International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2017, 7(4), 231-239.

Methodological Approaches to Estimation of Energy Efficiency within the Framework of the Concept of Green Economy and Sustainable Development

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ABSTRACT

The transition of the world developed countries to a "low-carbon" economy and "green" economic growth leads to the fact that energy indicators are actively included in the system of environmental and economic assessments at the present stage of development. Taking into account the synergetic approach required in the analysis of energy efficiency, reflecting its impact on three main areas of activity: Economic, social and environmental, we consider the index of adjusted net savings to be the final link of the World Bank's "green" indicators. Based on the analysis, it is argued that there are fundamental differences in economic policy regarding energy efficiency for different groups of countries. The experience of leading foreign countries in the field of energy efficiency is summarized, such as Germany and Japan, which occupy leading positions in the energy efficiency rating. However, the authors pay special attention to two more countries: Finland and China.

Keywords: Green Economy, Green Growth, Energy Saving, Green Accounts, Energy Efficiency, Low-carbon Economy
JEL Classification: Q4

1. INTRODUCTION: FROM GLOBAL PROBLEMS TO GREEN ECONOMY

A problem of availability and exhaustibility of natural resources is a burning issue for the modern world. The XX century showed a rapid increase in the consumption of electricity and primary energy resources: Total energy consumption increased 15 times, 4.4 times per capita of the world population (Ushakov, 2011). Despite simultaneous development of primary energy resources with high energy content - coal, oil, gas, Uranium, - the increased needs of society and economies have been still not met, and that reflected in the 1970s energy crisis. Trends that formed in the XX century persist in the XXI century: Energy consumption continues increasing, even taking into account recurring economic crises leading to short-term energy consumption declines; the world community continues to be dependent on oil and other fossil fuels.

The environmental problem is closely related to the issues of resource deficiency. Over the past 15 years (from 2000 to 2015), world energy consumption has increased by 37%, amd carbon dioxide (CO_2) emission increased by 42% over the same period (Enerdata, 2016). In addition, by 2050, the earth's population is expected to grow to 9 billion people, which will be accompanied by a fourfold increase in the world economy and an increase in energy consumption by 80%. It is expected that 70% of the population will prefer urban life, which will further exacerbate problems associated with air pollution, waste processing (Consequences of Inaction Summary in Russian, 2016).

According to the forecast of the Organization for Economic Cooperation and Development (OECD), unless decisive measures are taken to prevent environmental degradation, 70% increase in CO_2 emission and an increase in the average surface temperature by 3-6°C instead of a threshold of 2°C can be expected by the year

2050. The existing methods of production and consumption will lead to the fact that by the year 2050, as compared to the beginning of the XXI century, 61-72% of the flora and fauna will be lost, and the integrity of 7.5 million square sq. km of natural areas will be irreversibly disrupted. This is comparable to the territory of Australia (Consequences of Inaction Summary in English, 2012).

Thus, for the world community, there is an urgent need to change existing economic practices in order to re-orient existing market incentives. At the present stage of the world economy development, the inclusion of energy indicators into the system of environmental and economic assessments is a common trend. The world community, striving to move towards improving the quality of life of society, set its sights on a new, sustainable "green" growth, which provides for the increase in the welfare of society with underlying careful attitude to the environment. A basis for the concept of sustainable "green" growth is the principles of prioritized high energy efficiency and minimum impact on the environment. Taking into account the multilateral impact of energy efficiency on various aspects of public life, its assessment indicators are social, environmental and economic indicators and are widely used in the "green" accounts of the World Bank for comparative cross-country analysis in the context of implementation of sustainable development programs.

2. LITERATURE REVIEW AND HYPOTHESIS

Theoretical and methodological foundations of the interconnectedness of environmental and economic interactions and energy efficiency were studied in the works of domestic and foreign authors. Among foreign authors, the problems of environmental and economic interaction were reflected in the works of Antikainen R, Bina O, Droste N, and others. The works of I. Bashmakov, V. Ushakov, S. Bobylev, A. Averchenkov can be attributed to the most significant and systematic works in this area by domestic authors. The main hypothesis of these works were the study of methodological foundations for the establishment of "green accounts" and identification of the role of the energy factor in the integrated assessment of energy efficiency.

