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Article

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International Journal of Energy Economics and Policy

International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2018, 8(3), 250-257.

Population of the World and Regions as the Principal Energy Consumer

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ABSTRACT

The article presents the forecast of consumption of the world energy volume taking into account the population growth up to 2030. While arranging the study it was found that most countries are in the process of rapid population growth, followed by a phase of outstripping growth in energy consumption and economics industrialization. The levels and dynamics of primary energy consumption per capita are fundamentally different in developed and developing countries. If developed countries have already passed the peak of their per capita energy consumption, then developing countries will witness the increase of per capita energy consumption. It has been established that a number of developing countries will not be able to significantly increase their per capita energy consumption during the forecast period with the outstripping population growth, and the problem of energy poverty will remain acute for them. Therefore the article substantiates the only theoretically possible way of overcoming the crisis which is represented by a large-scale use of renewable energy sources: Solar, wind, oceanic which are considered to be non-conventional or alternative ways of obtaining energy. It is less dangerous, practical, durable and environmentally sound.

Keywords: Energetics, Effective Energy Consumption, Energy Poverty, Renewable Energy Sources
JEL Classifications: C62, N70, O13, P48

1. INTRODUCTION

Human civilization has rapidly increased the amount of energy consumed over the past decades. World energy consumption includes all energy extracted from all energy resources and consumed by mankind in all industrial and customer-related economy sectors in each country. As an energy measure of civilization world energy consumption is of great importance for the socio-economic and political spheres of human civilization.

The main factors influencing the total consumption of primary energy resources in the world are:

- The Earth population;
- Per capita energy consumption;
- Technical level of energy-converting and energy-saving technologies.

The main consumer of energy consumption is population. The aim of this paper is to forecast consumption of the world energy volume taking into account the population growth up to 2030.

2. FACTORS INFLUENCING ENERGY CONSUMPTION

2.1. Forecast Population Numbers

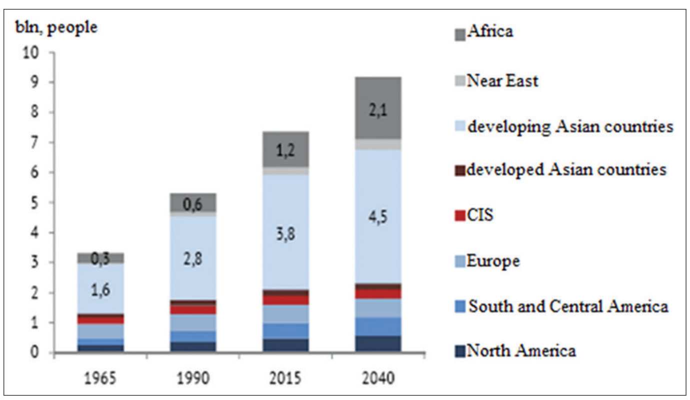
According to the UN data in mid-2015 the world's population reached 7.35 billion people, and by 2040 this figure will make 9.157 billion people, which will pose a challenge of providing extra 2 billion people with energy to mankind (Figure 1, Table 1) (Baranova, 2017; Tendencies and prospects…, 2017). This study specifies the UN population projections for Russia in accordance with the "Forecast of the socio-economic development of the Russian Federation for the period until 2030" (Sidorovich, 2015).

Table 1: Change in the number and structure of the world's population by regions and largest countries in 2015-2040

World's largest countries	Population, mln people		Average annual population growth,%2015-2040	Urbanization level,%		Activity rate or participation rate, %	
	2015	2040		2015	2040	2015	2040
North America	485.574	485.574	0.68	81.86	81.86	66.62	66 62
USA	322.374	322.374	0.60	82	88	66	60
South and North America	507.603	507.603	0.69	80	85	67	65
Brasil	208.236	208.236	0.51	84	87	69	66
Europe	617.633	617.633	0.10	74	82	66	59
EC-28	506.507	506.507	0.01	76	82	65	58
CIS	289.297	289.297	0.11	63	66	69	66
Russia	146.145	146.145	−0.04	73	75	70	65
Developed Asian countries	205.203	205.203	−0.05	90	94	64	56
Japan	127.114	127.114	−0.43	94	98	61	54
Developing Asian countries	3824	4457	0.62	44	57	68	66
China	1384	1404	0.06	57	75	73	62
India	1311	1634	0.88	32	43	66	68
Near East	240	340	1.41	71	76	66	67
Africa	1186	2063	2.24	40	50	56	61
the World	7352	7352 9169	0.89	54	62	66	64

