Low-carbon development

References:

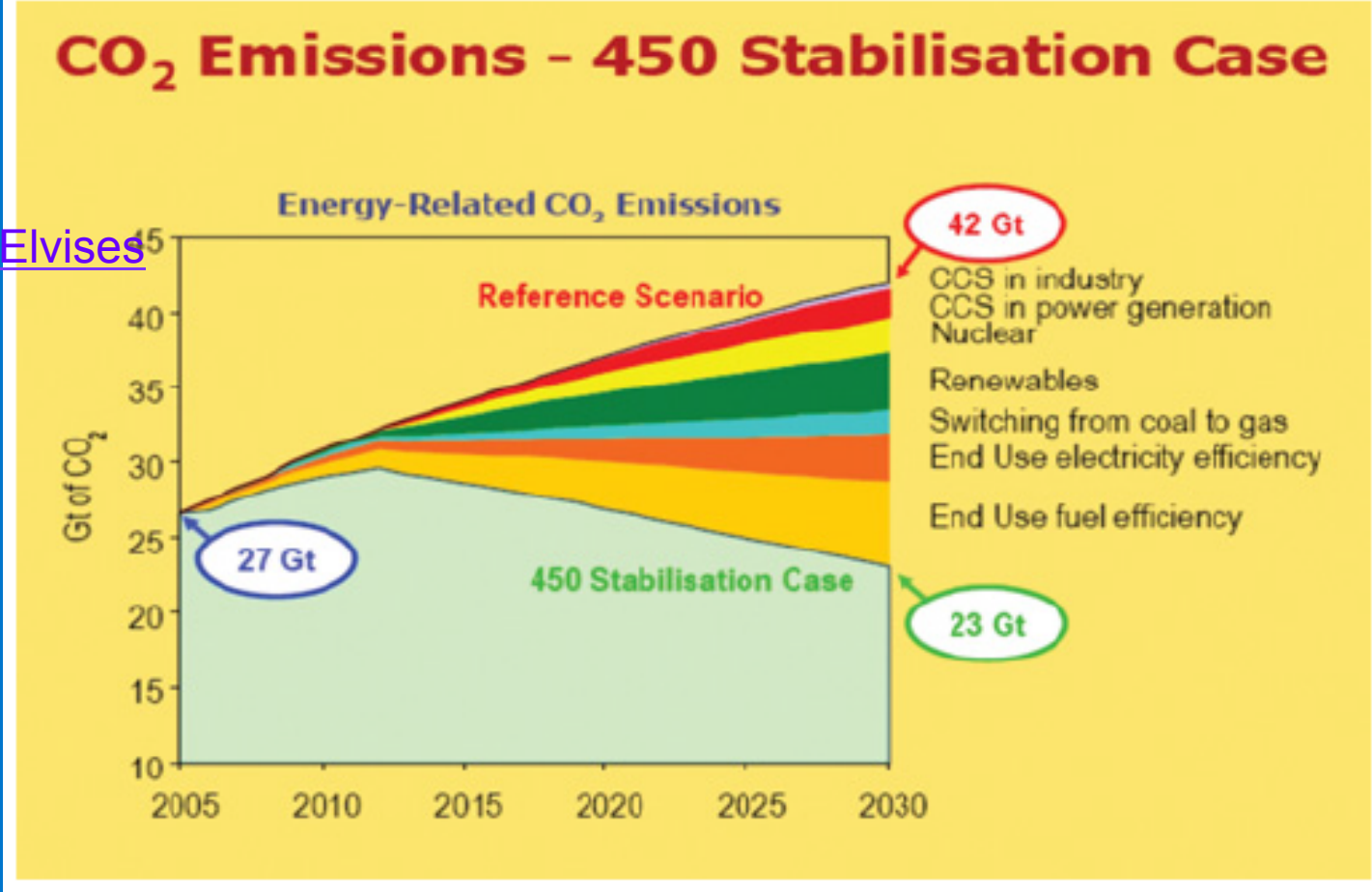
- IEA's data
- Gricevich I.G. Prospects and scenarios of low-carbon development: EU, China and USA in the global context. M.: Speed of colour, 2011.
- Fedorov U.N., Safonov G.V., Bagirov A.T. Low-carbon economy of Russia: tendency, problems of opportunity, M., 2009.
- Economy of climate change. Report review by Nicolas Stern/ Kokorin A. O., Kuraev S.N., Yulkin M. A. WWF, Strategic Programme Fund (SPF). – M.: WWF Russia, 2009.

Low-carbon development

- *Low-carbon development is a version of* sustainable development conception aimed at prevention of catastrophic consequences of global climate change in this century
- Not more than +2^{o} C
- To reduce global emissions of CO_2 by 2050 by 50% in comparison with 1990
- To stabilize the concentration of CO_2 on the level 450 ppm

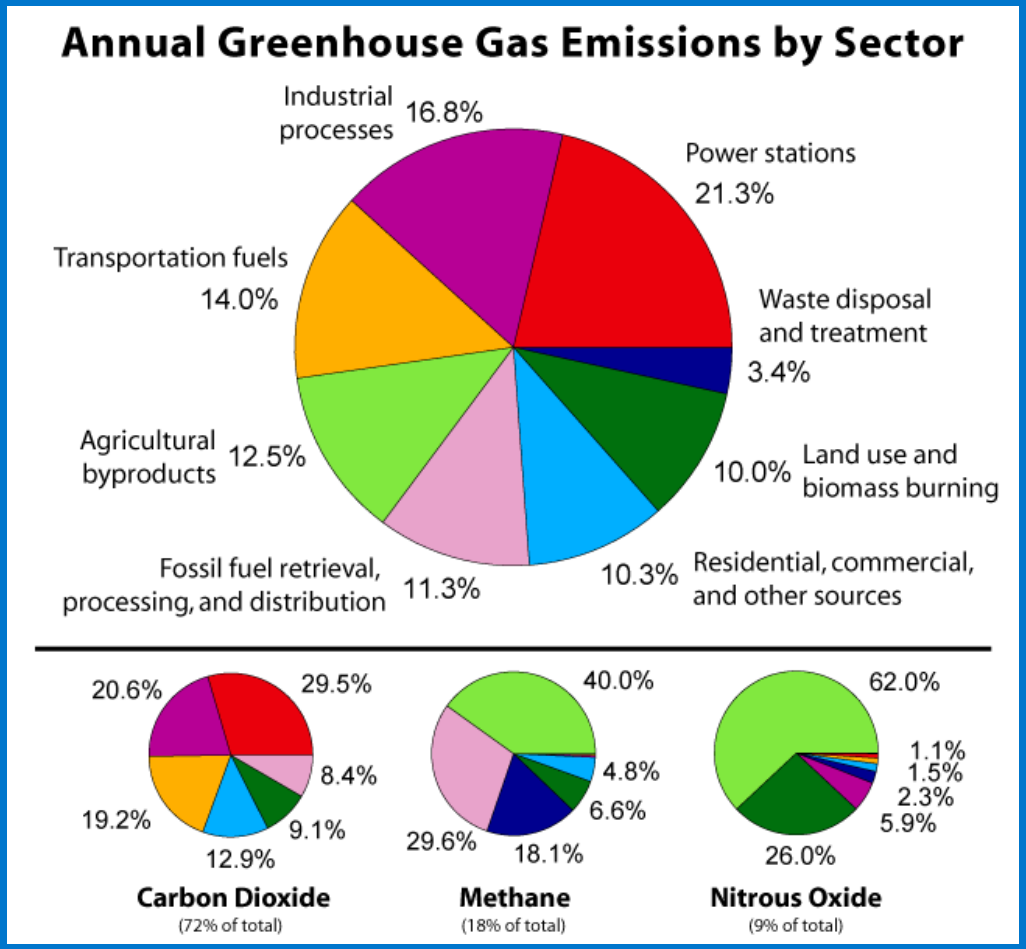
Opportunities of greenhouse gas emissions reduction in global scale for stabilization of carbon dioxide concentration on the level 450 ppm

The Red Elvises



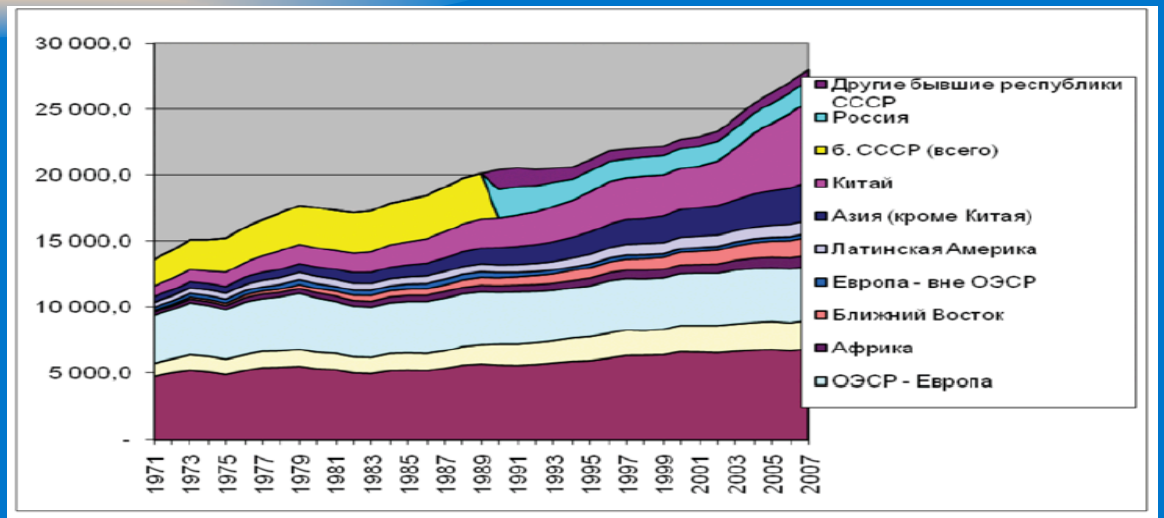
Source: data of IEA

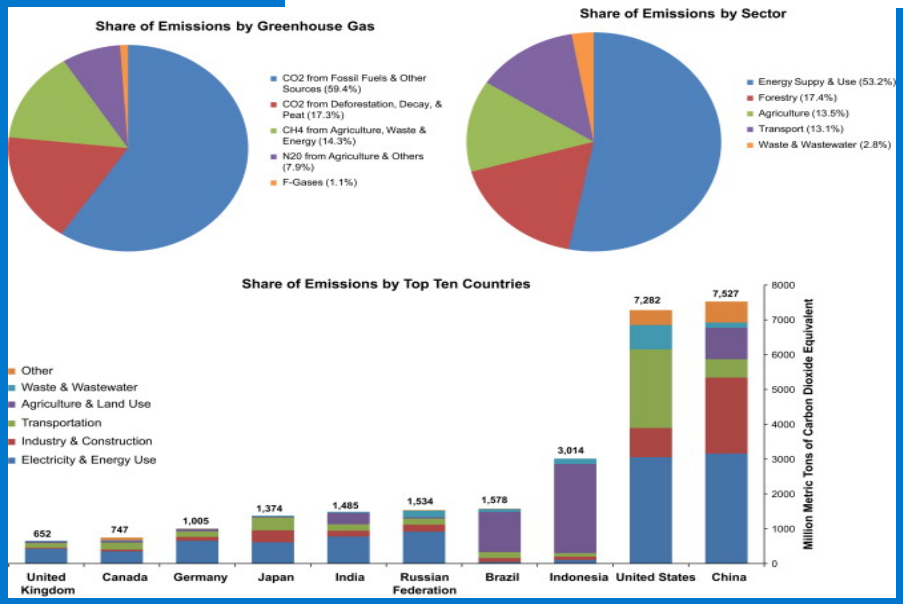
Greenhouse gas emission by sectors



Source: IEA

Dynamics of greenhouse gases emission from fossil fuel burning in regions and countries in the world, CO2-eq.

