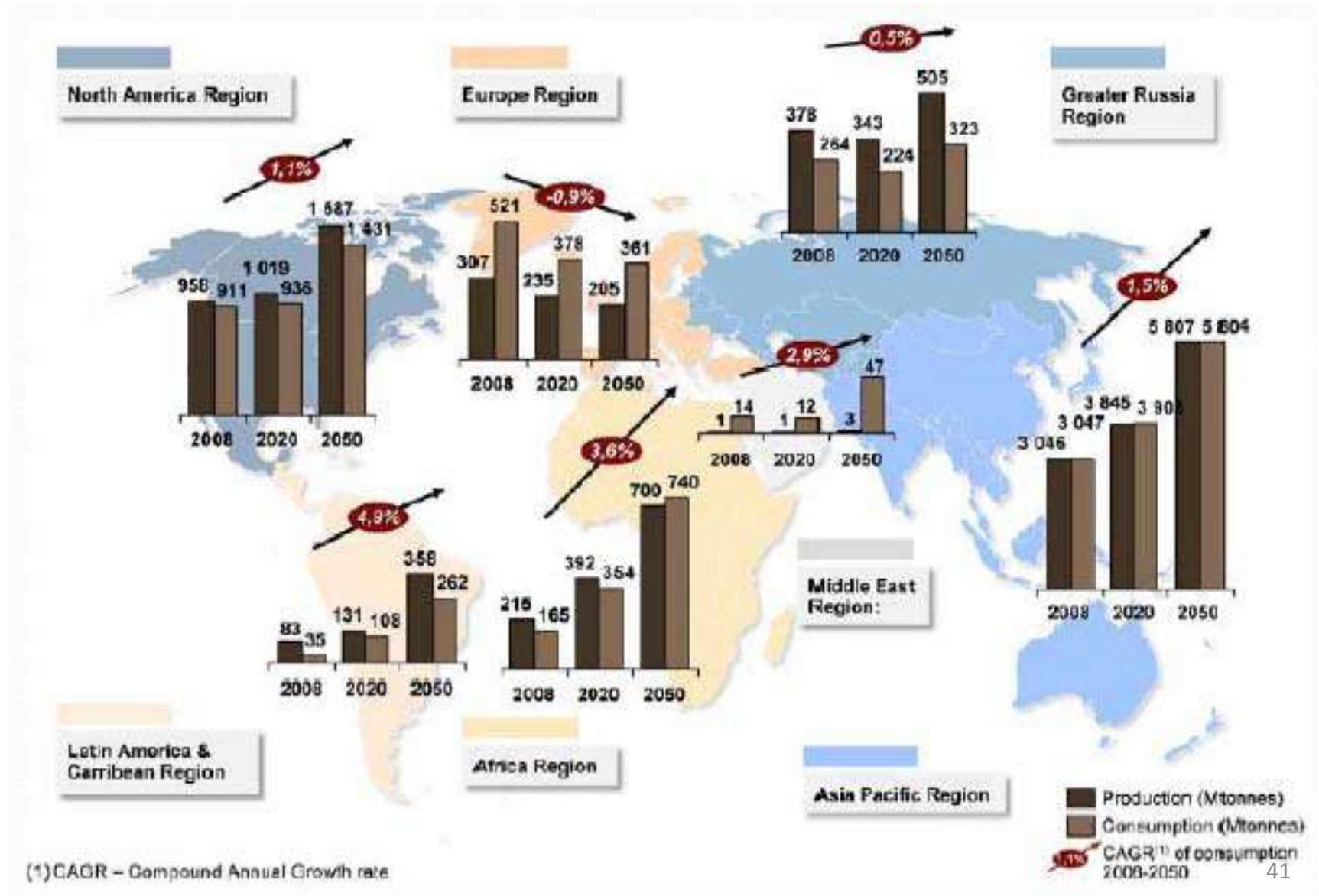


➤ **WEC POLICY SCENARIO (2050) - NATURAL GAS DEMAND BY REGION:**  
**CAGR-Compound Annual Growth rate.**      **Source: WEC, 2010c**