Source: Forecast of the energetics development in the world and in Russia 2016/ed. by Makarova *et al*. (2016). Davis *et al*., E. Phenomenon of Migration and Its Manifestations in the Modern World (2017)

Figure 1: Dynamics of the world population by regions from 1965 to 2040



Source: Forecast of the energetics development in the world and in Russia 2016/ed. by A.A. Makarova et al. (2016)

According to the UN data the demographic transition from high to low levels of fertility and mortality will end in all regions of the world in the forecast period that has already occurred in developed countries, which resulted in significant slowdown in population growth (Figure 2). This largely explains the expected slowdown in energy consumption growth rates. At the same time, the bulk of the population growth will be concentrated in the least developed countries of the planet and providing them with energy at affordable prices will be a very difficult task (Davis et al., 2017).

Half of the total new growth will be provided by only nine countries: India, Nigeria, Pakistan, Congo, Ethiopia, Tanzania, USA (where a half of the increase will come from immigration), Indonesia and Uganda, and what is more in 2022. India will become a world leader with a population of about 1.4 billion people having left China behind where the number of residents will start to decrease gradually after 2030.

The highest population growth rates will be in Africa, as a result its share in the world population structure will grow from the current 16% to 22% by 2040 (Figure 2). In absolute terms the population of the African continent will have increased by almost 900 million people with an average age under the age of 25 by the end of the forecast period compared with 2015, which can be a serious challenge to the sustainable development of all mankind (Enerdata, 2012).

The main factor in the population growth will be not the birth rate, but the increase in lifespan, while the number of young people under the age of 20 will be practically constant (BP Statistical Review of World Energy, 2015). The world number of able-bodied population (the age of 15-64) will grow by 21% for the forecast period while the population aged over 65 will more than double. As its world rate grows, the activity rate or participation rate is reduced to 64% by 2040 from a maximum level of 66% in 2015 (Figure 3). The activity rate or participation rate is declining at a faster rate in developed countries and China while developing countries including India sustain an upward trend.

For example, in future Africa will only increase its breakaway from the rest of the world in terms of population growth. It is clear that the demographic boom at such rates of growth and with such an initially low living standard creates a threat of poverty spreading with simultaneous increase in demands of the society (Electricity Regulation Report, 2006). The presence of natural resources on the continent in many cases does not contribute to improving the living standard and to reducing the energy poverty of citizens, but engenders the struggle between local elites and foreigners for accessing these resources and raising revenues while neglecting the interests of the local population.

2.2. African Challenge

Economic growth in Africa is expected to be within 2.5-4% per year depending on different scenarios. The countries of Africa are quite heterogeneous in terms of economic, demographic, social, religious and energy characteristics. The most uncertain development prospects concern the states to the south of North Africa and north of South Africa.

Despite major changes in Africa in recent decades, it still remains the most problematic region in the world (Sidorovich, 2015).

The continent witnesses numerous armed conflicts continuing to blaze which have already led to million deaths in the most recent period. The socio-economic situation in many African countries has a very difficult and sometimes chronically crisis-prone character. The real challenge for this region is poverty and a significant part of the African population lives almost on the verge of physical survival. Current rates of economic growth (with single exceptions) do not allow us to count on quick overcoming the gap in the development level of Africa and the rest of the world which continues to increase. All this is exacerbated by the unfavorable situation on the world markets for Africans, the massive spread of dangerous diseases on the continent, especially HIV/AIDS, tuberculosis, malaria, environmental problems, droughts, floods and other natural disasters. The unfortunate situation in Africa prevents the full participation of the continent's countries in world politics and international economic relations and has turned into a factor that threatens not only regional but also global stability. Much material and human resources are being diverted to peacekeeping operations in the region, humanitarian assistance and post-conflict rehabilitation. All members of the international community are affected by uncontrolled migration from zones of armed conflicts out of Africa, the related problems of the spread of crime, illegal drug turnover and infectious diseases. It is also necessary to take into account that instability provides a breeding ground for international terrorism and various kinds of extremist manifestations.