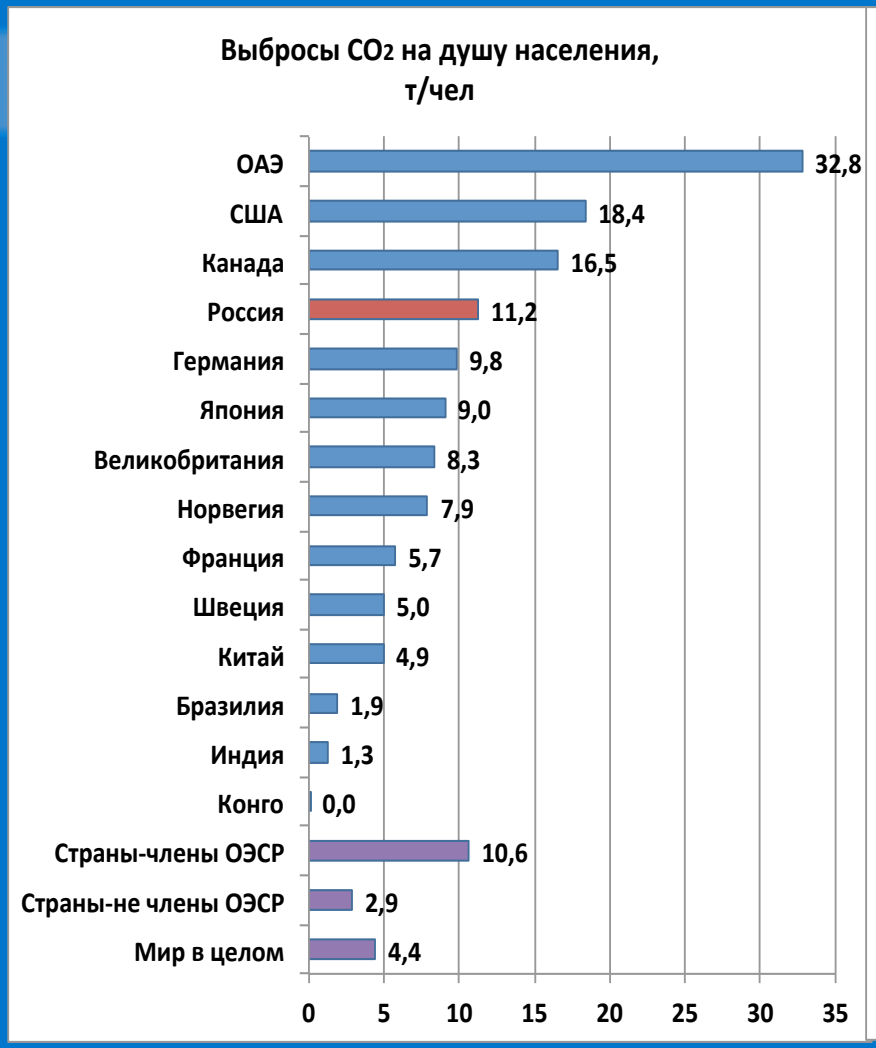




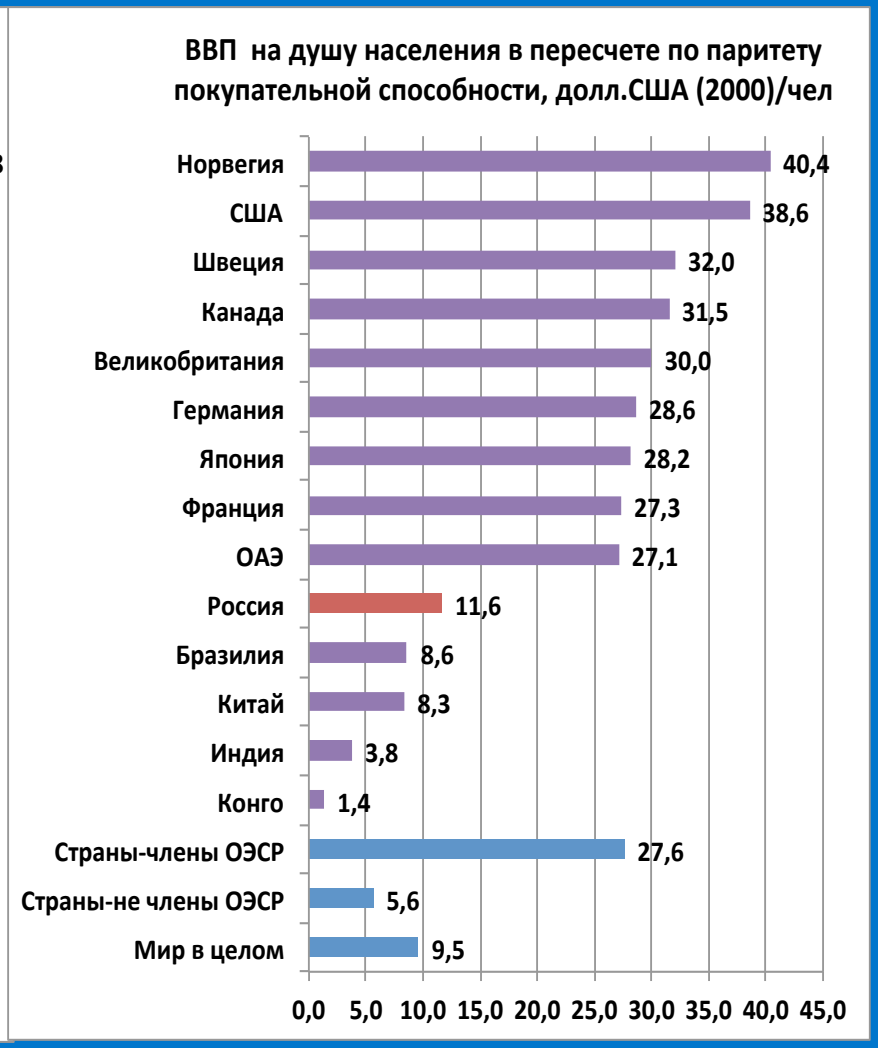
1. China (24%)
2. USA (21%)
3. EU-15 (12%)

Source: IEA, 2010

Emissions of CO_2 per head, tons/man



GDP per head, $/man



Constructed by data of IEA, 2010

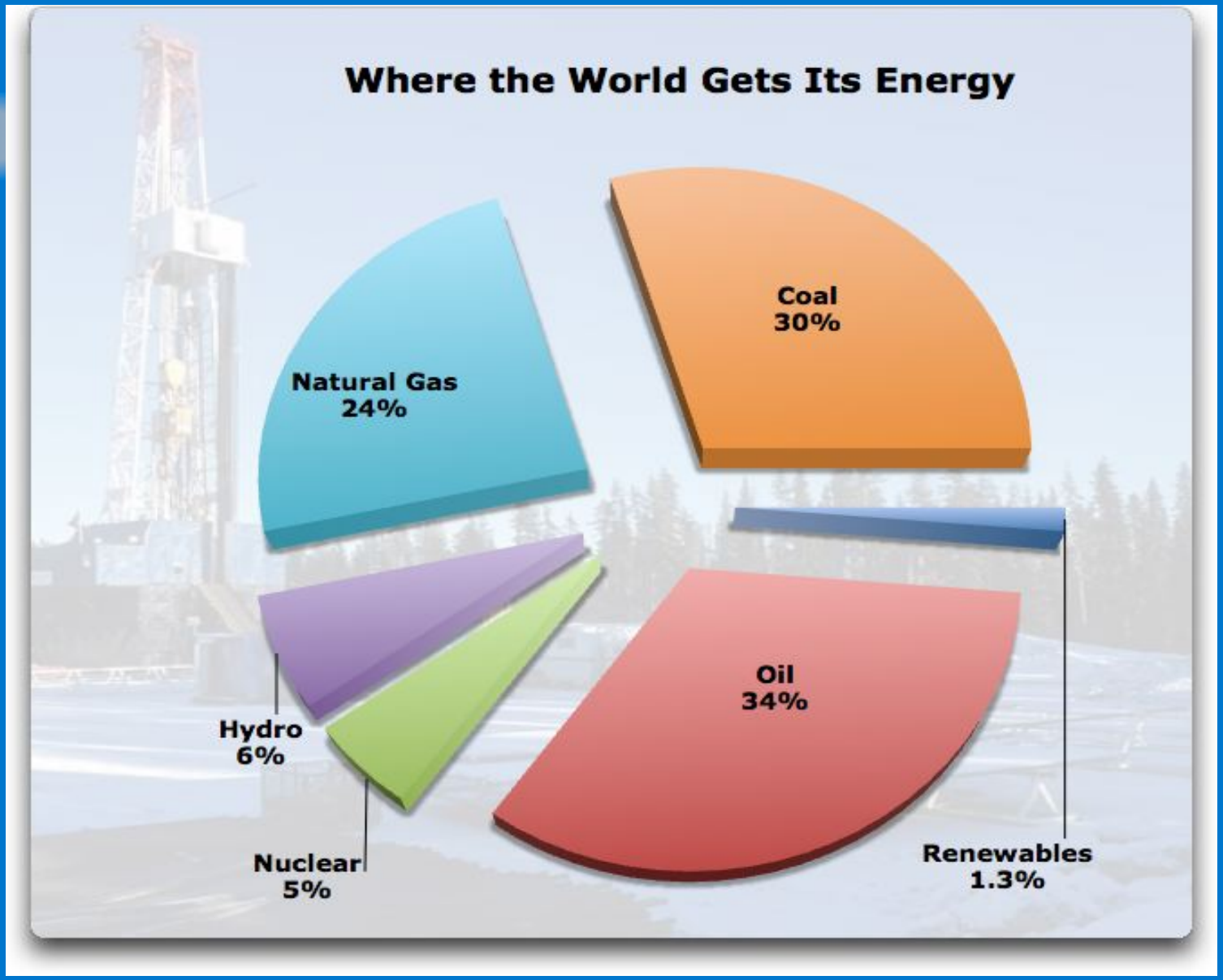
What does electricity consumption mean?

Average daily energy consumption per head:

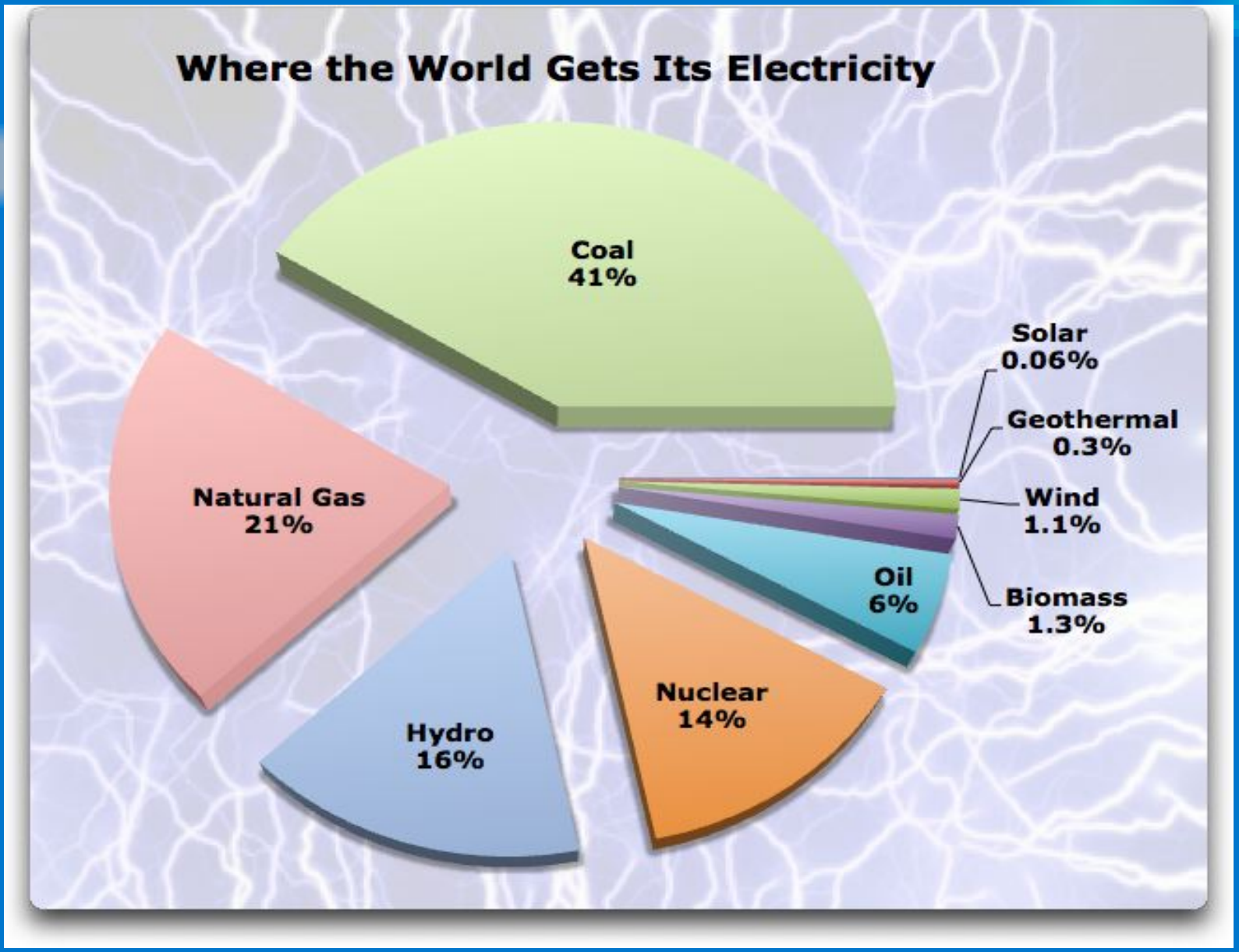
- Primitive communities - 2000 kkal,
- Hunters and gatherers – 5000 kkal,
- Early agricultural – 12000 kkal,
- Advanced agricultural – 20000 kkal,
- Early industrial – 60000 kkal,
- Modern industrial – 125000 kkal,
- Modern industrial (USA) – 230000 kkal.

