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ENERGY FUTURE OF INDIA

Abstract

India is analyzed according to the position and perspective of environmental Kuznets curve. Theoretical and practical aspects of CO_2 emissions in India are developed.

Key words:

Global CO_2 emissions, environmental Kuznets curve, India, climate change.

JEL: Q53, Q56.

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Introduction

Global emissions of carbon dioxide (CO_2) –are the main reason of global warming caused by human activity. Six countries/regions (official statistics 2014) emit most CO_2: China (29%), the USA (15%), European Union (11%), India (6%), Russia (5%) and Japan (4%). In China, emissions have increased by 4.2%, while emissions in the United States decreased by 2.5% in 2013 after declining by 3.8% in 2012. In the European Union, emissions decreased by 1.4% in 2013 compared to 2012. After the accident at the Fukushima nuclear power plant, CO_2 emissions in Japan, this showed an increase of 6.5% in 2012, decreased by 0.6%. In 2013, in the European Union emissions growth were, mostly in France and Germany, while emissions decreased in Spain (10.8%), Italy (5.5%) and the UK (2.6%).

India's GDP growth has slowed in recent years: in 2012 GDP grew by 4.7% and in 2013 – 5.0%, compared with GDP growth of 4% in 2008, which was the lowest in 10 years according to the World Bank (2014) (Eldyshev).

One of the famous works about implementation of the economic instruments to the control emissions is «Global climate change: economic and legal mechanisms for the implementation of the Kyoto Protocol in Ukraine» (Zharova, 2009). Such scientists as Voronchuk M., Piriashvili B., Vrolyk K., Brack, D., Grubb M., Danylyshyn B., Diukanov V., Dunayev V., Eremeev V., Efimov V., Zharov L., Ilyina M., Kosevtsov V., Binko I., Lear B., Nikitin E., Pisarenko I., Poplavska J., Poplavsky V., Raptsun M., Surnin S. develop prospects of implementation and effects of the implementation of the Kyoto Protocol in Ukraine.

According to the scientists Zharova L.V., Ilyina M.V. and those book «The economic mechanisms of the gas emissions monitoring» (Zharova, 2009), that most negative impact of the climate change affect the poor countries because of their higher vulnerability to disasters and natural catastrophes, lower technological capacity and limited ability of the adaptation to the change. For such societies, climate change brings new risks and threats: lack of food, lack of water resources, and destruction of infrastructure caused by such natural phenomena as floods, droughts and storms. Need to say, that ability to accumulate emissions is a serious factor which increases the negative effects of climate change.

1000-1500 billion tons of CO_2 emissions is necessary to reduce according to experts because world society can make13,2-18,3 billion tons of CO_2 each year. Moreover, the volume of CO_2 emissions and the possibility to limit/reduce these amounts greatly vary depending on the region of the world and the level of economic development.

Main material

CO_2 emissions in India continued to grow by 4.4% (2.1 billion tons), making this country the fourth largest of the CO_2 emissions in the world (2013). This volume partially caused by population and labor force in industry and services, and partly – international outsourcing. CO_2 emissions per capita were much lower in India than in most developed countries and China. In 2013 the increase of CO_2 emissions were mainly due to 7.3% growth in coal consumption, which accounted 59% of total fossil fuel primary energy consumption in India and 55% of total primary energy consumption.

This growth rate was lower than the previous year, but significantly higher than in 2010 and 2011 based on coal electricity production, which amounted 70% of all CO_2 emissions of coal in India; growth rate grewby13%in 2012.This situation is similar in Poland, Kazakhstan, and other countries with large coal resources (Trends in global CO_2emissions:2014 Report. Background studies; Trends in global CO_2emissions: 2013 Report. Background studies).

The number of imported coal and coke increased more than twice (168 million tons in 2013) over the past five years. In last 40 years, coal production increased in seven times caused by investment programs and using of the new technologies. According to the annual report 2013-2014 (Coal India, 2014), the demand will increase by 25% in the 2016–2017 years, while during the 2012–2017 years increasing coal output to 795 million ton during 2016–2017 years also contributes to the emergence of new power plants.