3. THE METHODOLOGY

The following general scientific methods were used in course of research: A method of content analysis intended for analyzing the semantic content of textual arrays on the subject of research, as well as tools for inductive and deductive analysis, allowing to combine separate conclusions on this problem and formulate the author's vision of the problem. Special methods were also used: Absolute and relative statistical indicators, dynamics indicators, the method of factor analysis.

The information basis for the study was published official reports, reports and statistical databases of international organizations such as the United Nations, the International Energy Agency, the World Bank Group; Russian State Statistics Service database, normative and legal documents on energy efficiency and energy preservation of various countries; state reports and projects on energy preservation and energy efficiency.

4. "GREEN" ACCOUNTS AND INTEGRATED ASSESSMENT OF ENERGY EFFICIENCY

Effective use of energy resources directly affects the three spheres of public life. Energy efficiency, being a way to solve the problem of resources exhaustibility and maintaining energy well-being, ensures rational energy consumption, which affects the economic side of the issue. Taking into account the high degree of dependence on the use of energy resources and environmental pollution, and the fact that the energy generation industry itself is the largest polluter, it can be argued that energy efficiency is a major factor of influence on the environmental aspect of public life. Finally, from the social point of view, effective resources use is a factor of improvement of the well-being and living standards of the population.

In this regard, it can be argued that assessment of the energy efficiency of the economy should be three-aspect, and the indicators used for assessment should be social, environmental and economic indicators.

Referring to the experience of developed countries, we can conclude that energy preservation, reducing energy intensity, reducing import dependence on energy resources, diversifying fuel sources, reducing CO_2 emission, increasing the proportion of renewable energy sources (RES) in the structure of energy resources and improving the quality of life of the population shall be integral components of energy efficiency (Sabilo, 2017). An assessment of energy efficiency taking into account the above characteristics, as well as monitoring of the implementation of basic principles of sustainable development and, consequently, the "green" economy requires the availability of adequate indicators of world development corresponding to new priorities towards sustainable, green growth (Loiseau, 2016).

Development of a system of necessary indicators was carried out by the UN with the support and partnership of the World Bank Group, the International Monetary Fund, the OECD and the European Commission. In 1993, the UN statistics division published the System for Integrated Environmental and Economic Accounting (SEEA), the main purpose of which was to take into account the environmental factor in the systems of national accounts.

In 2012, under the authority of the above-mentioned international organizations, the Central Framework of the System of Environmental-Economic Accounting (SEEA), designed to become the primary international statistical standard for environmental and economic accounting were published. The proposed system is based on consideration of interrelation of the country's economy (reflected in the system of national accounts) with environmental factors and natural resources (Central Framework of the System of Environmental-Economic Accounting (2012).

The difference between "green" accounts and the traditional accounting system is the adjustment of economic indicators by the value of two factors: Valuation of depletion of natural resources and environmental and economic damage caused by pollution.

Indicators of the World Bank's "green" guide for Russia for 2010 and 2016 are given in Table 1.

As can be seen from Table 1 "green" accounts of the World Bank contain information on the main parameters that characterize environmental and energy situation in the country.

Taking into account the synergistic approach required for analysis of energy efficiency, the indicator of adjusted (genuine) domestic savings which is the final link of the World Bank's "green" indicators, is of particular interest. Significance of this indicator is that it is the most elaborated aggregated indicator reflecting an integral approach to assessing the system sustainability, since its calculation involves consideration not only of natural resources but also of other components necessary to ensure equivalent opportunities for existence of future generations in comparison with the present time. An expanded account of human potential, energy and environmental factors that make up the national wealth of the country provide the necessary indicator adjustment. Thus, the excessive use of non-renewable sources of energy, which is their depletion, and the inefficient, irrational use of renewable sources, as well as the lack of attention to environmental aspects (CO_2 emission) represent a deduction from the national wealth of the country. On the other hand, investments in education that increase human capital have a positive impact on the national wealth of the country, ensuring its growth.

From the viewpoint of energy efficiency assessment the consideration of the energy factor in the indicator by correcting gross (unadjusted) savings by the depletion of energy resources is essential. The social and environmental aspects of energy efficiency are taken into account through the CO_2 and particulate matter emission indicators.