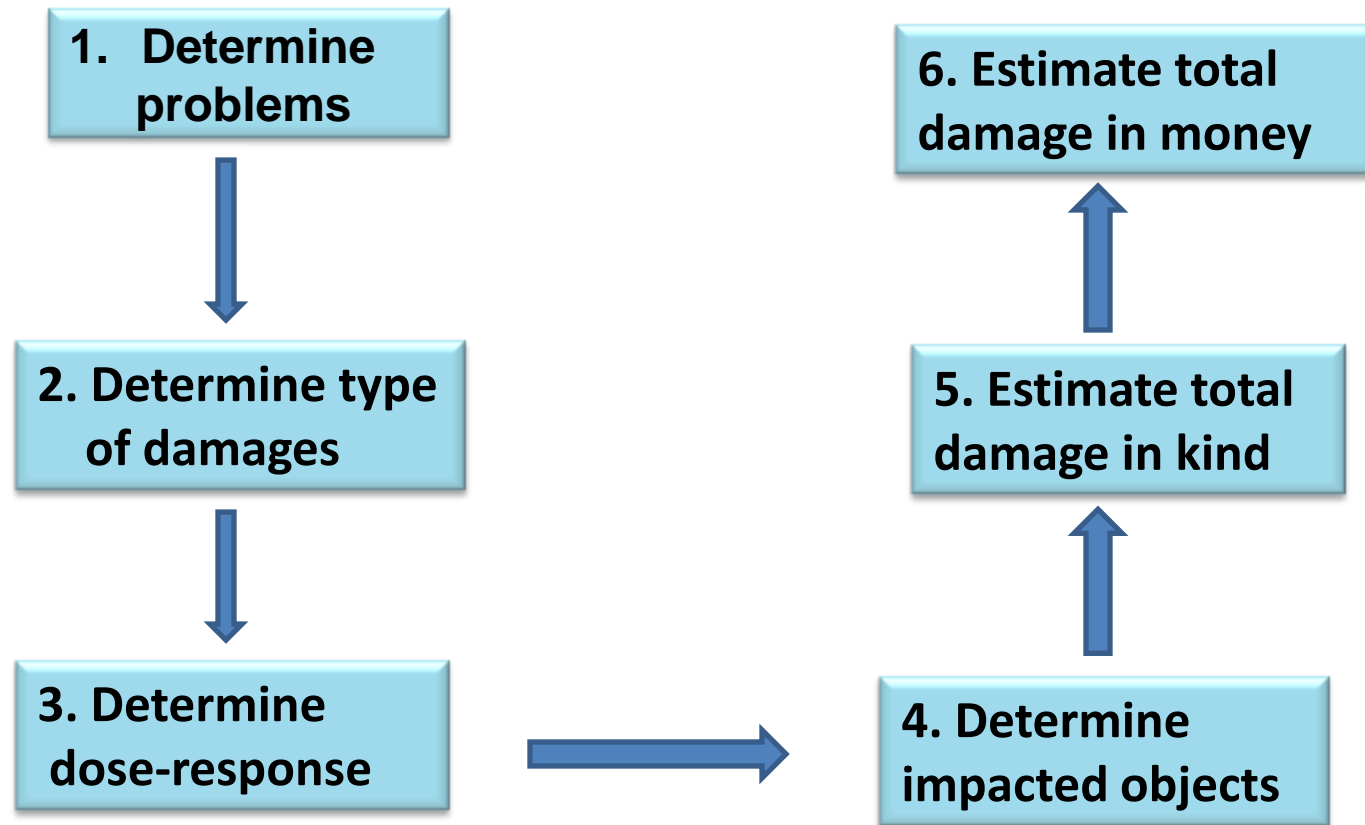
➤ **WEC POLICY SCENARIO (2050) – COAL DEMAND BY REGION:**  
**CAGR-Compound Annual Growth rate.** Source: WEC, 2010c