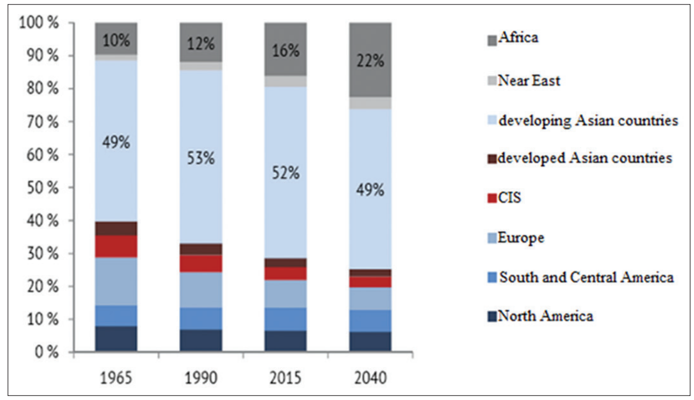
In future sustainable development of Africa is impossible without improving the living standards of local people, developing industry and other sectors of economics. The task of local energy supply in the presence of stable state support mechanisms can be partially solved by attracting renewable energy sources, but traditional fuels will be required in order to meet the needs of the public sector, industry and transport. The necessary condition for the development of the energy sector is represented by the availability of effective demand, financial resources, personnel, technology and most significantly political stability which largely determines the investment climate.

2.3. Urban Development

Another significant factor in estimating energy consumption is expressed by the urbanization process (62% of the population will live in cities by 2040 compared to 54% at the moment) although its level will still vary significantly by region (Figure 4). Patterns of energy consumption, typical of city residents, are beginning to differ more essentially from energy consumption patterns in rural areas.

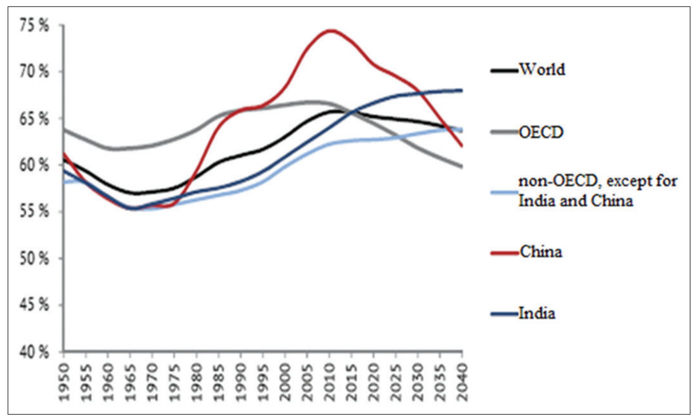
Compact settlement of people in urban areas, development of public urban transport, organization of effective use of waste as a renewable energy source, introduction of modern energy saving and energy efficiency technologies and most importantly the latest experiments on demand management based on artificial intelligence tools and Smart City projects become significant for braking and even decreasing in per capita urban energy consumption in comparison with the overall energy consumption.

Figure 2: Dynamics of the world population by regions from 1965 to 2040



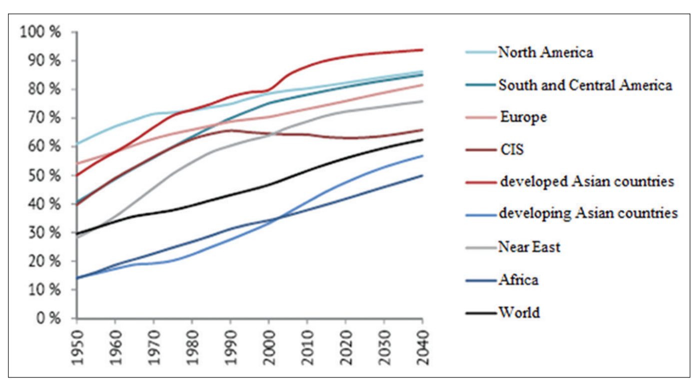
Source: Forecast of the energetics development in the world and in Russia 2016/ed. by Makarova et al. (2016). BP Statistical Review of World Energy (2015)