Life expectancy dynamics

Age period on the Earth (century, epoch)	Life expectancy, years
Copper, bronze, ferrous	30
By the early XIX century	35-40
By the end of XX century	60-63

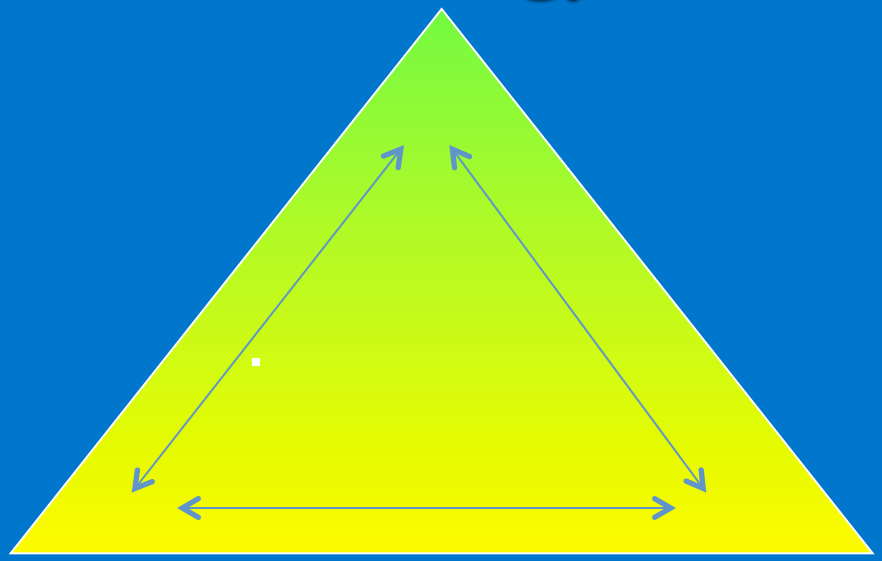


Data from the BP Statistical Review



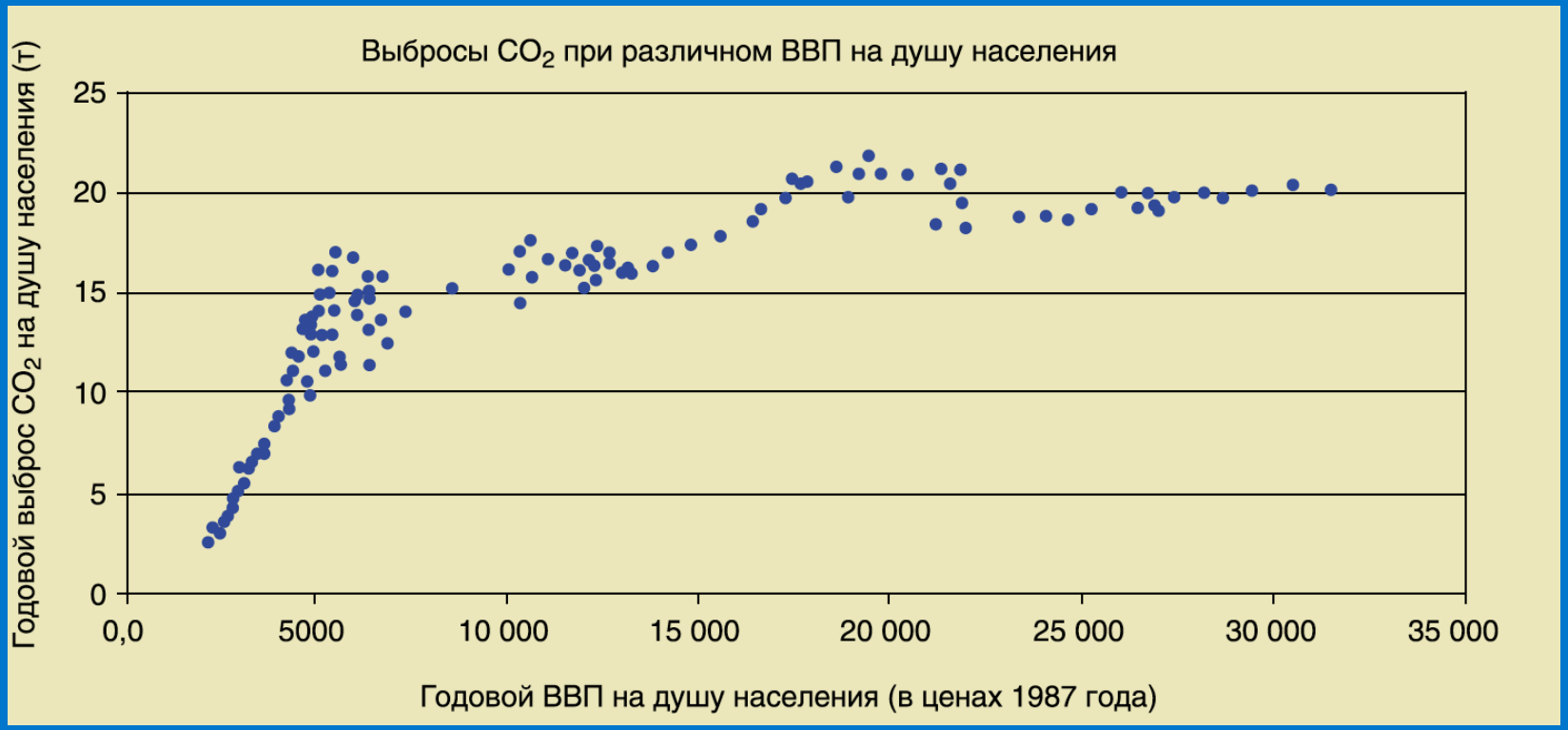
Data from National Geographic

Energy consumption – environmental problems – life quality

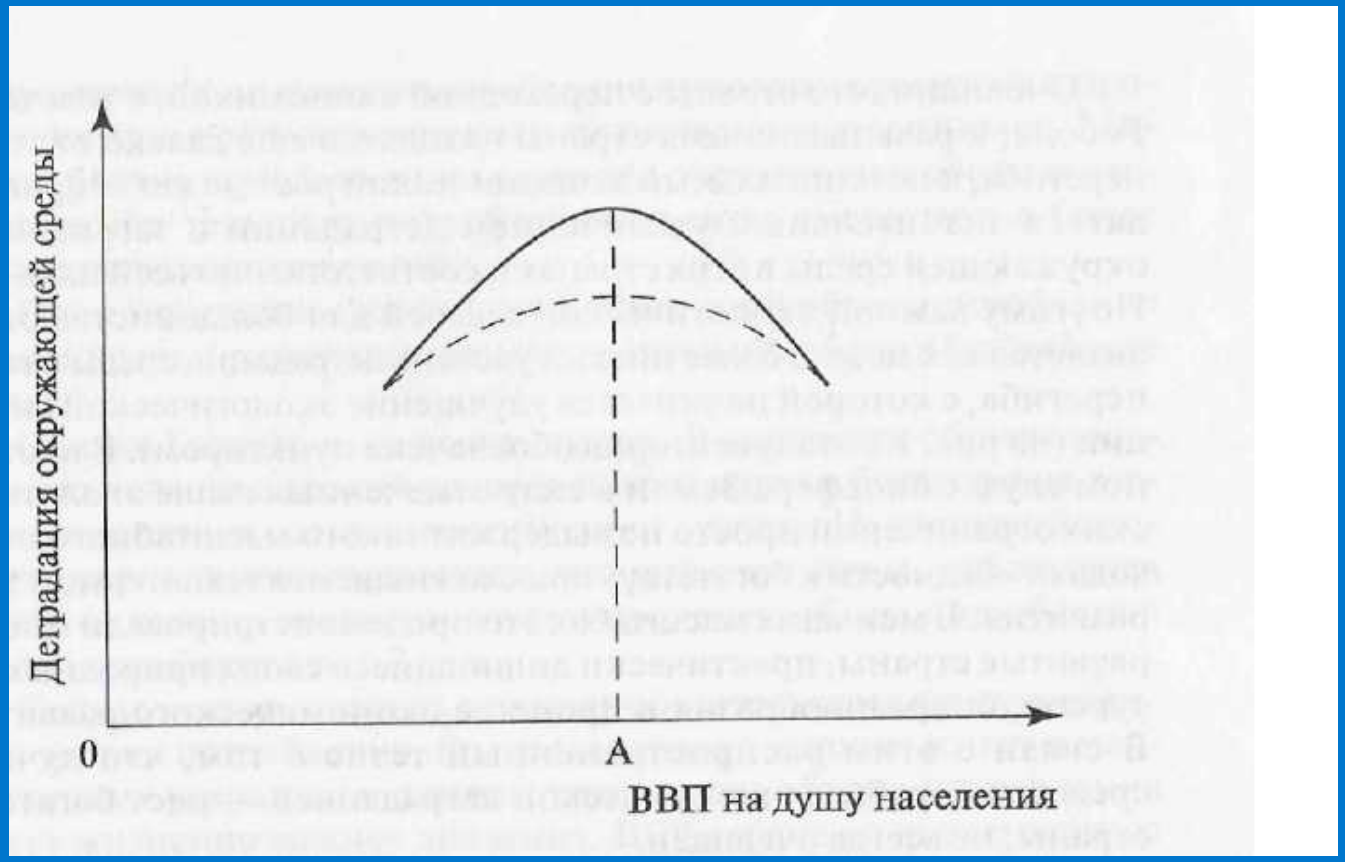


Ecology, energy consumption, life quality – interconnected factors

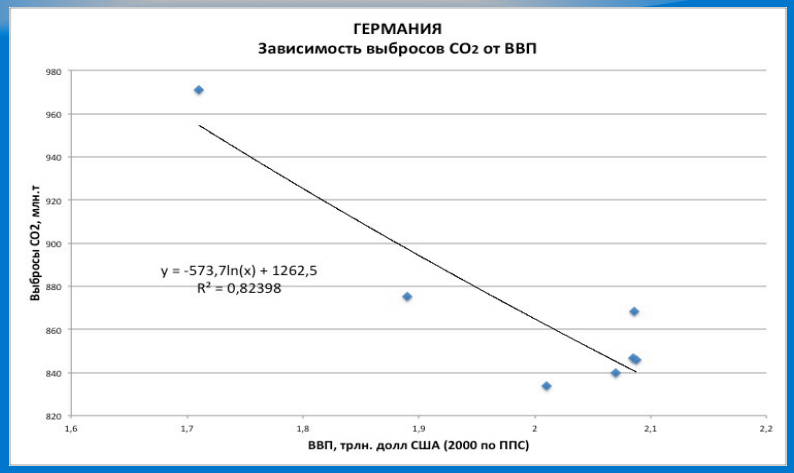
Dependence CO_2 on social standard of living (the case of USA)