Thus, the calculation of adjusted gross savings (GS) is a two-stage adjustment of gross domestic savings (GDS) for the value of consumption of fixed capital (CFC), for the purpose of determining net domestic savings, and then for the amount of education expenditure (EDE), the amount of depletion of natural resources (DPNR) and damage from environmental pollution (DMGE) (Bobylev et al., 2012):

$$GS=(GDS-CFC)+EDE-DPNR-DMGE \quad (1)$$

Consideration of this indicator as an aggregated energy efficiency index has the advantage of having a single calculation methodology for the world and individual countries, as well as its basing on official statistics and an annual update, which allows for cross-country comparisons. It can be noted that a number of countries are already using this indicator as official indicator at the macrolevel (Bobylev et al., 2010).

Thus, adjusted GS allow us to consider and evaluate energy efficiency as a factor of modern, and hence sustainable development.

It bears noting that the World Bank calculates this statistics for more than 100 countries, and the analysis of gross (traditional) indicators and environmentally adjusted indicators showed significant discrepancies.

Table 2 compares the main components of adjusted GS for the developed countries of the world, which achieved the greatest success in the field of energy efficiency, and for Russia.

As noted above, environmentally adjusted indicators significantly differ from traditional ones. So in Japan, as of 2016, the true savings amounted to only 15.8% of the actually recorded GS. It is interesting that the Russian Federation is on the third place among the countries surveyed: Traditional and adjusted indicators differed by 51%.

However, for a complete assessment, it is important to consider the adjustment components of savings. Thus, for the developed countries of the European Union a relatively high level of consumption of fixed capital is typical, it is compensated by significant expenditures on education, i.e., investments in human capital (the costs of education are the largest among the analyzed countries). Japan and China differ in diametrically opposite situations: The rapidly growing Chinese economy is characterized by a low consumption of fixed capital, while for Japan this figure is almost 100% of GS. The Russian Federation is characterized by low consumption of fixed capital and average EDE.

From an integrated energy efficiency assessment point of view, an analysis of such components of GS as depletion of energy resources and damage caused by particulate matter and CO_2 emissions that completely change the ranking of countries is indicative. Unconditional leaders are Japan and Germany, showing a minimum, close to zero values for the depletion of energy resources and environmental pollution. It should be noted that these countries shared the first line in the American Council for Energy-Efficient Economics (ACEEE) 2016 rating on energy efficiency. Finland is third in terms of energy consumption and environmental pollution. The fourth position is taken by China, which shows relatively low rates of energy resource depletion, given the high growth rates of its economy (gross domestic product [GDP] growth rate for the last 6 years was 69.8%). Significantly behind in terms of energy efficiency is the Russian Federation – the percentage of depletion of energy resources is 8.8% of Gross national income; as for the level of environmental pollution, both China and Russia show equal values. It must be noted that for Russia it is the depletion of energy resources that is the main factor determining the amount of adjusted GS. With a relatively constant level of GS, EDE and the amount of environmental damage, it is the energy rent that determines the indicator value (Bobylev et al., 2012).

Thus, the indicator of adjusted GS reflects fundamental differences in economic policy across the world.