The population density and growth rate 2000-2012 are higher by seven times in India than world average rate. Number of Indians is growing more than two times faster than the number of Chinese and it is expected that India will be the most populous country by 2025 without a significant reduction in the rate of population growth. Some environmental issues, climate change, CO_2 emissions and poverty will be difficult to solve simultaneously. The ability of individual countries to decide the climate change measured by the following indicators.

Implementation of the Kuznets ecological curve hypothesis is one of the methodological tools of the research influence the pace of social development, the effectiveness of it energy on the ecological state in the world. It is difficult to define a critical point in the Kuznets curve: what level of income per capita is start of the environment improving (point A in Figure 2). It depends on many factors: level of welfare, the characteristics of the economy, its technological structure, types of pollution, their primary level and others.

Figure 1

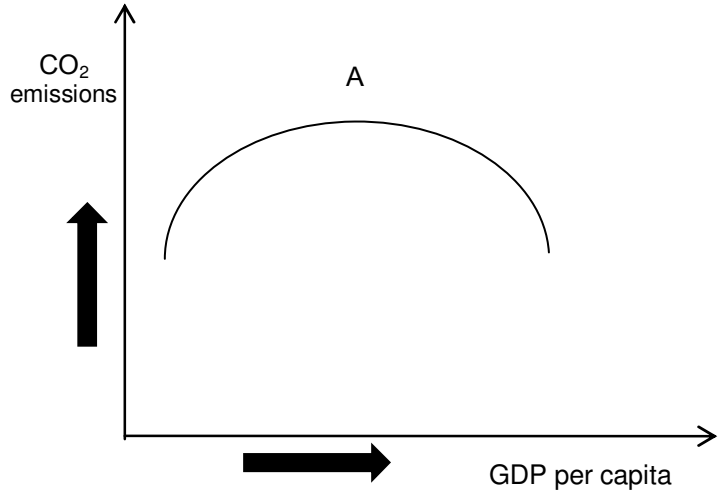
Indicators measurement of the ability of individual country to solve climate change problems

Indicators	the country's share of global CO_2 emissions
	GDP per capita
	changes in the level of CO_2 emissions during the specific period
	CO_2 emissions per capita
	share of renewable sources energy

Note: Made by author: (Inshekov, 2009).

Figure 2

Environmental Kuznets curve[1]



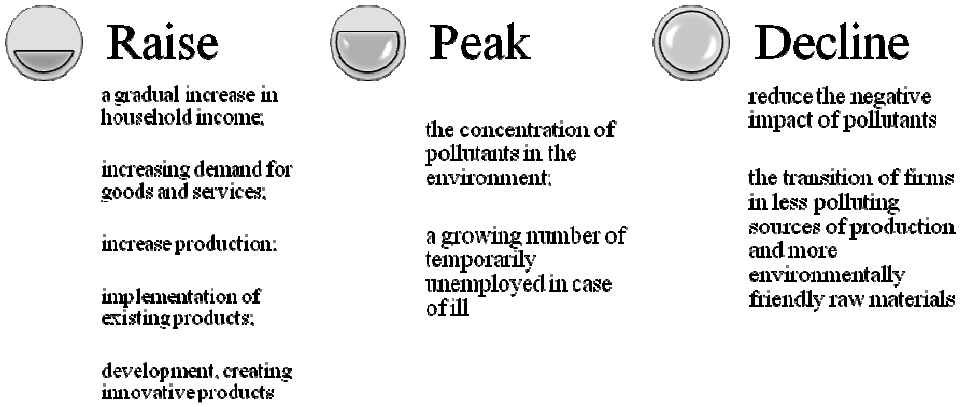
[1]In his most famous work «Economic growth and income inequality» (1955), he came to nontrivial conclusion that economic growth leads first to increased and then to a weakening of inequality.

The Princeton economists Grossman and Krueger, who studied the effects of free trade oil, first talked in the early 1990s about the Kuznets curve, which describes the dynamics of the environmental process. Instead of the above-mentioned income inequality in the «environmental» Kuznets curves pollution is dependent variable. The pattern kept the same – with the growth of the independent variable – gross national product (GNP) – the environment at an early stage is deteriorating rapidly: plants are becoming stronger smoke, increasingly deforestation.