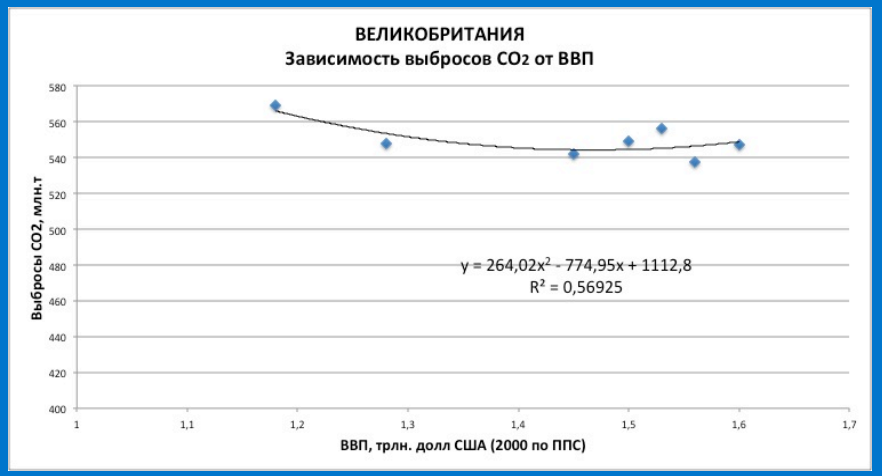


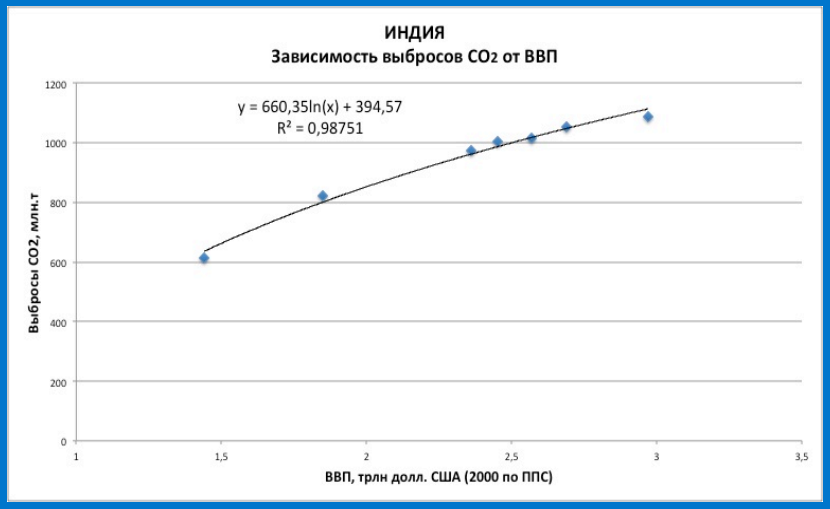
Ecological graph of Kuznetca

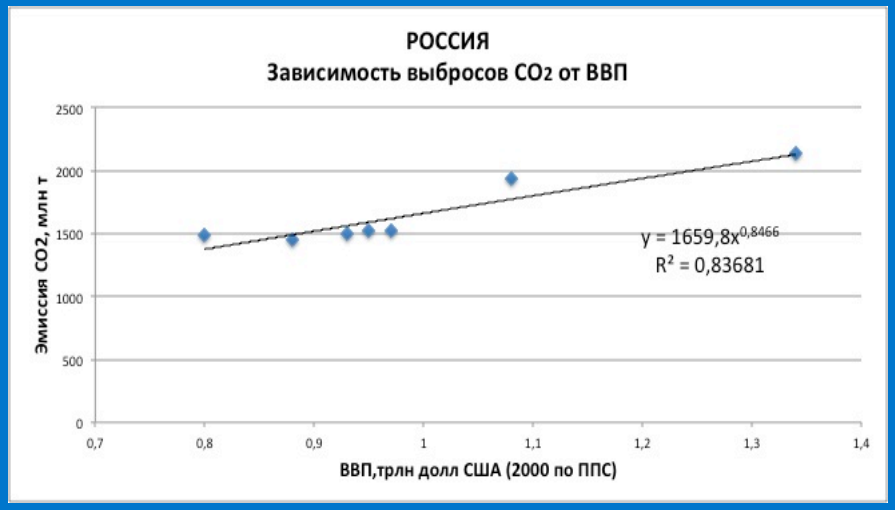


Dependences of CO_2 emission on GDP

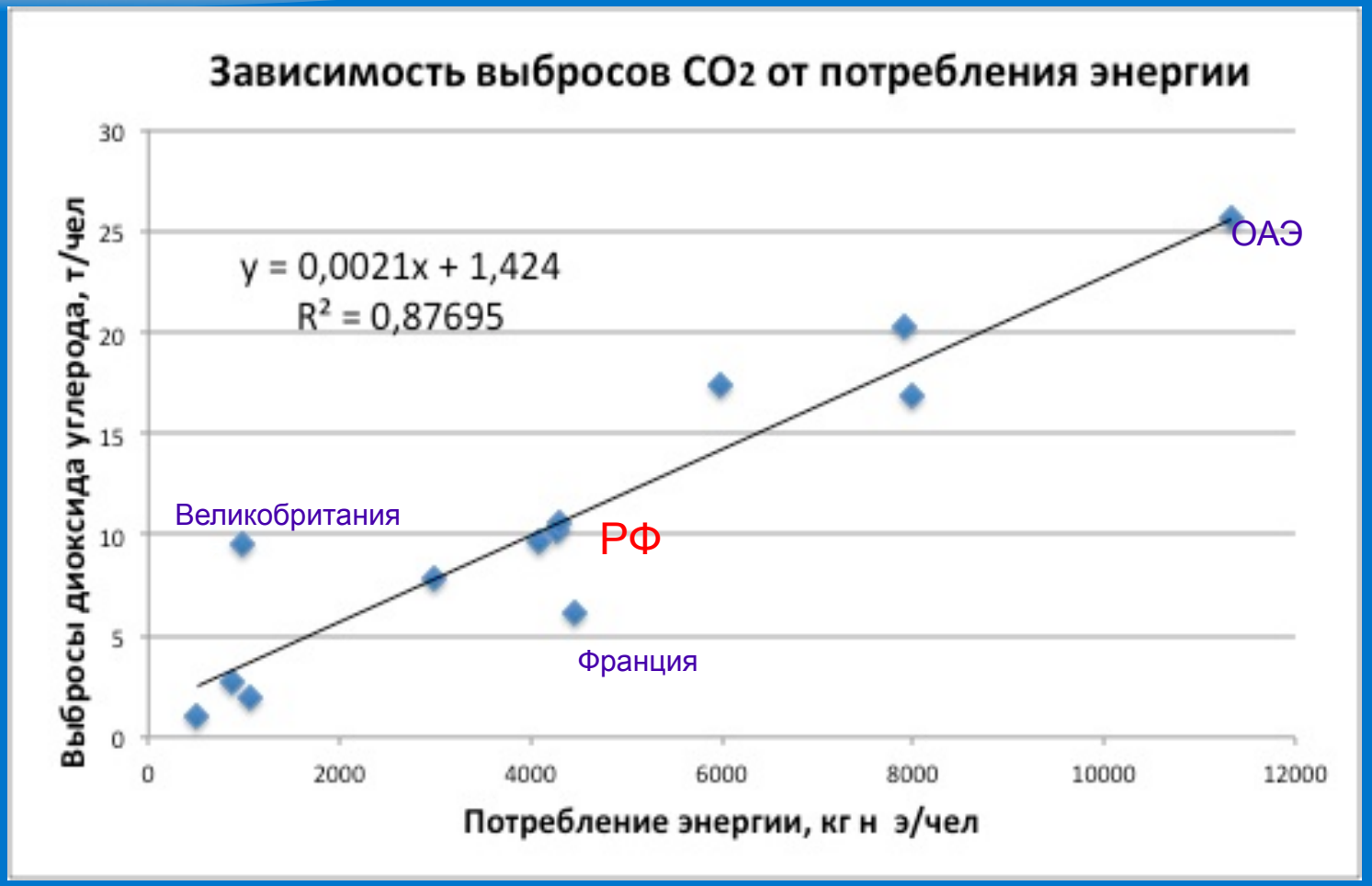




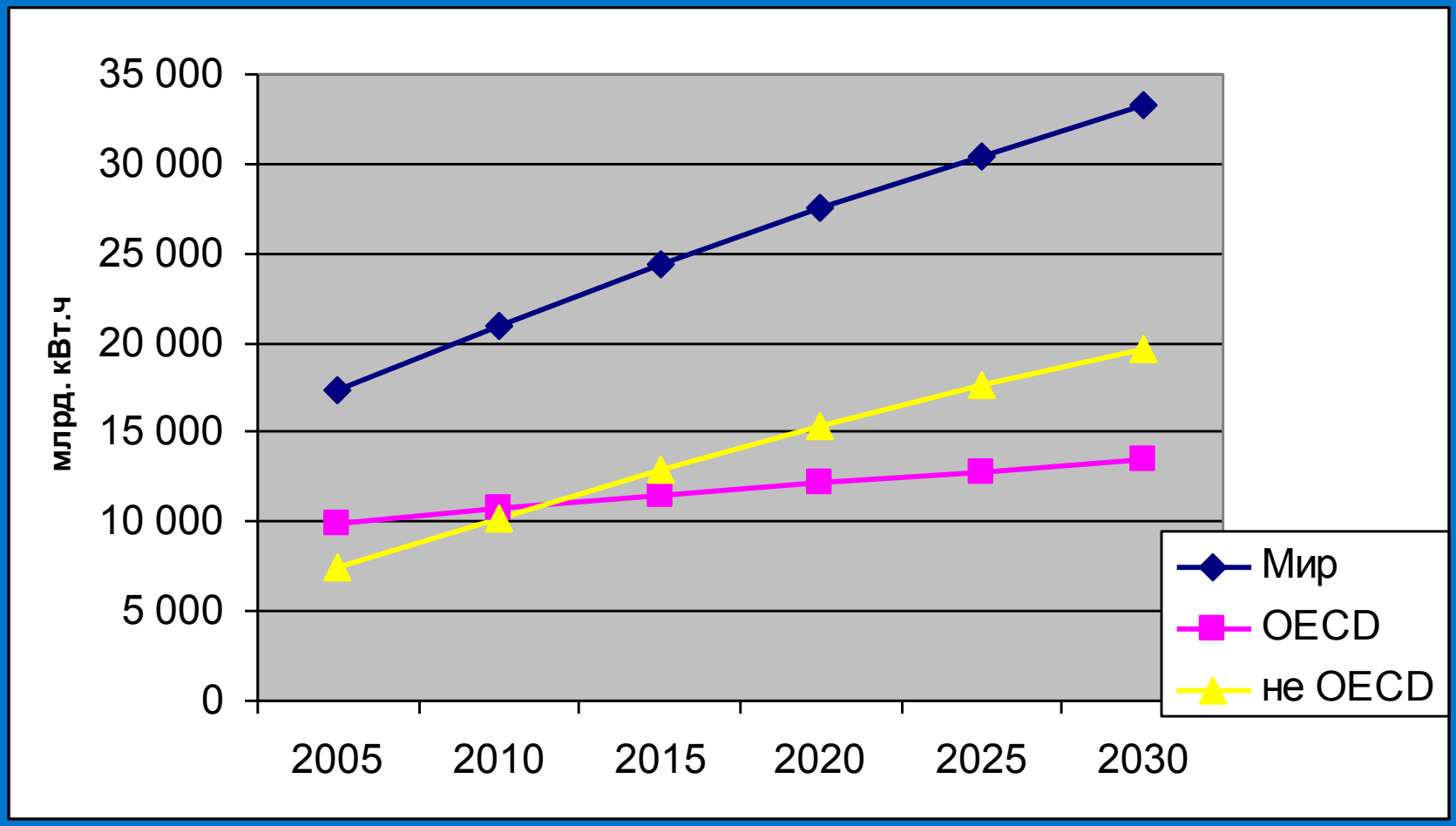




Зависимости уровня эмиссии парниковых газов от потребления энергии



Dynamics of electricity production in the world, 2005-2030



Source: Energy Information Administration / International Energy Outlook, 2010

Low-carbon economy

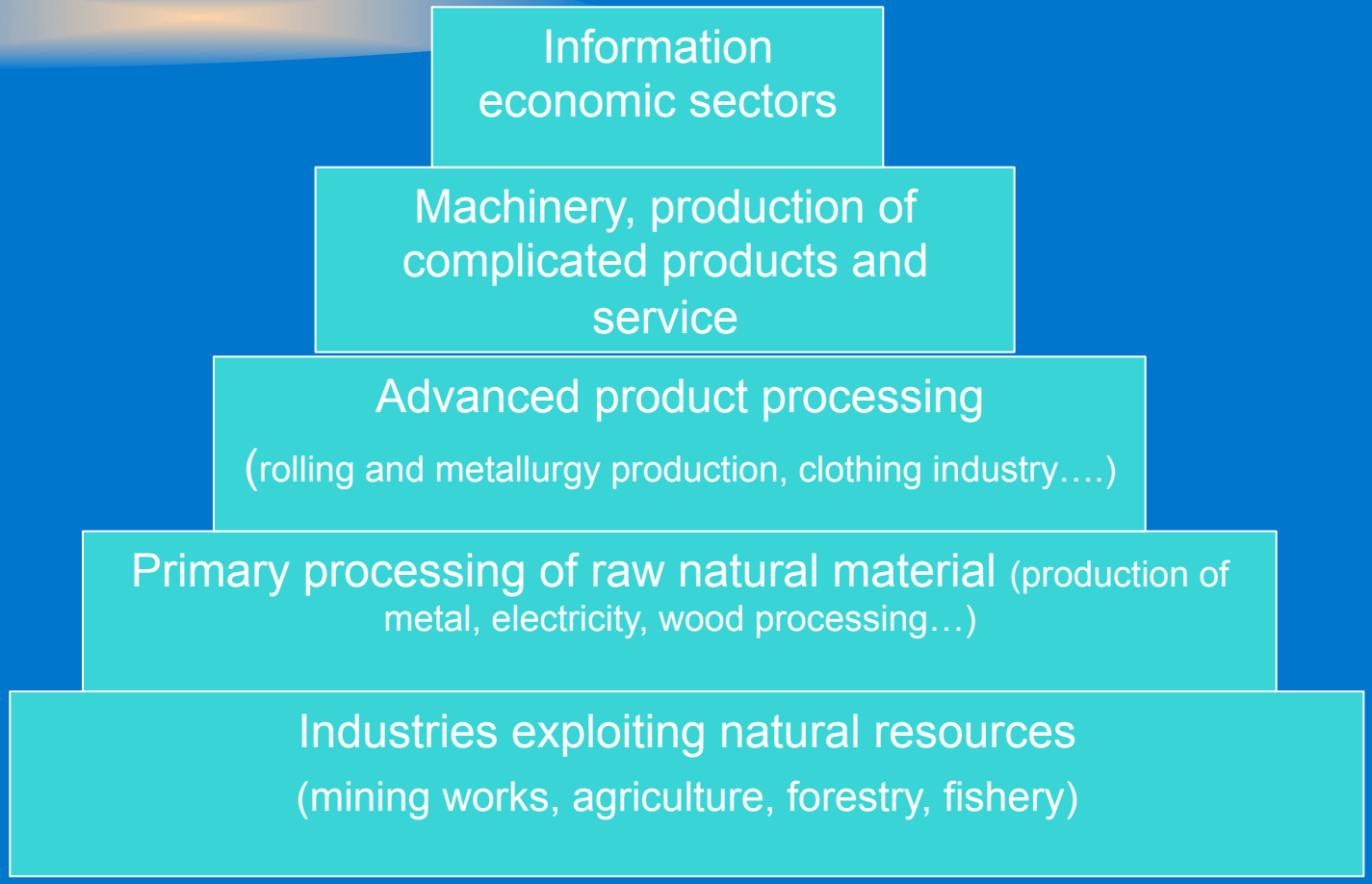
New social economic and technological system aimed at greenhouse gases emission reduction (in comparison with customary economy) without damage to temps of social economic development.