Table 1: The Little Green Data Book, world development indicators, Russia

Indicator name	2010	2016
Population, million people	142.0	143.8
Area, thousand km^2	16,378.0	16,377.0
GDP, billion US dollars	1,679.5	1,860.6
GNI per capita, atlas-method, US dollars	9,660.0	13,220.0
Adjusted net national income per capita, US dollars		10,677.0
Number of urban population (% of total number)	73.0	73.9
Urban population growth, % (average for 1990-2008)	−0.3	-
Population growth, % (average for 1990-2008)	−0.2	-
Agriculture		
Agricultural lands, % of total area	13.0	13.0
Irrigated lands, % of total agricultural land area		2.0
Productivity of agriculture, additional cost per employee (2005, US dollars)	-	6,301.0
Grain output, kg/ha	-	2,443.0
Density of rural population, person per km^2 of arable land	32.0	-
Index of food production (1999-2001=100)	123.0	-
Forests and biodiversity		
Forest area, % of total land area	79.4	49.8
Annual deforestation, change in %, 2000-2015	0.0	0.0
National protected areas, % of land area	9.0	11.4
Mammals, endangered species	33.0	29.0
Birds, endangered species	51.0	54.0
Fish, endangered species	32.0	40.0
Plants, endangered species	7.0	59.0
GEF - benefits index for biodiversity (0-100)	31.4	-
Oceans		
Total amount of fish production, thousand tons	-	4,396.0
Growth of fish catch, average % for 2010-2014	-	0.4
Growth of aqua culture, average % for 2010-2014	-	5.5
Marine protected areas, % of territorial waters	-	11.5
Coral reef area, km^2	-	-
Mangrove forests, km^2	-	-
Energy and emissions		
Energy consumption per capita, in kg of oil equivalent	4,730.0	5,093.0
Energy from biomass and waste products, % of total amount	1.0	1.0
Electricity consumption per capita in kWh	6,317.0	6,539.0
Electricity produced using fossil fuels, % of total amount	66.4	66.2
Electricity generated at HPPs, % of total amount	17.5	17.1
CO_2 emission per capita, metric tons	11.0	12.6
Water supply and sanitation		
Fresh water reserves per capita, m^3	30,350.0	29,989.0
Total fresh water intake, % of internal resources	1.8	1.5
Agriculture, % of total fresh water intake	18.0	20.0
Access to purified sources of water, % of total population	97.0	97.0
In rural areas, % of rural population	88.0	91.0
In cities, % of urban population	100.0	99.0
Access to water and sanitation, % of total population	87.0	72.0
In rural areas, % of rural population	70.0	59.0
In cities, % of urban population	93.0	77.0
Environment and health		
Pollution PM2.5, average annual value, mkg/cub m	-	14.0
Exposure to PM2.5.,% exceeding the WHO established level	-	73.0
ARD disease rate, % of children under the age of 5	-	-
Diarrhea disease rate, % of children under the age of 5	-	-
Mortality of children under the age of 5, per 1000 births	13.0	10.0
National statistical aggregates		
GS, % of GNI	32.8	24.3
Fixed assets consumption, % of GNI	12.4	4.9
Education costs, % of GNI	3.5	3.5
Depletion of energy resources, % of GNI	20.5	8.8
Depletion of mineral resources, % of GNI	1.0	0.6
Aggregate percentage of forest depletion, % of GNI	0.0	0.0
Damage from CO_2 emission, % of GNI	0.9	1.1
Damage from particulate emission, % of GNI	0.1	0.4
Adjusted GS, as % of GNI	1.5	11.9

Source: Compiled by the author on the basis of (The Little Green Data Book, 2016), (World Energy Outlook, 2016). (Data of the Official Site of the Information Center Enerdata).
CO2: Carbon dioxide, GDP: Gross domestic product, GS: Gross savings, GDS: Gross domestic savings, GNI: Gross national income

Table 2: Adjusted GS for some developed countries and for Russia, 2016

Indicators, % of GNI	Germany	Japan	China	Finland	Russia
GS (GDS)	26.3	21.5	49.4	19.0	24.3
Consumption of fixed capital	17.4	21.0	12.9	19.0	4.9
EDE	4.7	3.2	1.8	6.8	3.5
Depletion of energy resources	0.0	0.0	1.3	0.0	8.8
Depletion of mineral resources	0.0	0.0	0.9	0.2	0.6
Aggregate percentage of forest depletion	0.0	0.0	0.1	0.0	0.0
Damage caused by CO_2 emission	0.2	0.3	1.1	0.2	1.1
Damage caused by particulate matter emission	0.1	0.1	0.4	0.0	0.4
Adjusted GS	13.3	3.4	34.5	6.3	11.9
Proportion of GS in GDS, %	50.6	15.8	69.8	33.2	49.0

Source: Compiled by the author on the basis of (The Little Green Data Book, 2016). GS: Gross savings, GDS: Gross domestic savings, GNI: Gross national income, CO_2: Carbon dioxide, EDE: Education expenditure

Thus, the negative values of this indicator are feature of the countries that have a strong dependence of the economy on raw materials, primarily oil production and exports. Russia also belongs to such countries (in 1998 the adjusted GS amounted to minus 3.3%, in 2006 – minus 4.4%, and in 2008 – minus 13.8%). This is due to the fact that, usually, for the countries that are highly dependent on natural resources, especially energy resources, their consumption is not compensated by investments in basic and human capital, which is necessary for sustainable development in the future.

Countries with high positive index values are characterized by minimal damage to the environment and insignificant level of energy and mineral resource consumption. This is both due to geographical features that determine energy resources (for Europe), and strengthened measures of government policy on decrease of raw materials dependence. A positive example in this case is Norway, which has significant reserves of energy resources and actively exports them, but at the same time has positive index values.