## **II. Environmental cost and social cost.**

## 2. Social and Environmental cost.

### ➤ Environmental cost evaluation process



## 2.1 Environmental cost

- Direct cost to prevent or reduce environmental pollution or indirect cost of using natural resources or damaging ecosystems.
- In some cases, the environmental treatment cost can be taken back through recycle, reuse (wastewater,...), reducing medical treatment, healthcare cost, etc .
- Environmental costs are costs connected with the actual or potential deterioration of natural assets due to economic activities.
- Such costs can be viewed from two different perspectives, namely as **(a) costs caused**, that is, costs associated with economic units actually or potentially causing environmental deterioration by their own activities or as **(b) costs borne**, that is, costs incurred by economic units independently of whether they have actually caused the environmental impacts.

## 2.2 Cost - benefit analysis

- **Cost-benefit analysis Microscale:**

Agricultural structure, Feasibility of services, Attitude, Capacity, Monetary system.

**Community – Macroscale: Law, Policy, Regulation, Orientation.**

**Mediumscale: Support Finance and Service.**

**Microscale: Provide finance and Service.**

- **Cost-benefit analysis Medium scale:**

investment, Monetary management, Payment system, Management support.

**Community – Macroscale: Law, Policy, Regulation, Orientation.**

**Mediumscale: Support Finance and Service.**

**Microscale: Provide finance and Service.**

- **Cost-benefit analysis Macroscale:**

Regulation and policy, Government supply, National monetary policy.

**Community - Macroscale: Law, Policy, Regulation, Orientation.**

**Mediumscale: Support Finance and Service.**

**Microscale: Provide finance and Service.**

## 2.3. Cost and benefit analysis of Environmental for Development.

❑ Environmental and social cost and energy

➤ Social cost evaluation criteria

Kind of impact	Criteria	Goals
emigration	1. Number of emigrants. 2. % ethnic minority.	Proper resettlement, social equity .
Cultural and social impacts	1. Impact culture and religion 2. Lose of important cultural monument 3. Impact cultural organizations 4. Change the mean to access the outside world . 5. Lack of community participation in planning. 6. Increase social crime, evils .	Properly compensate .

## Social cost evaluation criteria (cont)

Kind of impact	Criteria	Goals
Impact on job	Change the mean to access the natural Resources Lose agricultural Soil.	Properly compensate.
	Productivity reduction .	Properly compensate .
	Job opportunity.	Create jobs and support small enterprises .
	Limit the area for resettlement and cultivation .	Area for resettlement .

# Social cost evaluation criteria (cont)

Kind of impact	Criteria	Goals
Loss of biodiversity.	A large area with high biodiversity is influenced.	Biodiversity program .
	Reservation zone is influenced .	Follow regulations of reservation zones .
	Rivers, water – base.	Reduce .
	Loss of wetlands.	Reduce .
	Impact cold - water ecosystems.	Reduce .
Loss (reduction) of access to natural resources.	Impact immigrant birds .	Design electric line, wind turbines properly .
	Lost of forest .	Re-Planting Program.
	Fish catching.	Property compensate.
	Increase in soil erosion.	
	Influence landscape .	



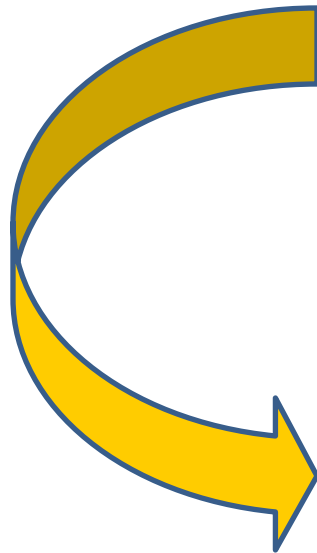
## 2.4 Difficulties in determining social-environmental cost.