Figure 3: Activity rate or participation rate by major regions, %



Source: Forecast of the energetics development in the world and in Russia 2016/ed. by Makarova et al. (2016). Electricity Regulation Report (2006)

Figure 4: Dynamics of urban population rate by major regions of the world



Source: Sharma et al. Fuzzy rough set based energy management system for self-sustainable smart city (2018)

This is still relevant mainly for developed countries; however, we consider that this will become a global factor restraining the growth of energy demand in the forecast horizon (Sharma et al., 2018).

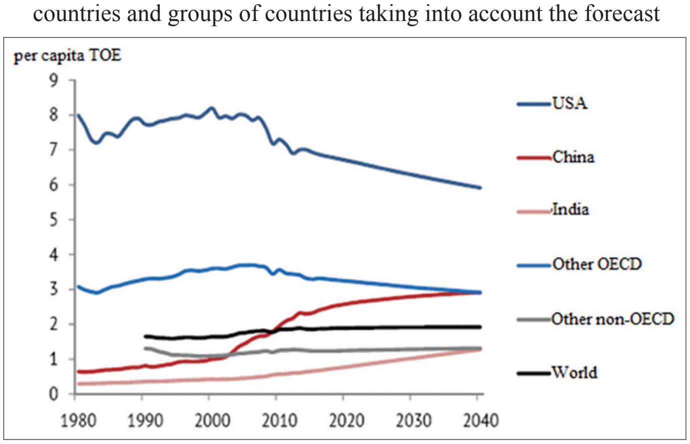
2.4. Indian Challenge and Poverty

Analysis of big sets of data demonstrates that most countries go through stages of rapid population growth followed by a stage of outstripping growth in energy consumption and economics industrialization, and then by growth in per capita gross domestic product (GDP) production which is faster than energy consumption growth. This is mostly associated with emergence of postindustrial economics and the share increase of the less energy-intensive services sector. Therefore the levels and dynamics of primary energy consumption per capita are fundamentally different in developed and developing countries. If developed countries have already passed the peak of their per capita energy consumption, then developing countries will witness the increase of per capita energy consumption (Figure 5). Some developing countries will not be able to significantly intensify their per capita energy consumption during the forecast period with the outstripping population growth, and the energy poverty problem will remain acute for them (Panse and Kathuria, 2018).

India is of particular interest as after 2025 it will become the most populated country in the world. But at present average per capita GDP (about $6,000) in India is more than twice as low as in China (about $14,000) and its per capita energy consumption is almost 4 times lower (Jiménez-Preciado et al., 2017). In general the differences besides overall level of economic development are associated with several factors:

- A significant part of the population (slightly less than one-fifth, mostly in rural areas) is generally deprived of access to energy.
- The middle class in India is not yet so numerous and does not require much energy to consume.
- The share of industry in GDP is only 32% in India which is relatively small for the industrialization stage. But the country managed to ensure high growth rates through the export of the following services: Software and “outsourcing services”, tourism and labor migration. There are tens of billion dollars transfered by the Indian wage workers just from the countries of the Persian Gulf.

Figure 5: Per capita energy consumption in the world, particular countries and groups of countries taking into account the forecast



Source: Panseand Kathuria. What explains investment-resource gap in wind power technology in India? (2018)

Thus, lower energy consumption is quite typical for the economics based on services and rural sector. In the long term the process of socio-economic development in India will not follow the exact Chinese way: In India there is no centralized planning and overwhelming state ownership with the possibility of financing projects through the banking system (except for the coal industry where approximately 80% of the extraction is owned by the state-owned company which made system slowly changing and should change soon in connection with privatization plans).

India is likely to continue cautious reforms to liberalize the economics since the inequality of urban and rural areas, social groups (castes) and various states is too large to risk the current stability.