Summarizing the analysis, we note that according to the index values, developed countries are characterized by sustainable development, followed by a minimal depletion of natural capital. The main factor of falling living standards in developed countries is depletion of fixed capital. Depletion of energy resources is typical for developing countries and countries with economies in transition, this is connected, to a greater extent, with energy-intensive production and raw-material orientation of the economy. Russia belongs to such states as well.

Certainly, adjusted GS are a generalized indicator of energy efficiency assessment, and for a deeper assessment of economies, it is necessary to conduct a qualitative analysis of the corrective components in accordance with the features of a particular country for the most influential component in order to determine primary sources of the problem. In addition, this indicator does not include a number of factors of environmental degradation.

Nevertheless, this indicator is the most developed, having an official unified statistical base, which allows for cross-country comparisons. In addition, it reflects the need to balance the economic growth of the country and its effects on the environment by compensation of DPNR by investing in basic and human capitals.

To sum up, it is worth noting that a single methodology for assessing energy efficiency as an integrated characteristic and the basis for sustainable development has not yet been developed. The analysis presented above is based on the most developed and statistically comparable indicators. At the same time, further "greening" of the World's development indicators and, accordingly, the development of integrated indicators of energy efficiency are in a number of topical tasks being solved by national and international institutions and organizations.

5. MAIN INITIATIVES OF DEVELOPED COUNTRIES IN THE FIELD OF ENERGY EFFICIENCY POLICY

In 2016, the ACEEE published the International Energy Efficiency Scorecard, 2016, containing the rating of the countries for energy efficiency of economies, which analyzed the energy efficiency of the 23 leading countries in terms of energy consumption. Together, these countries account for 75% of global energy consumption and 80% of the world's GDP. The leading position in this ranking is of Germany, which scored 73.5 points out of 100 possible, second place was shared by Japan and Italy, which gained 68.5 points. The experience of the first two countries will be considered further in this paper. The success of implementation of energy efficiency policy and its role on the world stage makes the experience of these countries in the context of sustainable development and energy efficiency particularly significant. However, the authors pay special attention to the two more countries: Finland, as one of the most successful countries in the field of energy efficiency, and China, which has a rapidly developing economy, but nevertheless emphasizes the importance of ecology and resource efficiency.

5.1. Germany

The first legislative acts aimed at regulating energy efficiency, appeared in 1995, soon this legal and regulatory framework developed into a targeted state policy on reformation of the Germany energy system.

Fundamental decisions in the field of energy policy were adopted in the 2000s. In 2000, the RES act was adopted. On September 28, 2010, the German government adopted a comprehensive strategy called "Energiekonzept 2050", which offers a new way to develop energy up to 2050. The adopted program was a continuation of the integrated program on energy and climate protection that has been successfully implemented since 2007, with the help of which energy efficiency data of all industries were accumulated with more stringent targets. The essence of the new concept is to adapt to RES by 2050, reduce energy consumption and greenhouse gas emission into the atmosphere, and increase energy efficiency. In accordance with the adopted plan, the proportion of RES shall be 18% of the final energy consumption by 2020 and 60% by 2050. In the electricity sector, these figures shall reach respectively 35% and 80%. In 2011, after the accident at the nuclear power plant in Fukushima, the FRG decided to accelerate the abandonment of nuclear power by 2022. This decision led to the adoption of an additional package of measures known as the "Energiewende", which shall result in the complete abandonment of nuclear energy by 2022 and the reduction of CO_2 emission by 80-85% by 2050 (compared to 1990). So the work of 17 nuclear power plants was stopped. The most important component of "Energiewende" is the decrease of primary energy consumption by 20% by 2020 and by 50% by 2050, compared to 2008 (Energy Policies of IEA Countries, Germany (2013).

The adopted plans are being successfully implemented. Alternative and renewable sources of energy are widely used: Wind power plants, solar batteries, devices for processing various materials into biofuel; gas power stations with increased efficiency, tidal power plants, etc. A lot of attention is paid to improvement of energy efficiency in industries, transport and the country's housing stock (Review of the state of economy and main foreign economic activity directions of the Federal Republic of Germany, 2015). The main mechanisms of state support are donations and subsidies, common mechanisms are tax and tariff benefits. Thus, payments are made to network operators at fixed tariffs per kilowatt-hour of electricity generated on the basis of RES. Some benefits are provided for installing and improving power systems in homes and enterprises, in order to increase energy efficiency and reduce energy consumption (for example, 90 euros per unit when installing a solar battery). The construction of "passive" and "active" houses is funded. Since 1999, there is a system of environmental taxes for the use of natural resources, CO_2 emission, as well as an energy tax.