- Social-environmental cost is not included into market price.
- Some social-environmental cost causes by the community, and not be accounted.
- Some cost is very difficult to evaluate.
- Lack of data on social-environmental cost related to emission in Laos.
- There are a lot of undetermined factors during the evaluation process.
- A comprehensive study on health impact cost should be carried out in order to find out the appropriate policies for energy sector and other sectors as well.

# **III. Ethics and behavioral change issues.**

# Why needs to change behavior?

- Environmental pollution.
- Natural resource depletion.
- Global climate change and its impacts.
- Etc.



**For what ?**

**Sustainable development.**

# **3. Social and Environmental cost in Energy Project**

## **Energy production and use status:**

- Awareness.
- Natural resource degradation.
- Ineffective use of equipment and energy.
- Inappropriate planning.
- Strongly depend on non-renewable energy.
- Not yet pay much attention on renewable energy.

## **Why needs to change behavior in the energy?**

- Improve productivity by reducing waste and improving effectiveness.
- Improve economic benefits.
- Waste prevent instead of waste treatment.
- Seek for environmental standards.
- Improve health and living condition.
- Improve living standard.

## **Example: Laos energy sector**

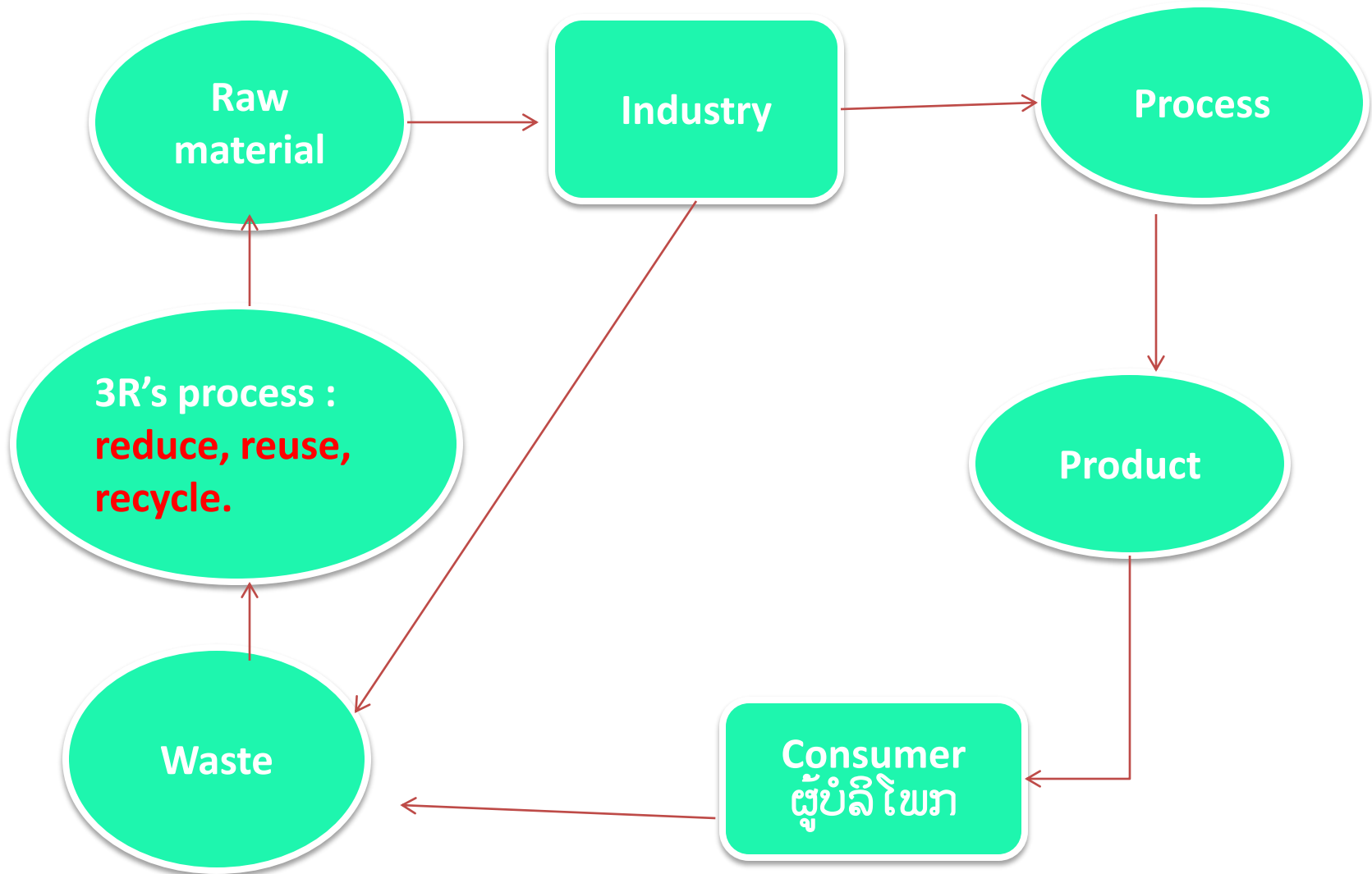
- **More difficulties in operation of water reservoirs .**
- **Increase in electricity demand due to global temperature raising.**
- **Reducing emission requires new, high tech and huge investment cost.**
- **Electricity transmission systems are overloaded.**
- **Increase in demand of new energy sources.**