In future India expects to remain the 34% share of industry in GDP with service growth of up to 58%. In fact only such industrialization accompanied with the growth of education sphere and the high role of business services can provide the country with GDP growth for 1.6 billion inhabitants by 2040. According to the likely scenario Indian per capita GDP will reach $13,000 by 2030 (current level of China) and $19,000-20,000 by 2040 (Enerdata. Global Energy Trends, 2017).

Having such a structure, GDP and per capita energy consumption in India will be significantly lower than in China or OECD countries with similar per capita GDP (China currently has $14,000 of per capita GDP and 2.3 TOE of per capita energy consumption, but with the same per capita GDP energy consumption in India will reach 1 TOE per capita, that means doubling of energy consumption to compare with the same indexes in 2013). For reasons of energy security India plans to reduce coal imports and dramatically increase its production (the target of 1 billion tons or more is usually mentioned) at the same time. In combination with ambitious plans to increase the use of solar energy this can enable further success in reducing energy poverty, but is clearly not enough for public and industrial sectors. Implementation of the Paris agreements on climate will more likely contribute to braking of coal mining since India’s emissions are now inferior only to those of the United States and China (although their per capita amount is extremely small). Coal in India already provides 73% of energy production and the further growth of its use will cause considerable external pressure from investors and international organizations. Thus solving the task of ensuring India’s energy needs (even with low per capita consumption) is extremely difficult and will depend not only on the growth rate and economics structure, but also on the interests balance of federal and provincial governments.

3. GLOBAL ENERGY CONSUMPTION STUDY

The trend for reducing energy intensity will be demonstrated by all largest countries and regions. Globalization promotes unification of the technologies used and convergence of energy intensity levels of the regional economies (Enerdata. 2017 edition, 2017).

However, the rate of this decline will depend on many factors: Changes in the product and sectoral structure of GDP (the growth of the service sector significantly reduces energy intensity), the possibility of transferring energy-saving technologies and the availability of investment resources for their implementation, etc. (The EU is approaching, 2017).

The world enters a new stage of energy development when after many decades of continuous rising energy consumption economic growth began to break away from the energy consumption growth for the 1st time. Primary energy consumption levels have stabilized in many of the most economically and technologically developed countries (OECD members), but in some countries (certain European countries and Japan) they have already begun to decline gradually (Figure 5).

Taking into account this fundamental change and the prerequisites for a more restrained global economic growth and a slowdown in China's economic growth and energy consumption, the likely scenario demonstrates that the world primary energy consumption for 2015-2040 will increase by 4 billion TOE and will amount to 17.5 billion TOE which is noticeably lower than in the previous forecast. The increase in world energy consumption will be almost twice as slow in the next 25 years as compared to the previous period.

Among non-OECD countries only the developing countries of Asia and Africa will consume energy most rapidly (correspondingly 1.8% and 2.1% annually) in the next 25 years. Leaders for the absolute increase in energy consumption will become India and China: They will account for more than half of the world's growth.

By 2030 the energy consumption of China and India will exceed the energy consumption of all OECD countries. The developing countries of Asia by 2040 will account for 44% of the world's energy consumption.

Thus, the population of the Earth can reach 20 billion people in 75 years. These data indicate that one has to think about current cutting the rate of population growth approximately in half but the fact is that civilization is absolutely unready for that. An imminent energy and demographic crisis is quite evident. This is another weighty argument in favour of developing non-traditional energy.

Many energy experts believe that the only way to overcome the crisis is the large-scale use of renewable energy sources: Solar, wind, oceanic or the so-called alternative energy sources. However, wind- and water mills have been known since time immemorial and in this sense they are the most traditional. Today, the turn to the use of wind, sun and water energy happens at a new higher level of science and technology development.

Data from the European Commission show that the share of renewable energy in the total energy consumption in the European Union continues to grow and is approaching to the target of 20% by 2020 while this index was equal to 16.7% in 2015. The European Union seeks to increase its share of renewable energy in final gross energy consumption up to 20% by 2020 and to 27% by 2030. Such indicators are reflected in the new data set published by Eurostat, the statistical office of the European Union. The primary production of renewable energy sources also increased, which is a part of a long-term trend concerning an increase in primary production by 184% over the period from 1990 to 2015 when the decline was recorded only for 2 years (in 2002 and in 2011 due to the impact of hydropower).