But then the critical turning point comes, the cause of which is, according to the World Bank report: with increasing income, demand for a secure and safe environment is growing. In other words, first, richer citizens strongly feel the need to breathe clean air and swim in clean water, and secondly, can afford to spend more money to improve the environment.

Figure 3

Stages of the environmental Kuznets curve



Note: Made by author: (Inshekov, 2009).

Therefore, you should not «turn off» the economy to save the environment, but rather develop it intensely. Applicability of «environmental» Kuznets curve to describe the real environmental situation in particular countries have sought to justify comparing income levels and pollution both in different countries and in dif-

ferent areas of these countries. For example, the researchers who have tried to analyze the dynamics of emissions in Taiwan, which has long remained a world record in terms of economic growth, got next conclusions. The results were impressive: first, the emissions of carbon monoxide, nitrogen compounds and other pollutants really grew rapidly, and then just as abruptly began to decline.

The value of the average income per capita (curve is decline and emissions started to decline) amounted 7 thousand dollars for decline of CO_2 and about 13 thousand for nitrogen dioxide NO_2.With increasing prosperity, people can afford environmental cars, with less harmful exhaust (using expensive catalysts)[2].

Unfortunately, catalysts do not save from the carbon dioxide (CO^2), so they cut through other, more expensive approaches, including internal combustion engines. It is one of the two fundamental problems: doubts of the applicability of the Kuznets curve to describe the dependence «damage» inflicted to the environment a particular society at a particular stage of development depending on the level of development.

Some time ago, experts do not hide their skepticism about the Kyoto Protocol institutionalized attempts to regulate emissions hoping to confront warming. Proponents of this view has repeatedly drawn attention to the fact that the use of «environmental» curve Kuznets not quite correct and urged instead a graph axes which postponed the value of GNP and absolute emissions of CO_2, using curves that reflect emissions per unit (for example, $ 1) GDP. This correlation indicates that according to the level of the average GDP 12 thousand dollars «contamination» of the economy begins to fall.

In other words, the absolute values of emissions continue to rise with the growth of GDP, but more slowly than before: for example, increasing the per capita income of from 12 thousand to 24 thousand dollars they do not grow to 2, but approximately 1.6 times. Therefore, the main difference «carbon dependence» of the economy is next fact: CO_2 emissions per unit of GDP to the development of the economy are not reduced, but just slowly growing. However, the applicability of «environmental» Kuznets curve is more questionable to describe the evolution of the emissions of these compounds.

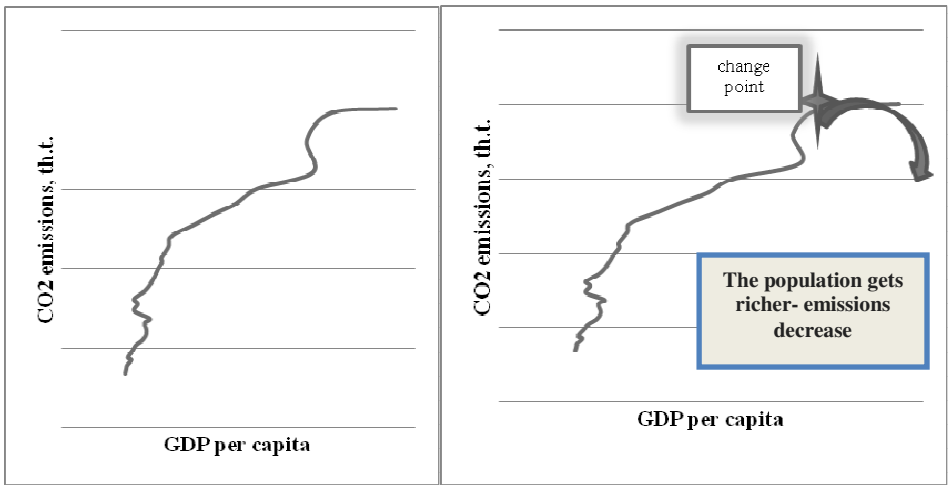
For example, one of the major arguments of the opponents is that during increasing of income in any country its emissions cannot be reduced, but simply redistributed: the rich countries and regions render their «dirty» production in poorer countries and regions. Thus, «clean» Taiwan was the result of transfer of the production capacity in mainland China.