## **Green economy/green productivity**

- **Production, distribution, consumption and service activities.**
- **Above activities improve living standard but generate environmental problems .**
- **Green investment/green productivity: waste management, green techs, recycle, etc.**

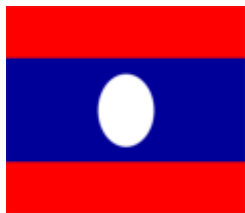
## 3.1 Specific Issues .

Green economic model:



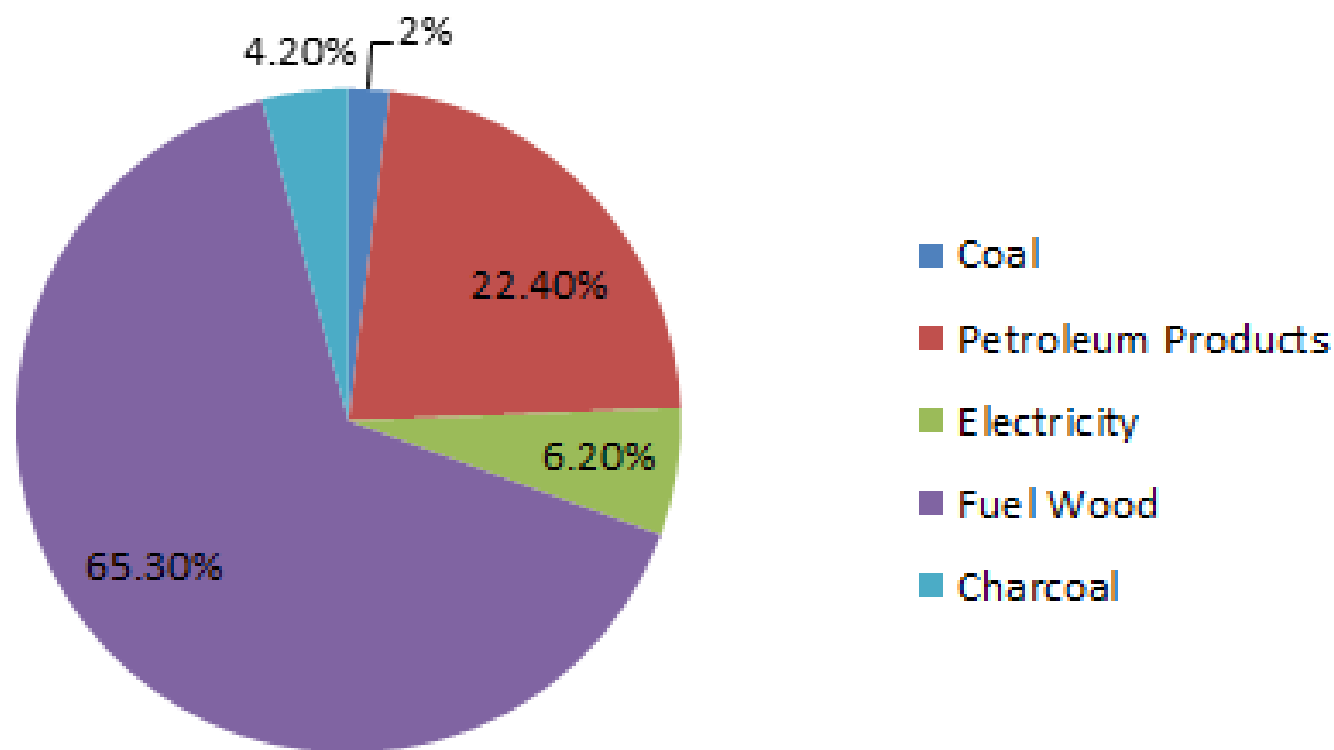
➤ **Behavioral change: using energy- saving products**  
**saving light bulb** (*reduce 80% energy*)