In support of energy reform, the government intensifies research and development in this area, this way, in August 2011, the Energy Research Programme was adopted, and R&D financing in the energy sector increased. Demonstrative results of effective research activity is market appearance of installations with "Energy-in-Gas" scheme, the construction and commissioning of the thermonuclear reactor Wendelstein 7-X in December 2015 in Germany (Review of the state of economy and main foreign economic activity directions of the Federal Republic of Germany, 2015).

5.2. Japan

The foundations of energy efficiency policy were laid down at the legislative level in the mid-1970s. Subjects of legislative regulation are mainly construction activity, industries, household appliances production and use. Fundamental legislative acts in the field of energy preservation and energy efficiency are the Law on Rational Use of Energy (1979) and the Law on the Promotion of Energy Preservation (1993).

The consequences of an accident at the nuclear power plant in 2011 determined the need for a radical review of the state energy policy. In 2014, the government adopted the fourth "Strategic Energy Plan", and on its basis in 2015 the Ministry of Economy, Trade and Industry prepared "Prospects for Long-Term Energy Supply and Consumption" until 2030. The adopted plans are aimed at increasing the diversification of energy consumption (reducing consumption of fossil fuels, increasing the use of RES), and aiming at reducing carbon emission by 26% between 2013 and 2030 (Energy Policies of IEA Countries, Japan, 2016).

To promote the development of RES, namely solar, wind, geothermal and biofuel energy, the government adopted a law and implemented the feed-in tariff program, the essence of which is the obligation of universal electric companies to private producers to buy electricity from "green" sources at fixed prices (Review of the economy and foreign economic activity of Japan, 2015). The TopRunner program, which sets standards for energy efficiency for the most energy-intensive products, such as household appliances and cars, continues to be successfully implemented. Products that have the best characteristics are promoted by the state in by means of marking and media promotion. At the same time, companies that produce products that do not meet the standards are subject to fines. As of 2015, the program covered 31 product categories. In the sphere of construction and operation of buildings and facilities, the regulation and standard for housing and construction, adopted in 1980, is of particular importance. Housing and construction standards include specific energy preservation measures for residential and non-residential premises, as well as the obligation to report on the implementation of appropriate measures (Energy Efficiency Market Report, 2016).

In the field of industry, there is an obligatory labeling of cars; the purpose of this is to provide information on fuel consumption and CO_2 emission in order to increase consumer awareness. The government actively concludes target agreements with large industrial companies and holdings aimed at partnership of the state and business in the field of increasing energy efficiency, reducing harmful impact on the environment. There is a system of subsidies and tax incentives to facilitate the acquisition of energy-efficient industrial equipment (Bashmakov and Bashmakov, 2012).

The introduction of the newest production technologies ensures a low level of energy consumption in the economy, in order to maintain appropriate developments, R&D funding in this area is financed; assistance to national RES producers on entering the world markets of high-tech products is provided. Also by 2030, noncurrent coal and gas generation facilities are planned to be replaced, this shall increase their efficiency by 20-25% (Reference and analytical materials on energy development in the countries of the Asia-Pacific Region, 2015).

5.3. China

As a result of 2015, China demonstrated a decrease in energy consumption per unit of GDP by 5.8% compared to 2014. The production of electricity by wind power plants increased (by 12.8% compared to 2014). In terms of the number of integrated solar installations, their production and export, and also as for primacy in the field of wind power, China is the leader (China Triples the Capacity of Alternative Energy, 2016).

The year of 2015 was marked by significant successes in the automotive sector with new energy sources (3.3 times growth in production) and production of electric vehicles (4.2 times growth), supported by the state policy on subsidizing these areas. Priority direction for innovations is modernization and innovative development of manufacturing industries (the program "Made in China-2025"), which provides for the formation of 15 innovation centers, which should provide a breakthrough in the development of 10 key industries, including energy saving equipment and cars using new sources of energy (Annual Review of the State of the Economy and the Main Foreign Economic Activity Directions of the PRC, 2015).