[2]If carbon monoxide not bad were caught even the simplest car catalysts, the nitrogen dioxide- only the latest and most expensive of stamps.

These arguments indirectly confirmed by the recent assessment of famous Japanese economists Katsumi Matsuura from University of Hiroshima and Fumiko Takeda from Tokyo University according to which the volume of Japanese imports of energy-intensive products from various Asian countries directly connected (tightly correlated) with the volume of industrial production and emissions of carbon dioxide in them (Ahearn; Vestergaard, 2011; Human Development Report, 2013).

Figure 4

Environmental Kuznets curve of India



Note: Made by author: (Darshan Goswami; Can India Achieve 100% Renewable Energy?).

Similarly, we tried to analyze and identify trends Kuznets curve for India as one largest emissions of CO_2. For this, we analyzed the CO_2 emissions and GDP per capita from 1980 to 2013, the results displayed in fig. 4. Indian environmental Kuznets curve is in the stage of recovery and a turning point has not come yet. Reducing emissions and projected population wealth will be in the near future.

Thus, the data presented in the report of the Agency Energy Information Administration(EIA)at the US Department of Energy, the energy sector of the country only in 2009 reduced carbon dioxide emissions by 7% (in absolute terms – to 405 mln. tons), a record of all 60 years (statistic of CO_2). For comparison: in2008 the reduction was 3% (or 180 million tons).

Experts acknowledged that the sharp reduction emissions in 2009 caused by the combination of special factors of different nature, including the global financial crisis and the significant downturn in the economy. As experts estimated, a slowdown in economic growth since the beginning of XXI century is «responsible» for the reduction of total emissions by 1.5% (according to the proportion between the size of GDP and the volume of their annual emission growth it would be 0.6–0.7 %, while in reality emissions decreased annually by about 0.9%in 2000–2009).

According to the report, in 2009a sharp drop of the emissions was due to three main factors: a decrease in the value of GDP per capita (the contribution of this factor- 3.3%), energy savings and increased energy efficiency in the economy (2%) and reduction specific emissions (per unit of energy) in the energy sector(over 2%). Two last circumstances were largely caused a significant reduction in fossil fuel consumption.

This led both to lower «hydrocarbon capacity» of the economy (emissions per unit of GDP) and to the reduction of emissions in absolute terms. Due to the estimates, emissions from burning coal decreased by 12%, gasoline – by 5.3%, natural gas – by 1.6%. At the same time, experts of EIA said that other types of energy consumption has increased by about 2%.

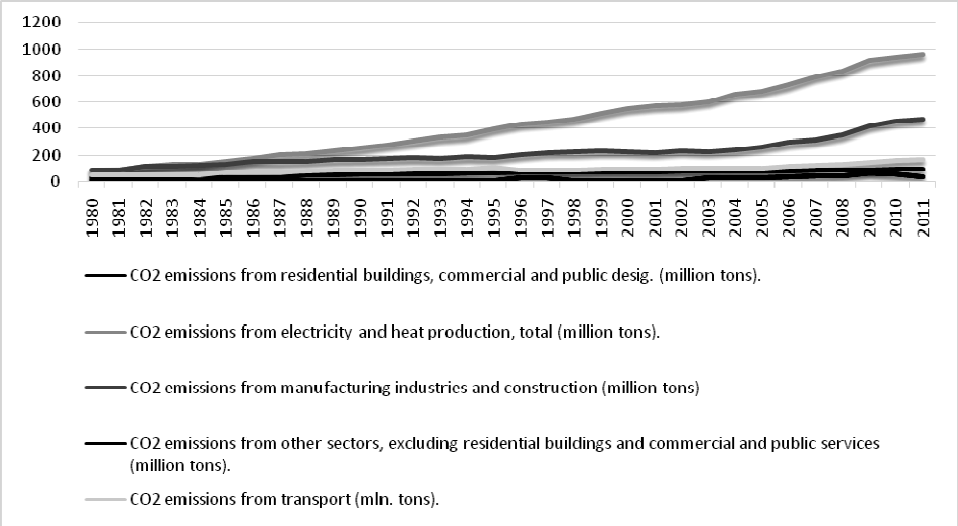
Let us to analyze the dynamics depicts CO_2 emissions from various sources for the years1980–2013 of India (Fig. 5). Information is confirmed that the greatest reductions realized from the production of electricity from processing industry in India. It should be noted that these two sources of carbon emissions are the most powerful on the «capacity carbon» economy, which affects the whole environment.