Sweden has the highest share of renewable energy equal to 53.9% of its gross energy consumption, followed by Finland with 39.3%, Latvia with 37.6%, Australia with 33% and Denmark with 30.8% (Ushakov, 2018). At the other end of the scale are Luxembourg and Malta which have the lowest share equal to 5% of renewable energy in their gross energy consumption, followed by the Netherlands with 5.8%, Belgium 7.9% and the UK with only 8.2%.

But these figures do not reflect the countries' achievement of their goals. Eleven countries have already reached the level planned for 2020 - Bulgaria, Czech Republic, Denmark, Estonia, Croatia, Italy, Lithuania, Hungary, Romania, Finland and Sweden. At the same time Austria and Slovakia are practically about to achieve their aims. At the other end of the scale are the Netherlands which still have 8.2% to reach the country's 2020 target, followed by France with a 7.8% lag, Ireland and the UK both falling behind by 6.8% (The EU is approaching, 2017).

Specific capacities of alternative renewable energy sources (ARES) in comparison with traditional sources are presented in Table 2.

Speaking about ARES, it should also be noted that many of them require the consumption of natural energy sources for producing each unit of electricity and maintaining operation (Table 3) (Chinnamuthu et al. 2017).

Table 2: Specific capacities of alternative renewable energy sources

Source	Capacity, W/m^2	Explanatory note
Solar energy	100-250	
Wind power	1500-5000	At a speed of 8-12 m/s it may be more effective depending on the wind speed
Geothermal heat	0.06	
Wind-driven ocean waves	3000 W/lin. m	It can reach 10,000 W/lin. m.
In contrast:	About 100 kW/l	‘
Explosion engine	Under 1 MW/L	
Turbojet engine	Under 1 MW/L	
Nuclear reactor		

Source: Ushakov Electric power engineering on the basis of renewable energy sources (2018)

Table 3: Energy needs for electricity generation when using renewable sources

Power facility type	Source per unit of electricity produced, rel. units
Biomass plant	0.82-1.13
Geothermal power station (geoPS)	0.08-0.37
Low-power hydro-electric power station	0.03-0.12
High-power hydro-electric power station	0.09-0.39
Solar photovoltaic plant:	
Terrestrial	0.47
Satellite-assisted	0.11-0.48
Solar heating system (mirrors)	0.15-0.24
Tidal plant	0.07
Wind power plant	0.06-1.92
Wave energy plant	0.3-0.58

Source: Bezrukikh and Strebkov. Alternative renewable energy in the world and Russia (2001)

3.1. Wind Power

Wind power is the acquisition of mechanical energy from the wind followed by its transformation into electrical energy (Marchenko and Solomin, 1999). There exist wind motors with a vertical and horizontal axis of rotation. Wind power can be successfully used at a wind speed of 5 m/s or more. The downside of this type is noise. The official assessment of the possible wind power share in the current structure of electricity consumption in such countries as the United Kingdom and Germany can serve as a guide in determining the technical potential of the Republic of Belarus. The share of wind power in these countries is estimated at 20%. The potential of wind power in the world is huge. Theoretically, this power could satisfy all needs of Europe. The latest engineering success in constructing wind generators capable of operating at low speeds make the use of wind economically justified. However, the restrictions on constructing wind-power station, especially in densely populated areas, significantly reduce the potential of this energy source.

In 2014 the amount of electrical energy produced by all wind turbines in the world made up 706 TW-h (3% of all electricity produced by mankind). Some countries develop wind energy sector particularly actively, in particular for 2015 wind generators generated 42% of all electricity in Denmark; for 2014 - 27% in Portugal, 21% in Nicaragua, 20% in Spain, 19% in Ireland, 8% in Germany, and 7.5% in the EU as a whole (Turner, 2017). In 2014 85 countries used wind power on a commercial basis. By the end of 2015 more than 10,00,000 people worldwide were involved in wind power (including 500,000 in China and 138,000 in Germany) (Turner, 2017). The cost of wind power reduces by 15% per year and even today it can compete in the market, and most importantly it has some prospects for further reduction in contrast to the cost of energy received at nuclear power plants (the latter increases by 5% per year). Meanwhile the growth rate of wind power currently exceeds 25% per year. The experience of wind power development in developed countries shows that the most optimal plants are wind turbines with a capacity of more than 100 kW, especially in the range of 200-500 kW. At the same time in Denmark, for example, the cost of 1 kWh of electricity generated at a wind power plant is cheaper than at a thermal power plant.