Since 1997, China has been awarding "environmentally exemplary cities, this award can be achieved when 25 conditions are met, for example, low specific energy consumption, potable water availability above 96%, use of modern industrial technologies, etc. In 2007, the PRC government announced a course for a "green" revolution in the country, which got in line with the course towards the industrialization of a new "green" type and the construction of an innovative economy. The so-called "green" cities are now developing: There is an approved plan for the construction of 30 eco-cities (Sino-Singapore, Tianjin, Dongtaun, the new Turpan, etc.). In 2010, energy efficiency standards were introduced in the field of construction, for example, in a number of provinces a house can not be commissioned unless it is equipped with solar panels (Zakharova, 2013). There is a demand for the construction of houses with "zero technology", that is technology of self-supply by the building of itself with energy (using solar panels and wind generators) and requiring no additional outside energy sources (Energy-saving Buildings in China, 2017).

There is a system for checking the compliance of products of companies with energy preservation standards, as well as a program of voluntary labeling of goods for producers. "Top-1000" and "Top-10000" programs targeting the largest enterprises in China with a significant energy consumption rates are effectively implemented. Since 2008, there is a target credit line of the World Bank and the Global Environment Facility for supporting the China Energy Efficiency Financing Program, through which local banks are financed, in turn providing funds to enterprises for energy-saving projects. Also, in 2007, the Chinese Government launched the process of complete elimination of incandescent lamps in favor of energy-saving lamps, which will save up to 60 billion kWh of electricity annually (Kuzmina et al., 2014).

5.4. Finland

The integrated energy efficiency program in Finland is based on the principle of "Plan-Do-Check-Act", which requires the mandatory implementation of the four stages listed at all stages of innovation in the energy complex functioning. The energy efficiency policy is comprehensive and integrated in environmental policy, quality policy, strategic planning policy and other areas of enterprise activity. Instruments of state support to enterprises for the integration of energy-efficient technologies are subsidies for the purchase of new technologies, and also tax incentives. Legislatively, there are strict rules for the operation of enterprises, with consideration of environmental constraints, for example, the involvement of enterprises in the waste treatment system.

The focus of government attention is now on energy production with the help of RES: By 2020, the goal is to achieve the production of 38% of electricity using alternative energy sources (water, wind, earth) (Dadanov and Kukhno, 2014). Stimulation of the RES development is provided by means of the "green" purchasing tariff. Scientific developments are aimed at increasing the use of energy produced from bioethanol, winter cress and chopping waste. The country holds a leading position in the use of bioenergy, as well as in the development of combustion technologies and efficient fuel chains. The energy cluster of the country is extensively experienced in the use of biomass, process automation and combined heat and power generation (congeneration), which allows not only to generate energy most efficiently but to reduce emissions. An important part of the congeneration is the central heating system.

There is widespread propaganda of achievements in the field of energy efficiency (exhibitions for demonstration of energy-efficient buildings, Viikki district) against the backdrop of high energy tariffs, which changes people's thinking towards resource saving and green products use (Dadanov and Kukhno, 2014).

6. CONCLUSION

1. Transition of the developed countries of the world to a "low-carbon" economy and "green" economic growth significantly contributes to the energy security of countries and overcoming financial and environmental crises. Major initiatives of developed countries in the field of energy preservation and energy efficiency show that there is a close relationship between energy efficiency and environmental and economic sustainability, and the comprehensive attention and impact on the given problem by the state, taking into account national peculiarities, allows achieving significant success in this area.
2. Energy indicators at the current stage of development are actively used in the system of environmental and economic assessments. The indicators of energy efficiency assessment are social, environmental and economic indicators and are widely used in the "green" accounts of the World Bank for conducting comparative cross-country analysis in the context of implementation of sustainable development programs. Taking into account the synergistic approach required for analysis of energy efficiency, the indicator of adjusted (genuine) domestic savings, which is the final

link of the World Bank's "green" indicators, is of particular interest.

3. Analysis of the indicator of adjusted savings showed principal differences in economic policies across the world. According to the index values, developed countries are characterized by sustainable development, followed by a minimal depletion of natural capital. The main factor of falling living standards in developed countries is depletion of fixed capital, which is compensated by minimal depletion of natural resources and significant EDE, i.e., investment with human capital. Depletion of energy resources is typical for developing countries and countries with economies in transition; this is connected, to a greater extent, with energy-intensive production and raw-material orientation of the economy, which casts doubt on further sustainable growth.

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