## 3.2 Case study in Laos

Laos Final Energy Consumption 2006

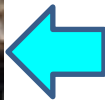
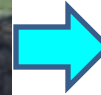
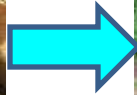


Source: Laos Ministry of Energy and Mines & ADB Bank



## ➤ Laos - Charcoal

**Wood, Burning wood become Charcoal, Charcoal Bag, Charcoal stove, Fishes on the charcoal stove.**





## Laos – Coal

<http://www.thailandfriends.com/showthread.php/45653-Hongsa-Lao-Thailand-invested-lignite-Coal-Plant-amp-Mine>

### Hongsa, Lao-Thailand-invested lignite Coal Plant & Mine

- Banpu still has a joint venture with Ratchaburi in the \$3.7-billion Hongsa lignite thermal coal power project in Laos.
- The 1,800-megawatt power plant, in which Banpu and Ratchaburi hold 40% each and the Laotian government 20%, is scheduled to be operational in 2015.

# ➤ Laos - Jatropha – Biodiesel

## Process chain of the study

[http://www.lao-ire.org/data/documents/data\\_research/general/LIRE-Using\\_Jatropha\\_Curcas\\_for\\_Generating\\_Energy.pdf](http://www.lao-ire.org/data/documents/data_research/general/LIRE-Using_Jatropha_Curcas_for_Generating_Energy.pdf)