By 2050, India could rely on renewable energy sources to create a sustainable energy future. In coming years, India will face insurmountable problems of his economy, environment and energy security. To solve these problems India must move to clean energy. Intergovernmental Panel on Climate Change has recommended major changes in world investment from burning fossil fuels to renewable energy sources in order to stop gas emissions and climate change.

India has its own huge energy needs, and it is becoming increasingly difficult to meet the traditional means of electricity generation. Over 40% of rural Indian households have no electricity. While India is still developing domestic energy sources to meet growing demand, it also imports a lot of fossil fuels, caused the trade deficit and the environment's problems. Imports of coal reached record levels in the last financial year and will grow the next five years.

Figure 5

Dynamics of CO_2 emissions in India



Note: Made by author: (Darshan Goswami; Can India Achieve 100% Renewable Energy?).

The inability of the country to create affordable food is also a major obstacle to achieving energy security. India should promote decentralized business model in order to make it easier to use renewable energy such as solar, wind, hydropower, biomass, biogas, geothermal and hydrogen power and fuel cells. India is full of huge amount of resources, but the country is spending millions of rupees on imports of oil, coal and natural gas. Renewable resources are the most attractive for investment as well as promote long-term economic growth in India.

To ensure its energy future India should urgently develop and implement innovative policies and mechanisms that promote increased use of sustainable, renewable resources. Investment in energy technologies will create millions of new jobs and provide economic stimulus at least $ 1 trillion and possibly much more indirect effects. It also can include the use of electric vehicles and the development of advanced Smart Grids. Ensuring the transition to 100% renewable energy is possible and available, but requires political support.

India has a number of disparate policies instead of a single overall energy strategy. Currently India has developed a cluster business models and energy policy that prevents the adoption of measures such comprehensive energy ex-

pansion. India must fundamentally transform approach, according to which produces, distributes and consumes energy to reduce its dependence on foreign oil, create jobs, improve global competitiveness and reduce carbon emissions.

The Indian Government made several significant steps towards improving the infrastructure (e.g. development of renewable solar and wind energy) but it need to be done more and quickly. One of the steps was the creation of the Jawaharlal Nehru National Solar Mission (JNNSM) at the end of 2009. However, obtaining 10% of the country's solar energy – 20GW by 2022 – is not enough. One of the next steps will be establishing a national solar initiative to facilitate the deployment of 100 million solar roofs and utilities over the next 20 years. Therefore, India can become a great player and a global leader in the field of solar energy for many years.

Wind energy can also help India to convert 100% renewable energy. According to the World Environment Fund, 170GWh could be used by 2050 on 7500km of coastline. Hydropower can generate 148GWh, geothermal10.7GWh and tidal power15GW.

If the available resources are properly designed and used, all new energy production in India can be obtained from renewable energy sources until 2030; all generations can be converted to renewable energy by 2050. There are social and political barriers, not technological or economic in the plan of renewable energy.

To achieve this goal of 100% renewable energy until 2050, need to follow next steps shown in fig.6.Renewable energy (especially solar and wind) could increase the energy security of India and is a bright spot of its economic and environmental future. When India stopped use coal, oil, natural gas and nuclear power plants, it is possible that 70% of electricity and 35% of its total energy can be produced from renewable resources until 2030.