Principles:

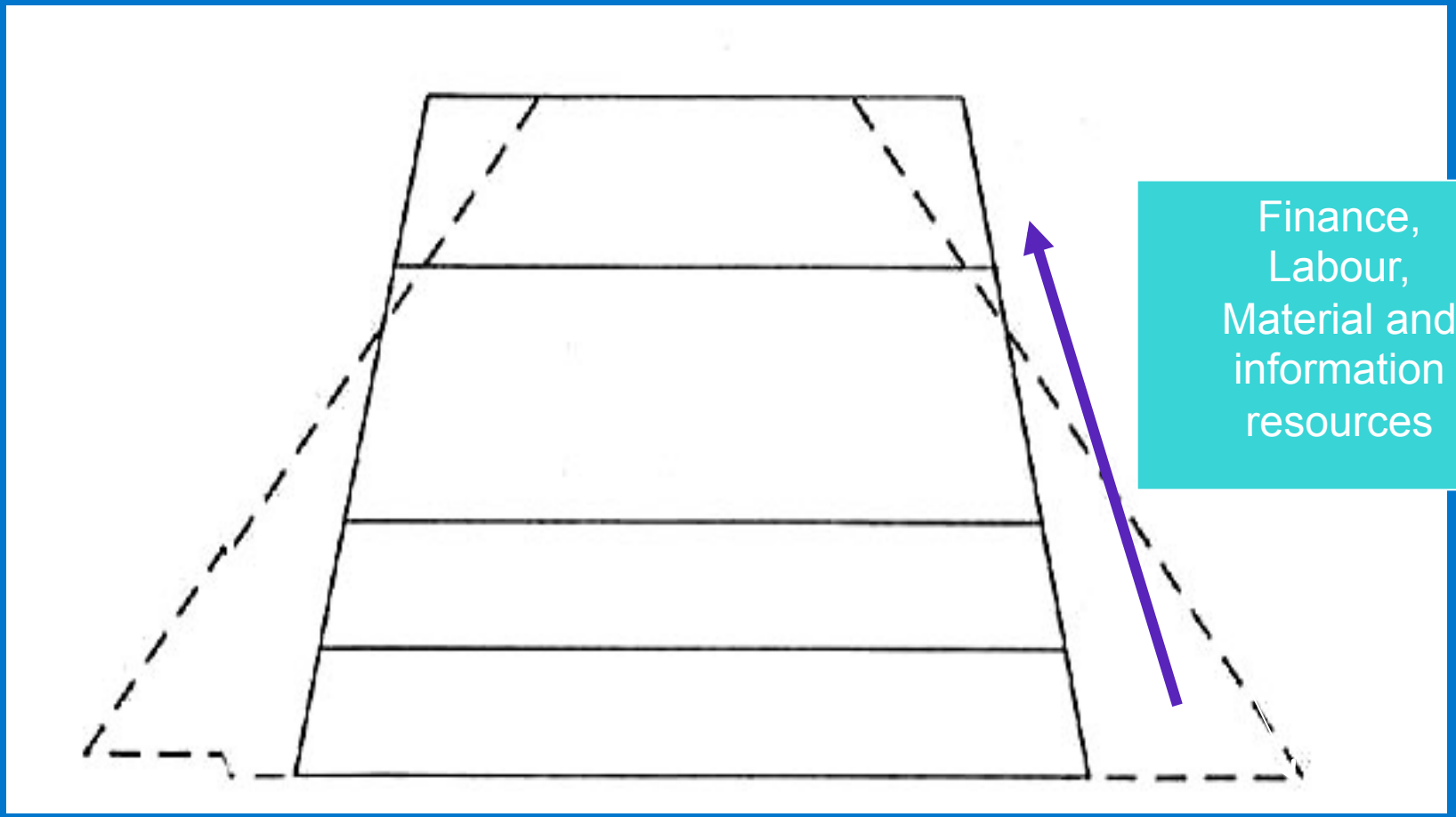
- Separation of economic growth from energy consumption growth and emission of greenhouse gases and other pollutants owing to *technological innovation, infrastructure and behavioral model change*

- Achievement of key goals of development including economic growth generating employment and other social economic goals, reduction of resources consumption and intensification of technological progress.

Production structure



Structural change is realization of the basic principle of low-carbon economy



Maslow's hierarchy of needs

How requirement satisfaction influence on carbon intensity of economy?

Changes of lifestyle and behavioral stereotype can contribute to reduction of the climate change consequences

- Change:

People's behaviour in buildings, cultural stereotypes, consumer's preference.

- Workers' behaviour on the industrial plants in view of the system of premium

- Reduction of the auto use and promotion of driving efficiency depending on town planning and accessibility of public transport

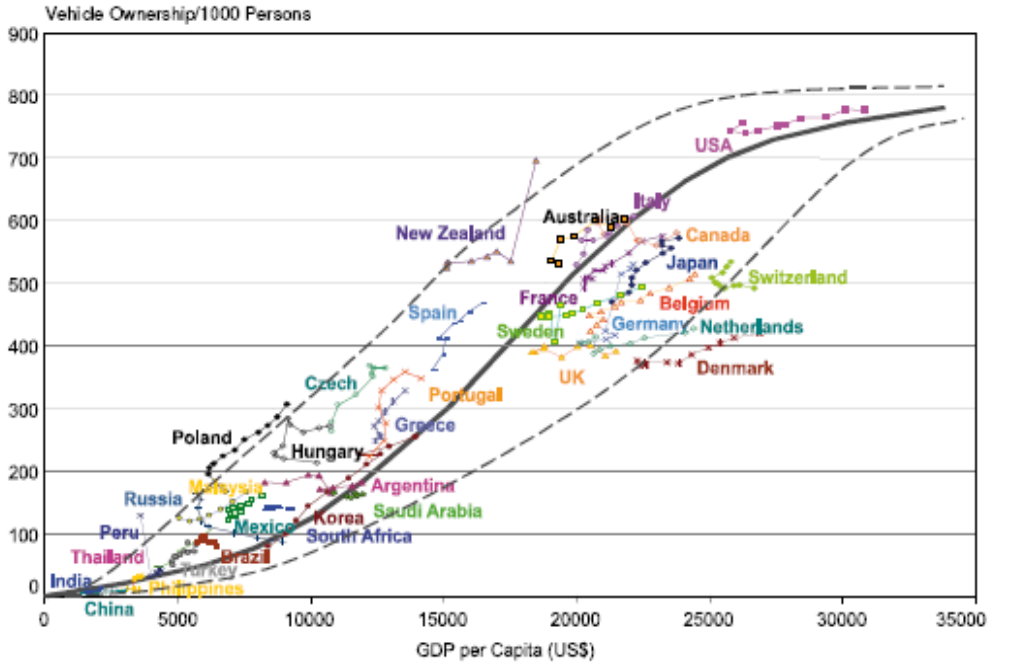
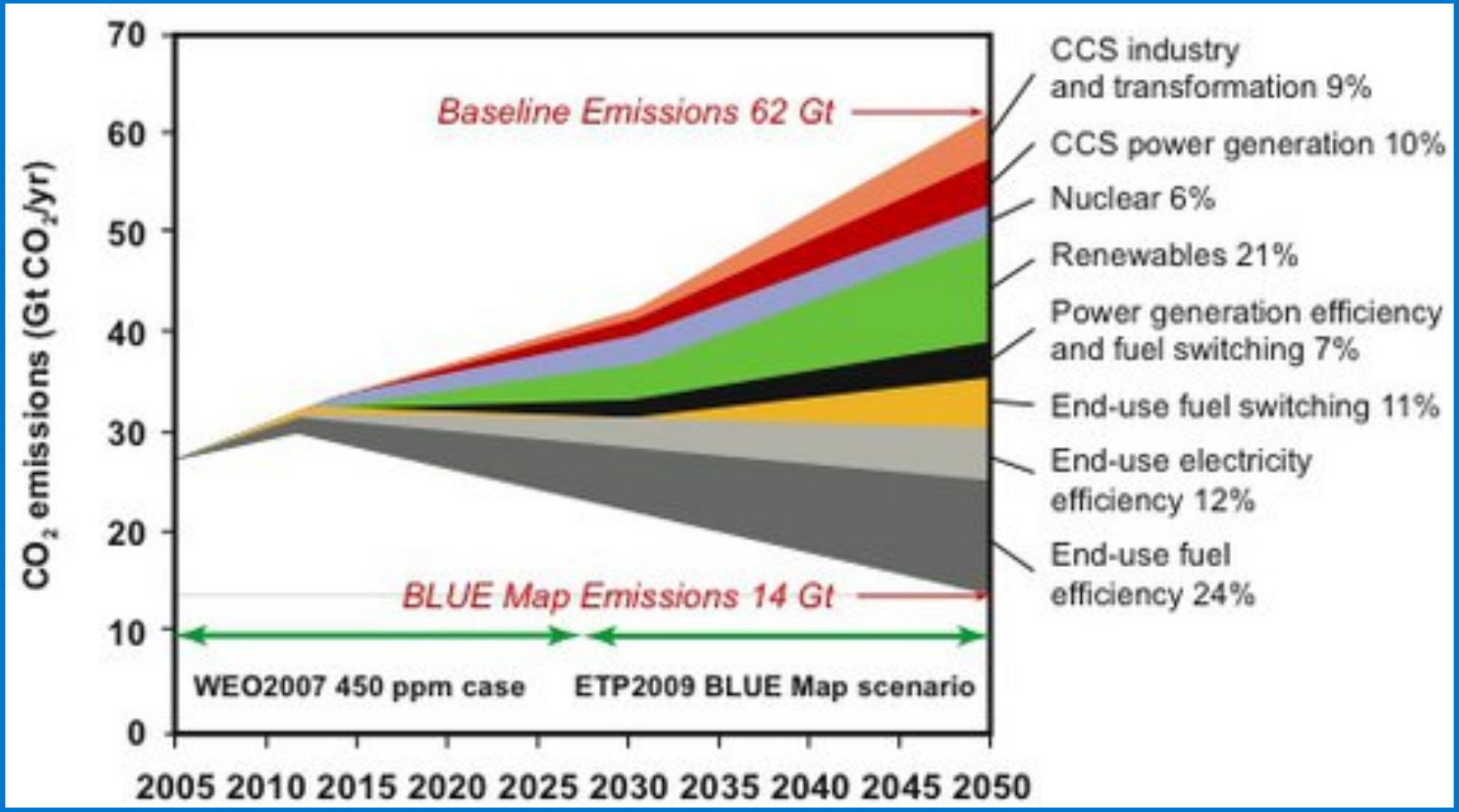


Figure TS.14: Vehicle ownership and income per capita as a time line per country [Figure 5.2]. Note: data are for 1900-2002, but plotted years vary per country, depending on data availability.