Jatropha Seeds from  
Laos, India and  
Vietnam

Seed crushing

Cold-and Hot pressing

Refining and Transesterfication

Crude Oil

Raffinate



Laos / Vietnam / India / CS



Laos / Vietnam / India / CS



The energetic use of Jatropha - A study of the properties during processing

18.10.2010  
23

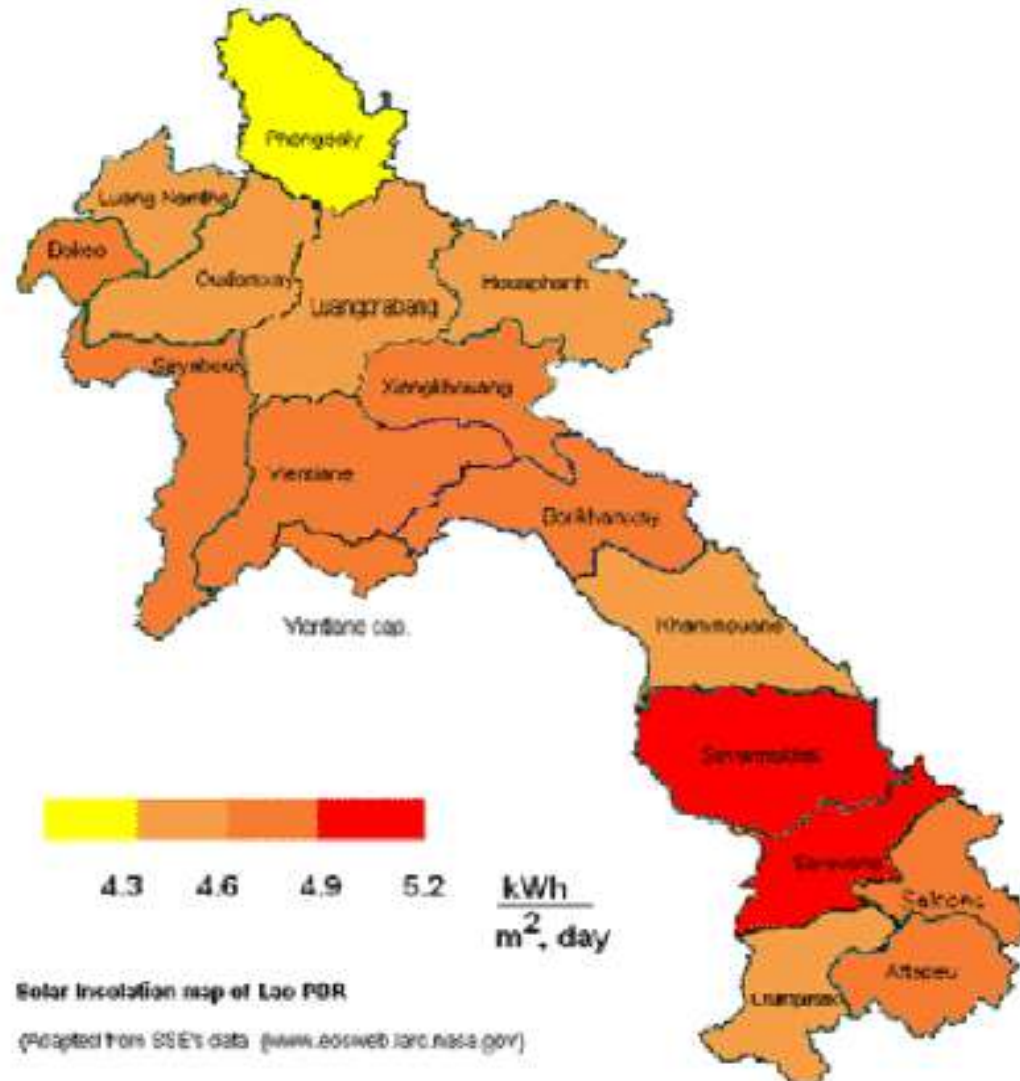


Chemical analysis and Comparison to  
DIN standard



# ➤ Laos - solar intensity

[Source: Adapted from SSE data ([www.eosweb.larc.nasa.gov](http://www.eosweb.larc.nasa.gov))]