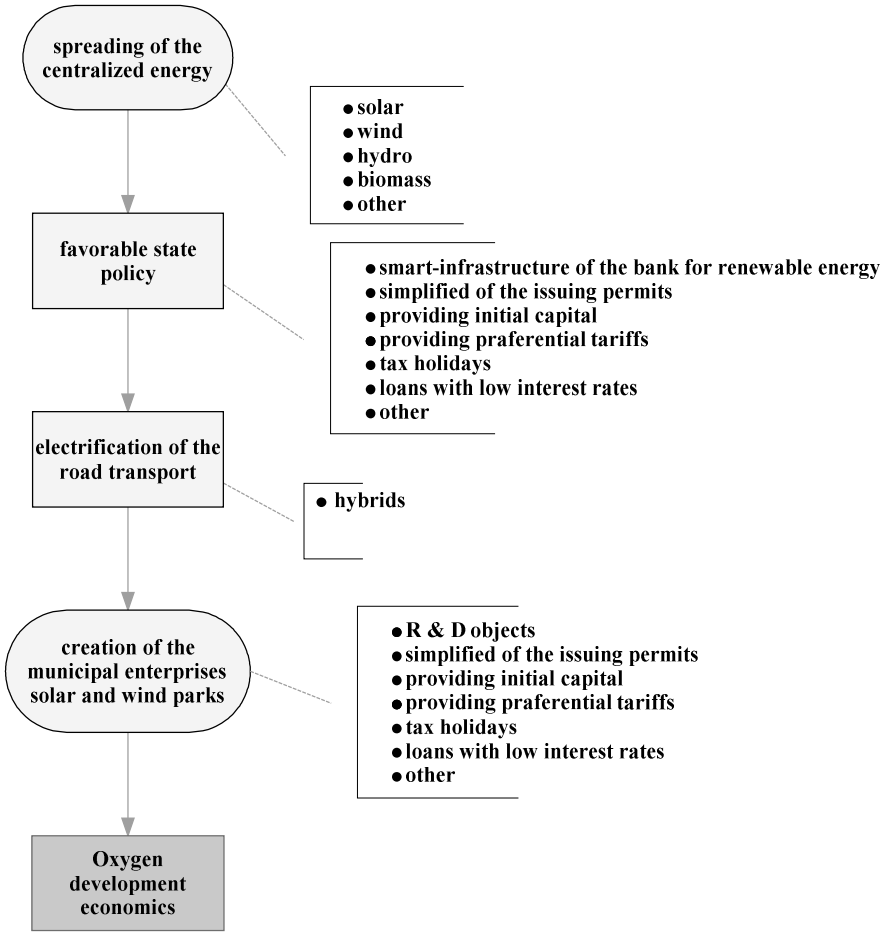
If India stops use coal, oil, natural gas and nuclear power plants, it is possible that 70%of electricity and 35% of its total energy can be produced from renewable resources by 2030. Surplus energy derived from renewable sources can be stored in various forms such as liquid or molten salt (a mixture of sodium nitrate and potassium nitrate), compressed air, hydrogen, batteries, etc. This stored energy can be used during periods of peak demand (Ahearn; Vestergaard, 2011; Human Development Report, 2013).

100% supply of energy needs in India using solar, wind, hydro and biogas clean renewable energy till 2050 technically possible and economically feasible. However, some political barriers must be over came. For example, the parliament of Denmark implements the most ambitious plan for a green economy: generation 35% of its energy from renewable until 2020 and 100% by 2050. Iceland, Scotland and Philippines, recently announced impressive plans about 100% of their power from renewable energy sources. Fukushima has promised to move to 100% renewable energy until2040 after the nuclear crisis in Japan

(Trends in global CO_2emissions: 2014 Report. Background studies; Trends in global CO_2emissions: 2013 Report. Background studies).

Figure 6

Model of Energy Strategy of India



Note: Made by author.

Concusions

Need to say, that 90% CO_2 emissions caused by the burning fossil fuels. It defines by the following three main factors:

- energy demand level or energy-intensive activities, particularly related to power generation, heavy industry and road transport;
- changes in energy efficiency;
- changes in the structure of fuel balance, for example, coal with low carbon dioxide, fossil fuels or nuclear or renewable energy sources.

Important drivers of fossil fuels are fuel prices in general and relative price differences between coal, oil and natural gas. Of course, energy policy also aims to control the use of fossil fuels. Providing 100% renewable energy is not fancy, ever, but today's reality. India has a great opportunity to solve three huge problems – poverty reduction, energy security, climate change. But it must act soon! India can no longer afford to delay the deployment of renewable energy to meet its future energy needs.

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