Measures for change-over to low-carbon model of economy

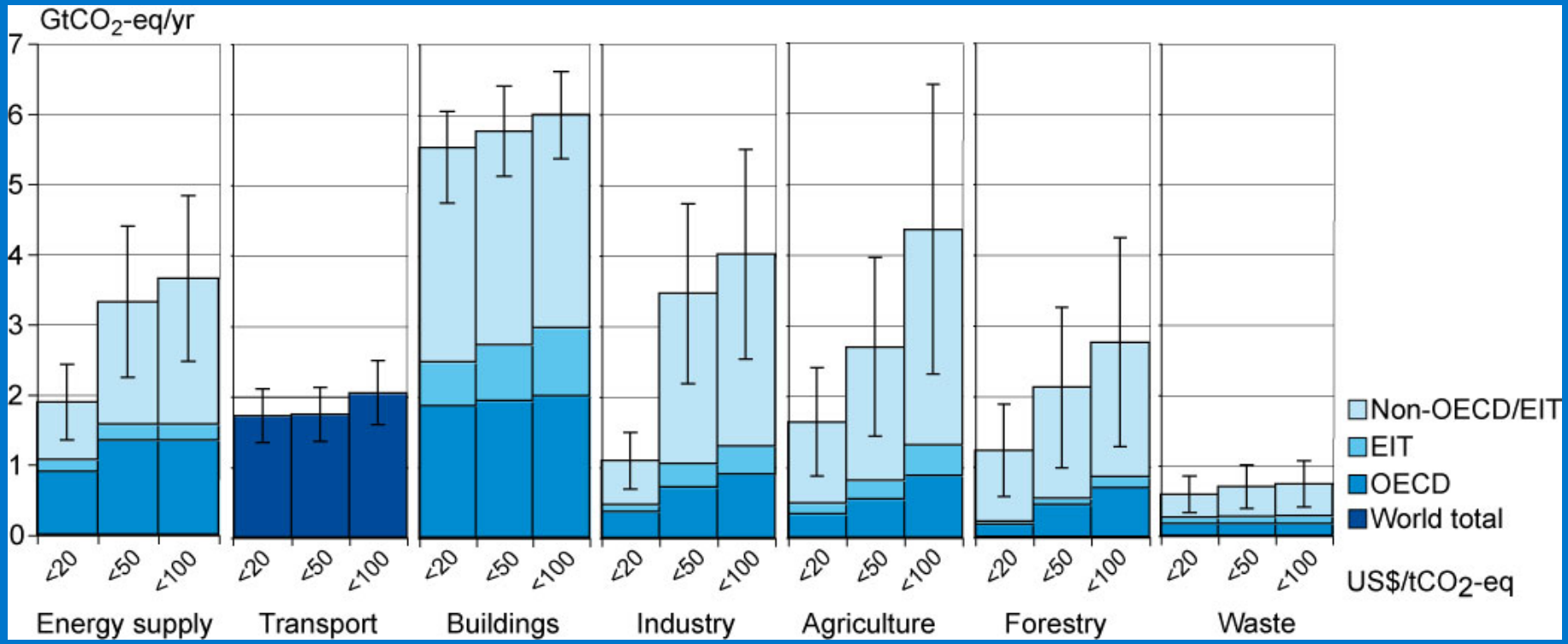
- a) reduction of demand for high-carbon prона высокоуглеродную production from consumers;
- b) increase in energy efficiency, notably contemporarily on the side of supply (i.e. increase in fuel efficiency for energy production) and on the side of demand (i.e. increase in energy efficiency and reduction of energy loss under production of final goods and services);
- c) development and introduction of low-carbon techniques;
- d) capture and storage of CO2;
- e) change of land and forest use, reduction of forests prevention and their protection.

Prognosis of CO2 emission reduction by means of techniques use



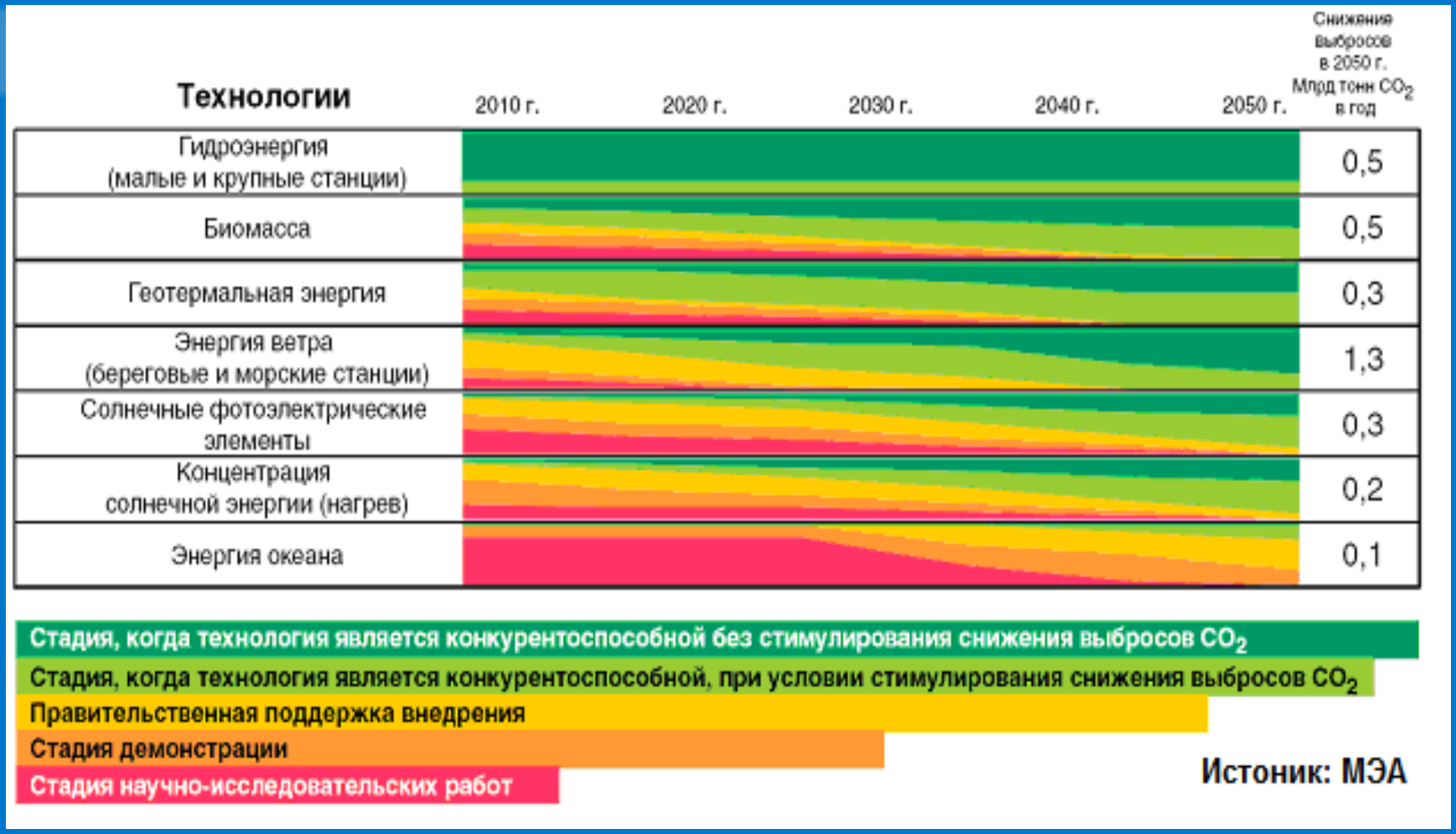
Source: IEA

World potential of emission reduction



Note: assessment does not include untechnical opportunities such as change of household customs

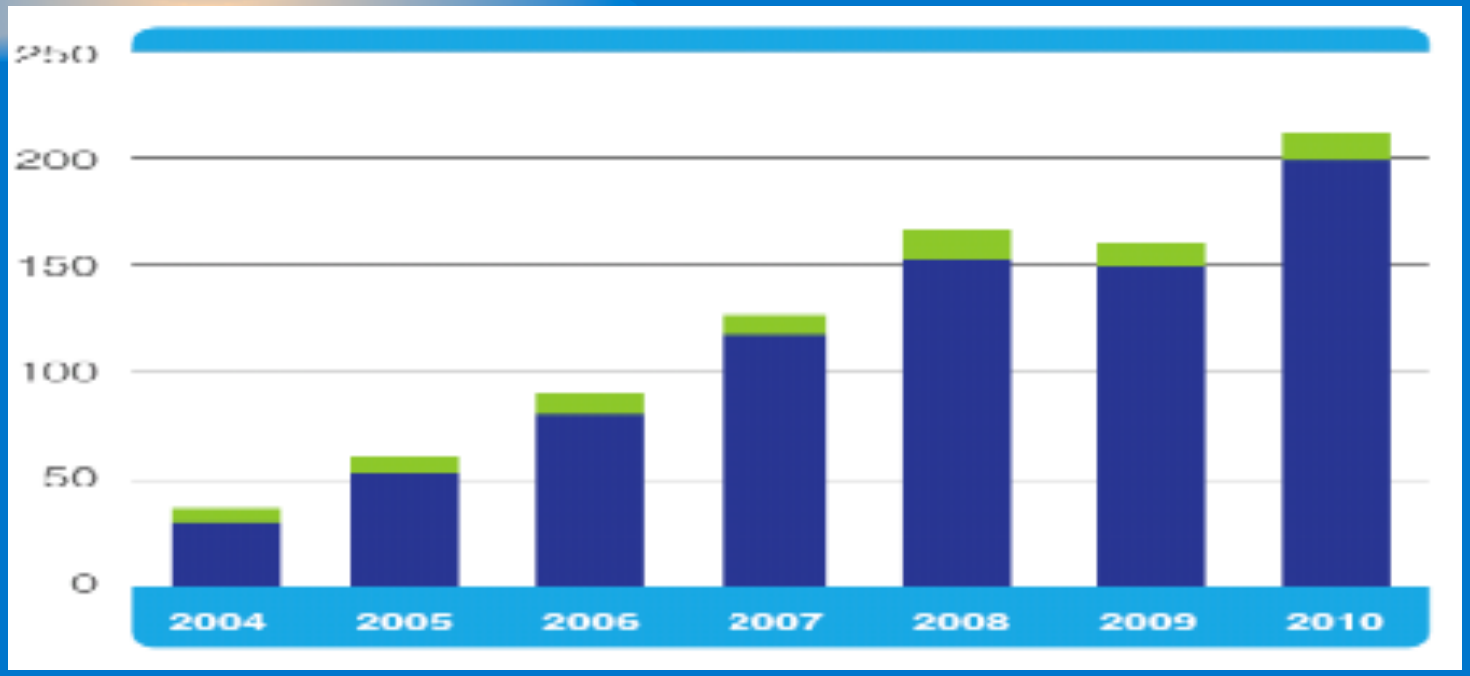
Technical innovations



World energetics

Growth of installed capacity of wind-electric plants in the world

Investment in pure energetics in the “Group-20” countries and in the world (bln. $)

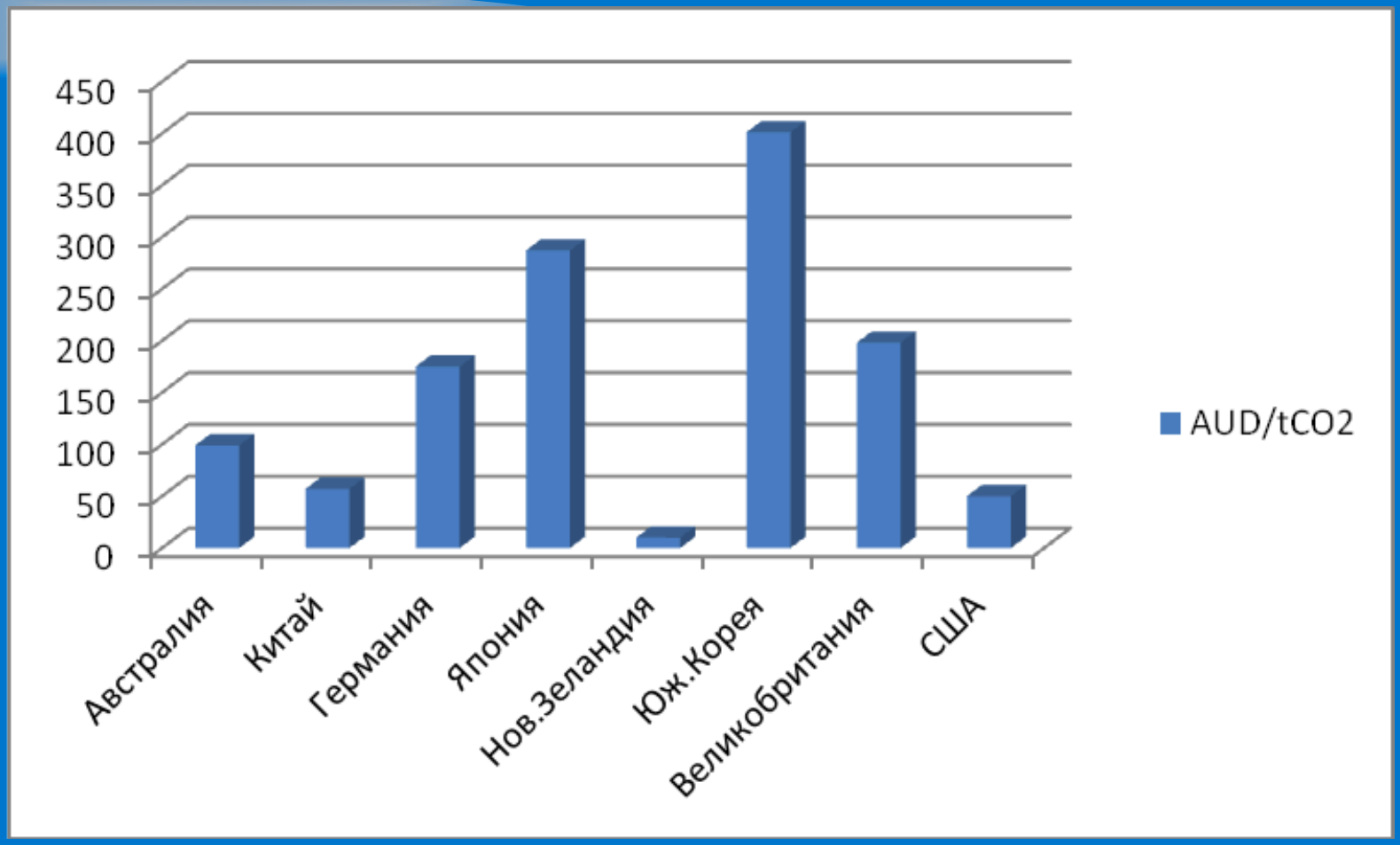


- Investment of the countries not entering “Group-20

- Investment of the countries entering “Group-20

Source: G-20 CLEAN ENERGY, AND ENERGY EFFICIENCY DEPLOYMENT AND POLICY PROGRESS (MEA,2012)