# ➤ Case Study at National University of Laos: Solar Energy

## ■ Greenhouse solar dryer

Crop capacity: 80-100 Kg

Temperature: 40-70 °C

Time: 9:00-17:00

Takes time: 3-4 days



## ■ Solar tunnel dryer

Crop capacity: 20-50 Kg

Temperature: 40-70 °C

Time: 9:00-17:00

Takes time: 3-4 days



## ■ Solar oven

Material: Steel box, Mirror, glass

Temperature: 50-100 °C

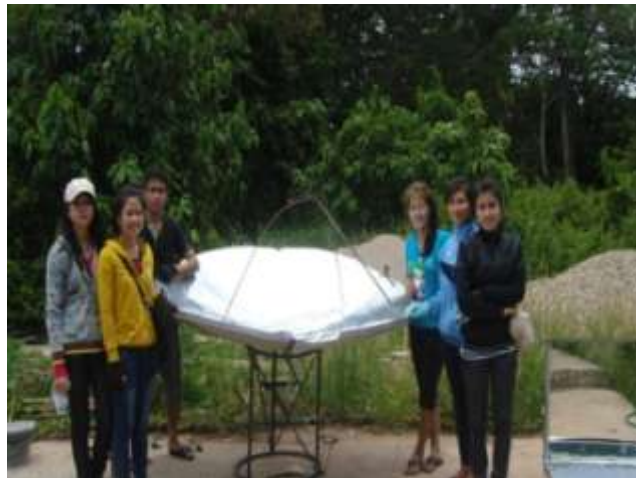


## ■ Solar cooker

Material: Aluminium foil adjoins dish

Focal Volume: 70 cm

Temperature: 60-120 °C





# ➤ Laos - Biogas

**Dung: Cows, ducks, chickens and pigs – biogas.**



**Fermentation  
tank**

**Biogas**

## ➤ Laos- Existing Dam: 10

Project (Province)	Installed Capacity (MW)	Project Sponsors (Country)	Purpose
Houay Ho (Champasak & Attapeu)	150	Suez Energy (Bengium) 60%, EdL(Laos)20%,HHTC(Thailand)20%	Export to Thailand
Num Leuk (Vientiane)	60	EdL(Laos)	Domestic/ Export to Thailand
Num Lik 1-2 (Vientiane)	100	China International water and Electric Corporation (china)90%,EdL 10%	Domestic
Num Mang 3 (Vientiane)	40	EdL (Laos)	Domestic/ Export to Thailand
Num Mong (Luang prabang)	70	Japanese funding, EdL(Laos)	Domestic
Num Ngum1 (Vientiane)	155	EdL (Laos)	Domestic/ Export to Thailand



<b>Num Theun 2 (Khammouane &amp; Bolikhamxay)</b>	<b>1070</b>	<b>Nam Theun 2 Power company (NTPC),Comprising:Electricite Du France-ED F (France)40%; Electricity Generating Company- EGCO(Thailand) 35%; Lao Holding State Enterprise- LHSE(Laos)25%</b>	<b>Domestic/ Export to Thailand</b>
Theun-Hinboun (Bolikhamxay)	210	Theun-Hinboun Power Company(NHPC) Comprising:EdL(Laos)60%; Nordic Group [Owned by Statkraft] (Norway)20%; & MDX[GMS Power](Thailand)20%	Domestic/ Export to Thailand
Xeset 1 (Salavanh)	45	Edl (Laos)	Domestic/ Export to Thailand
Xeset 2 (Salavanh)	76	Edl (Laos)	Domestic/ Export to Thailand

➤ **Laos- nuclear power plant.**

**Laos have many hydroelectric  
Power, so no needs build nuclear  
power plant.**

# Conclusion

## **Current energy status, resources and future energy scenarios.**

Energy resources are generally defined as anything that can be used as a source of energy. Some important energy resources are oil, natural gas and coal, Important to development world economics.

Currently, Natural resource are reducing, needs use renewable energy such as solar energy, bio fuel, wind.

In the future, developing countries will use coal more than other fuel, but developed countries will use other fuel more than coal.

**In Laos:** Main energy is hydroelectric power, Many people use main fuels for cooking such as wood fuel, charcoal, coal, electric. From here Laos needs use and development on sustainable renewable energy

## **Impact to social and environmental in the energy sector**

### **Necessary cost to pay:**

- Reduce Environmental pollution.

- Damaging ecosystems.

- Medical treatment, healthcare.

- Deterioration of natural due to economic activities.

- Proper resettlement, social equity.

- Agriculture soil for cultivation.

- Appropriate other cost.

# **Behavioral change in the Energy consumption transform toward the future.**

Want to reduce Environmental pollution.

Don't want natural resource depletion.

Don't want global climate change and its impacts.

Need use 3R's process : reduce, reuse, recycle.



**Thank you for  
Your kind attention**