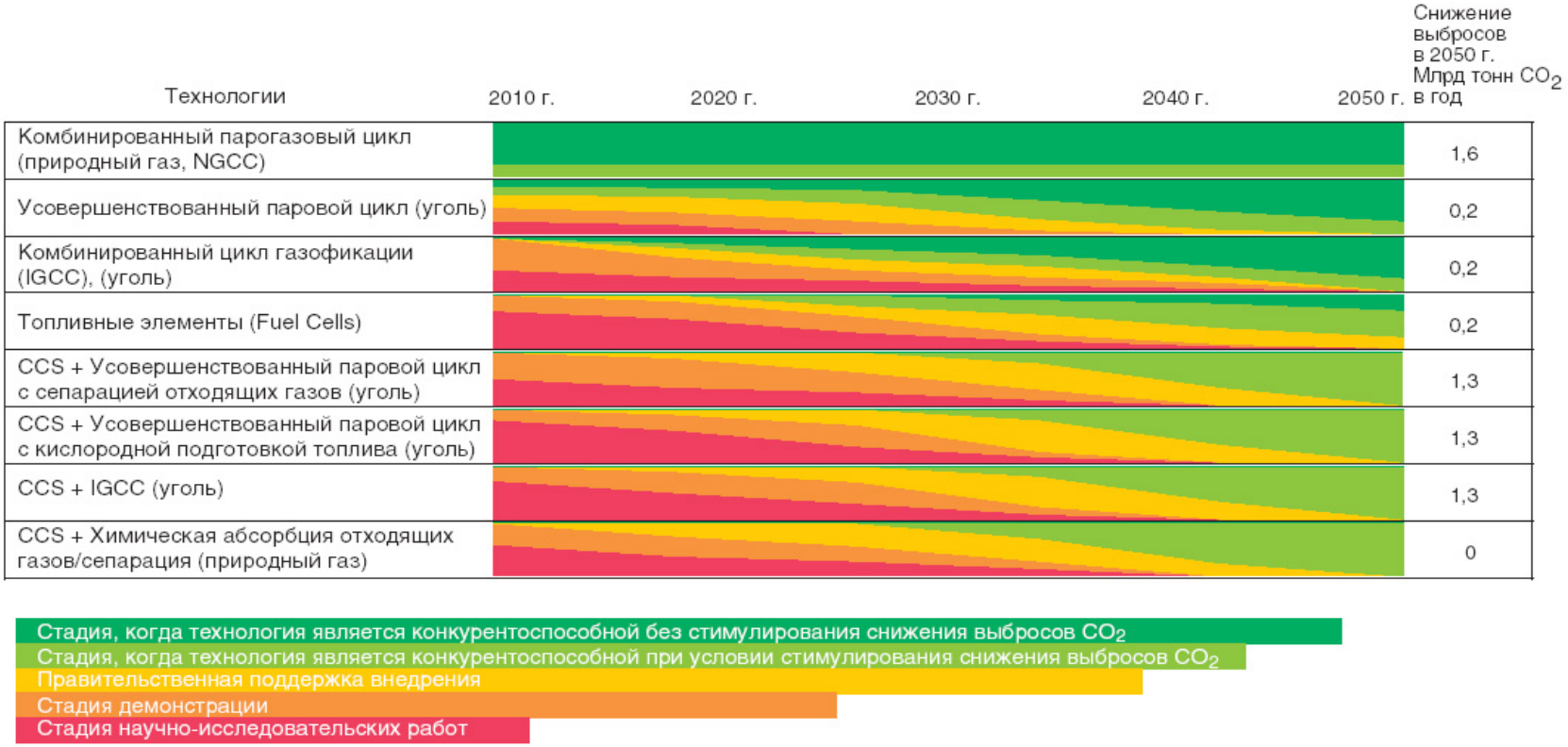
Consolidated expenses (subsidies) on CO_2 emission prevention in electric power



By data: Productivity Commission 2011, Carbon Emission Policies in Key Economies, Research Report, Canberra

Calculations of 5 phases of technology introduction

Рисунок 3.4 ▶ *Достижение ценовой конкурентоспособности технологиями генерации энергии из ископаемых видов топлива*



Source: IEA

Emission reduction in energy efficiency

sector	**Key technologies at the market and practice of emission reduction (examples)**	**Key technologies and practice of emission reduction that will appear at the market till 2030 (examples)**
Electric power supply 	Efficiency promotion; Change-over to other fuels; Electricity production on APS; Use of renewable types of energy (hydro, solar, wind, geothermalи bio); Cooperative heat and electricity production; premature use of technologies of capture and storage of CO2	Capture and storage of CO2, Power plants run on biomass and coal; Advanced technologies on APS; Advanced technologies of use of renewable sources of energy (tidal and wave, concentration of solar energy, solar photoelectric)

Emission of transport reduction

sector	**Key technologies at the market and practice of emission reduction (examples)**	**Key technologies and practice of emission reduction that will appear at the market till 2030 (examples)**
Transport 	Increase in fuel efficiency of transport; autos with hybrid drive; use of biofuel; emphasis on use of railway and public transport; cycling and hiking; land use planning	Biofuel of 2nd generation; more effective air transport; leading transport with electric and more reliable batteries

Emission reduction in industry and housing and public utilities

sector	**Key technologies at the market and practice of emission reduction (examples)**	**Key technologies and practice of emission reduction that will appear at the market till 2030 (examples)**
Industry 	Effectiveness of electric equipment promotion, warm and materials utilization, waste recycling, control under the greenhouse gas emission except CO2	High level of energy efficiency; capture and storage of CO2 in cement, ammonia and iron production ; inert electrodes in в aluminium production
Buildings 	Effectiveness of lightning system, household devices and air conditioners promotion; effectiveness of insulation promotion; heating and cooling by solar energy; an alternative to use of fluorinated gases in the insulation and devices.	Complex design of buildings of service sector including such technologies as smart devices of list, making an opportunity of inverse contact and regulation; use of built-in photovoltaic solar energy converter

Increase in carbon peak-up

sector	**Key technologies at the market and practice of emission reduction (examples)**
Agriculture 	Effectiveness of land use promotion, recovery of processable peaty soil and decayed lands, technological advancement of rice cultivation, cattle production and и dung utilization; advancement of the technique of natural fertilizers use, (+ growth of agricultural cultivation for biofuel production)
Forestry 	Forest cultivation, forestation, forest management, reduction of deforestation, advancement of harvesting of wood technology for logging (+ forest cultivation for biofuel production)

CO2 emission reduction is a global economic mechanism of innovation development

1 phase: "Kyoto protocol" – a basis of reduction of anthropogenic loading on the climatic system, mechanism of pressure with global climate warming

2 phase: "Postkyoto protocol" is one of the mechanisms of innovation development path of economic developoment by means of introduction of energy efficiency techologies. Renewable energy sources

Examples of markets of environmental tools

CO2 Emission trading system inEU
Markets in Europe - European Climate Exchange (Amsterdam),
IPE (London), European Energy Exchange (Leipzig) – realization of the mechanisms of Kyoto protocol

Tradable "white" sertificates

Mechanisms of efficiency introduction – supplier buys «white» sertificates (right in energy efficiency at a market)
Italy, countries of EU

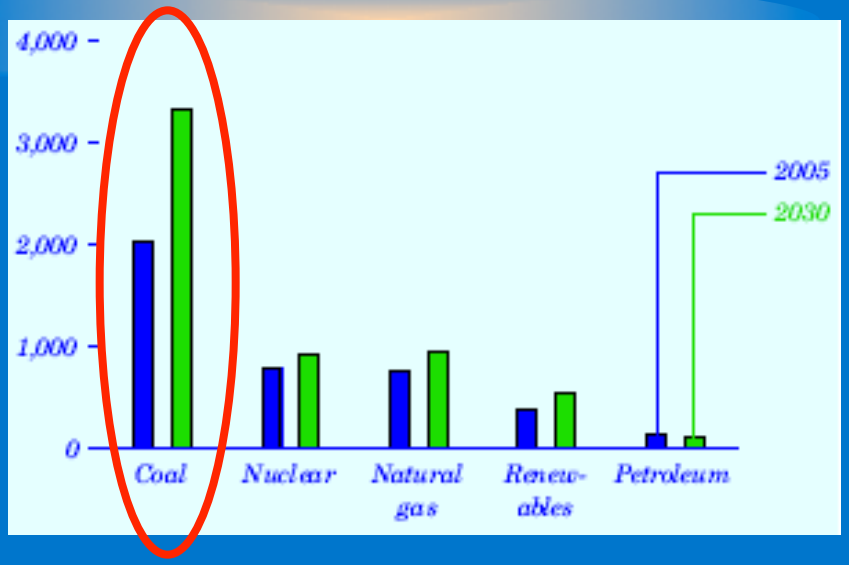
Tradable "green" sertificates

«Green» sertificates – volume of produced energy on the basis of RES (renewable energy sources)
24 countries of EU

Chicago climate exchange (USA)
Chicago Climate Exchange
(voluntary obligations of the participants along CO2 emission reduction)
Trade by CO2 emission permits by means of mechanisms of Kyoto protocol

Conclusion: 1. in different countries and in different periods of time markets of separate ecological tools – white certificates (energy efficiency), green certificates (RES) and blsck certificates (CO2) were formed
2. There's a tendency of integration of ecological tool markets
(example of the leadership – **Europe 20-20-20**).

Practice of USA in emission management in the electric power industry



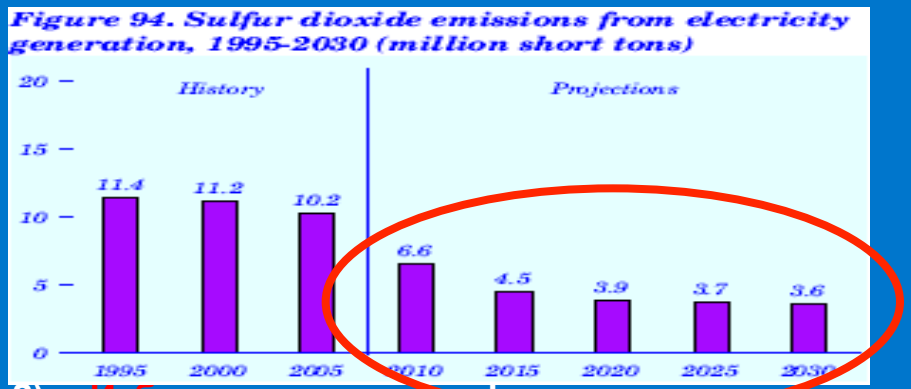
During 2005-2030 electricity production in USA will increase from 3,7 to 5,2 bln. kWh

At the same time a part of coal stations in generation will increase from 50% to 57%.

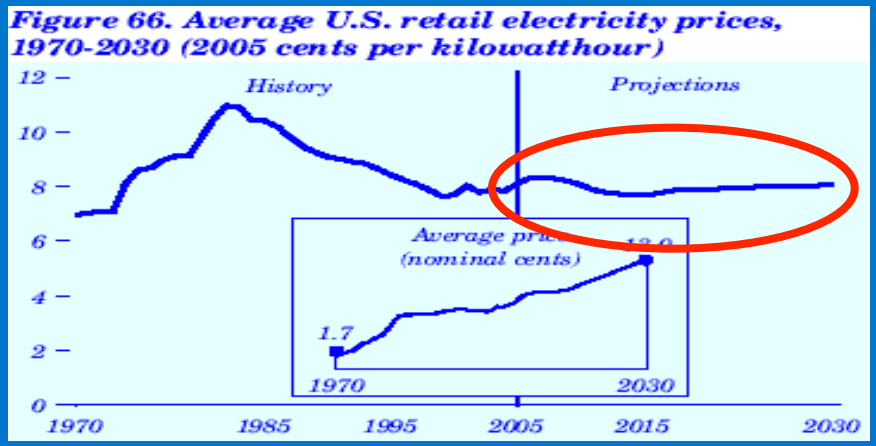
Source: Energy Information Administration / Annual Energy Outlook 2007

Emissions trading scheme allows USA :

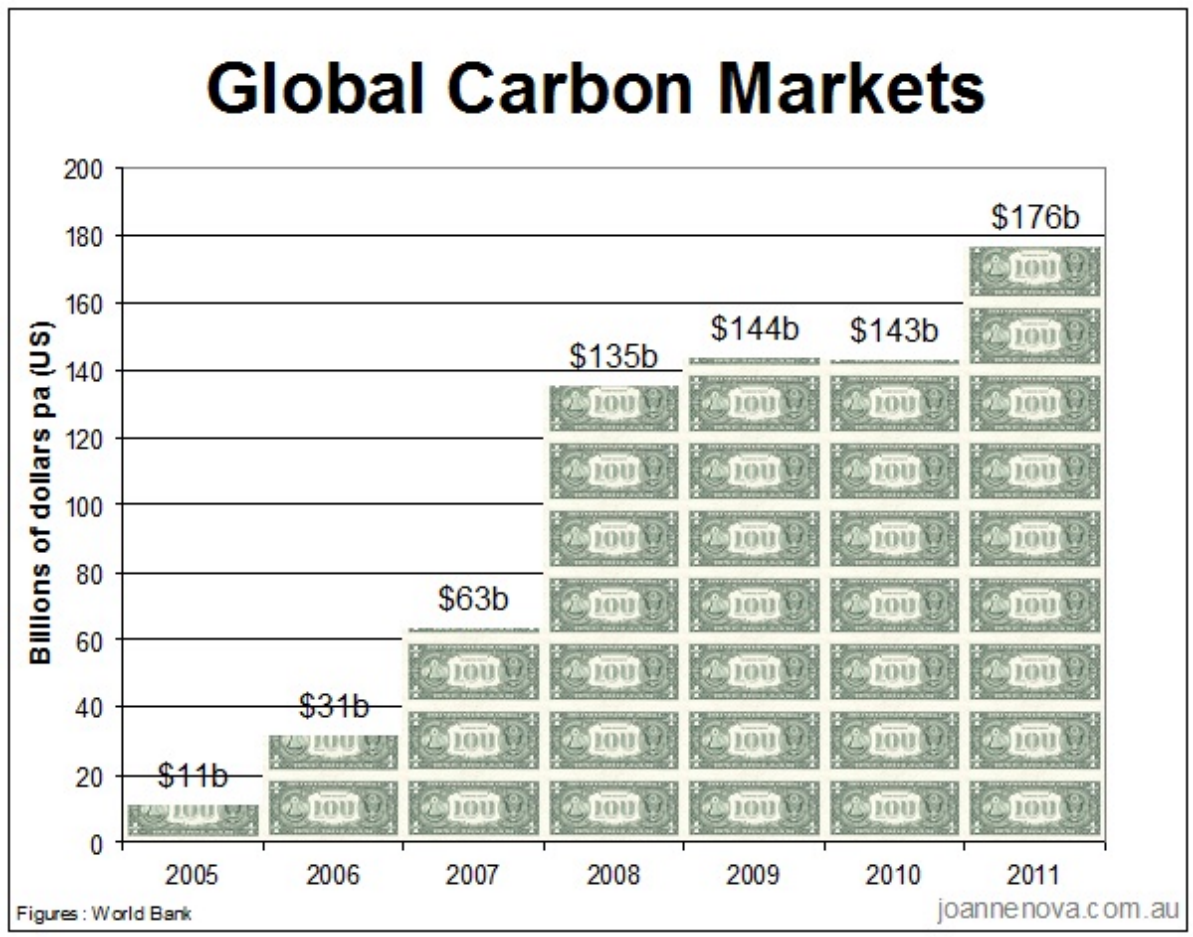
1) **To continue SO2 emission reduction by 3 times! (1990-2005 -40%)**



2) **Избежать роста тарифов на энергию**

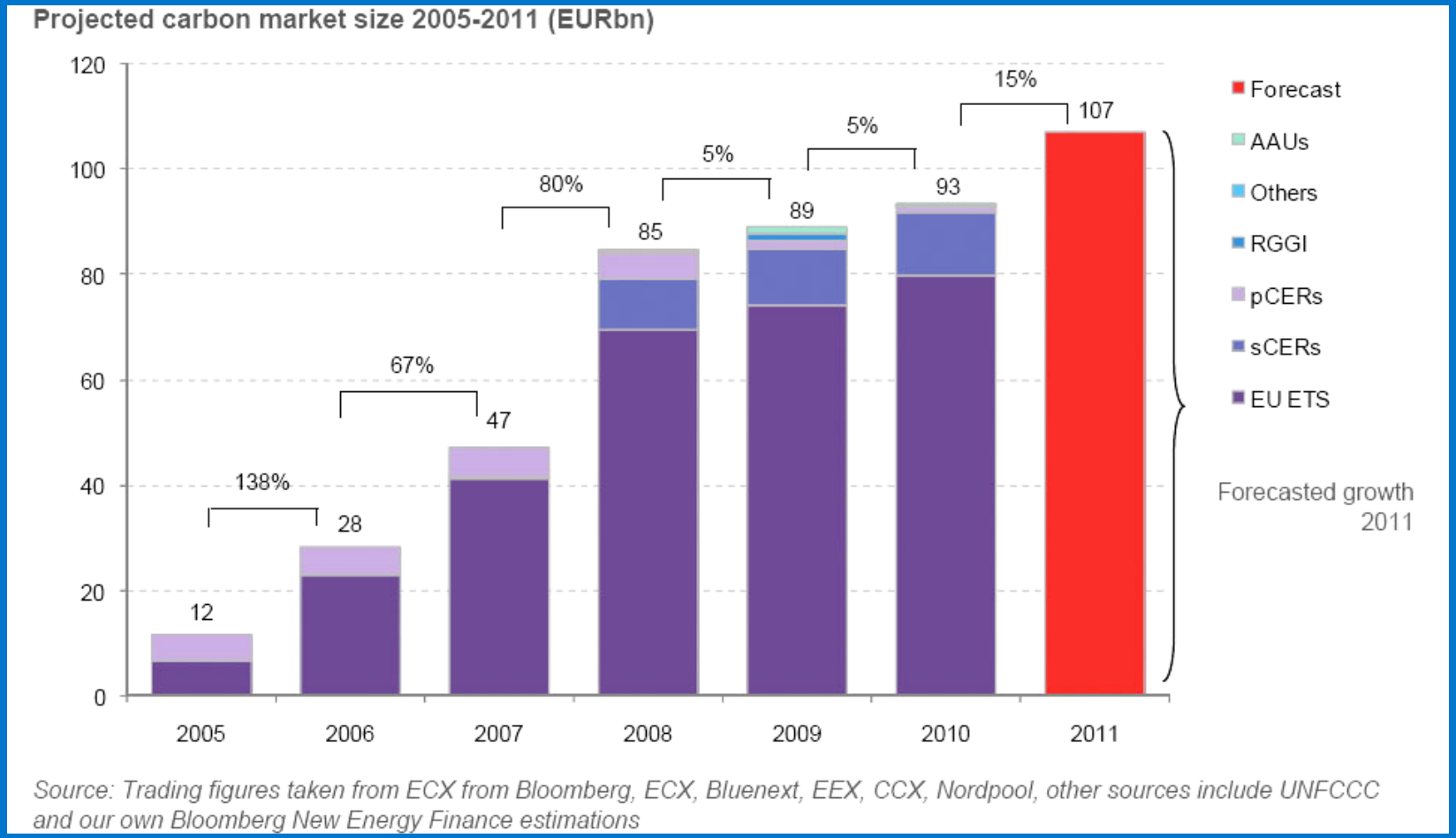


World carbon market growth



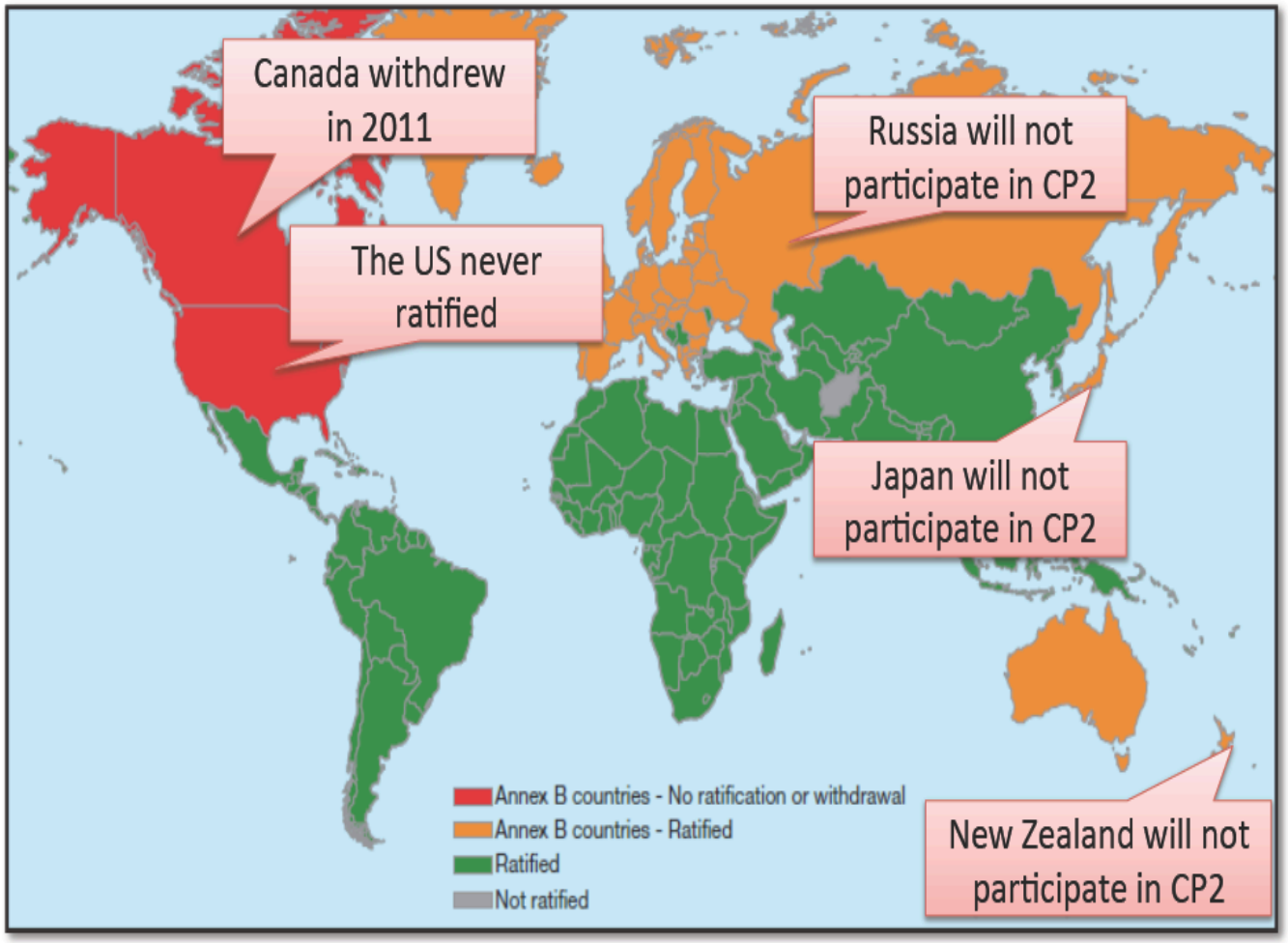
Source: http://joannenova. com.au/2012/06/global-carbon-market-hits-176--billion-in-2011/

World carbon market



Source: http://www.greenrhinoenergy.com/climatechange/carbon_markets/

Kyoto ratification (as of 2012)



Source: UNFCCC (2012)

Официальные намерения отдельных стран на 2020 год

Country	Official intention
USA	To decrease GHG emissions by 17% in comparison with 2005: in case of legal act on climate and energetics adoption the emissions are expected to decrease by 30% by 2025; by 42% 2030 in accordance with final goal – by 83% in 2050
EU	Proposes to decrease GHG emissions by 20in comparison with 1990 and in case of adoption of equitable obligations by other developed countries, EU is ready to increase obligations up to 30%
Japan	Plans to decrease GHG emissions by 25% in comparison with 1990, provided that impartial and profitable agreement will be signed in which all the major countries would take part in
China	Plans to take measures to reduce carbon intensity of GDP by 40-45% in comparison with 2005, increase a part of carbonless fuels in the primary power consumption by some 15%
Russia	Reduction GHG emissions by 25% by 2020 in comparison with the level of 1990, GHF emissions by 2020, reduction of energy intensity GDP by 2020 not less than reduction of GDP by 2020 not less than by 40% in comparison with 2007

The best existing technologies in the electric power industry

In 2007 Unified Energy System of Russia together with Energy for Forecasting of Electric Energy Balance established a collector "Modern nature-oriented technologies in the electric power industry"

It includes Chapter I "Air pollution controll from energy provider emissions

CO_2 emission in case of electricity produxtion

Technology	g CO_2 per kWh electricity
Solar power, water power and wind power	10 - 40
Nuclear power plants	90 - 140
Combined heat and power in private houses	220 - 250
Gas burning plants	330 - 360
New coal burning plants	1'000 - 1'100

Cocurrent positive effects

- Positive influence on people's health in the short term of air pollution reduction
- Increase in the level of energy security
- *Balance of trade improvement*
- *Providing rural population with modern современными energetic service*
- *Level of employment increase*

Thank you for your attention!