3.2. Solar Power Engineering

Solar power engineering means to acquire energy from sun. There exist several technologies of solar power engineering. Photovoltaic generators, designed for the direct energy conversion from solar radiation, collected from a large number of cells which are connected in series and in parallel, are called solar panels.

Obtaining electricity from the solar rays does not provide harmful emissions to the atmosphere, and production of standard silicone solar cells also does little harm. But production of large-scale multilayer elements using exotic materials such as gallium arsenide or cadmium sulfide is accompanied by harmful emissions (Kumari and Geethanjali, 2018).

Solar panels take a lot of place. However, in comparison with other sources, such as coal, they are quite acceptable. Moreover, solar panels can be placed on roofs of houses, along highways and also used in sun-rich deserts.

The special features of solar panels allow them to be located at a considerable distance, and modular structures can easily be transported and installed in a different location. Therefore, solar panels used in rural and remote areas provide cheaper electricity. And, of course, there are more sun rays around the globe than other sources of energy.

Residents of remote areas use the energy of solar panels for lighting, broadcasting and other domestic needs. The practical application of solar energy should also be noted when lifting water from wells and maintaining health care.

The main reason restraining the use of solar panels is their high cost which is likely to decline in future due to the development of more efficient and cheaper technologies.

The current cost of solar electricity is equal to $4.5 per 1 Watt and, as a result, the price of 1 kWh of electricity is 6 times more expensive than the energy received by traditional burning fuel. When the price of solar energy production is equal to the price of energy received from burning fuel, it will become even more widespread.

It is possible to use solar energy to produce thermal energy, in particular, for heating dwellings. One can find interesting examples of using solar energy in various countries. In the UK rural residents cover 40-50% of the thermal energy need due to the use of solar energy. In Germany (near Düsseldorf) a solar water heating system was tested with a collector area of 65 square meters. The system operation showed that the average heat savings spent on heating was 60%, and in the summer period was 80-90%. For the conditions of Germany a family of 4 people can provide themselves with enough heat having an energy roof area of $6\text{-}9^2$ m.

Modern solar collectors can meet the needs of agriculture in warm water in summer by 90%, in the transition period by 55-65%, in winter by 30%.

In Austria it is established that 80% of warm water in residential houses is provided to 1 person through the installation of solar collectors with a surface of 2-3^2 m and a water tank with a capacity of 100-150 L. The system with an area of 25^2 m and a capacity for heated water of 1000-1500 L provides warm water to 12 people or a small rural yard.

Solar power plants are operated most effectively in Greece, Portugal, Spain, France among other EU countries: Energy generation by solar power plants is respectively 8,70,000, 290000, 255200, 174000 MWh per year.

The largest total area of installed solar collectors is situated in: US - 10 million square meters, Japan - 8 million square meters, Israel - 1.7 million square meters, Australia - 1.2 million square meters. At present 1 square meter of solar collector generates electrical energy:
- 4.86-6.48 kWh per day;
- 1070-1426 kWh per year.

Heats water per day:
- 420-360 L (at a temperature of 30°C);
- 210-280 L (at a temperature of 40°C);
- 130-175 L (at a temperature of 50°C);
- 420-360 L (at a temperature of 30°C);

Saves per year:
- electricity - 1070-1426 kWh;
- conventional fuel - 0.14-0.19 tons;
- natural gas - 110-145 nm^3;
- coal - 0.18-0.24 tons;
- wood fuel - 0.95-1.26 tons.

Solar collectors with the area of 2-6 million square meters ensure production of 3.2-8.6 billion kWh of energy and saves 0.42-1.14 million TOE per year (Marchenko and Solomin, 2001).

As a result the energy received on the basis of solar radiation can hypothetically provide 20-25% of human needs for electricity and reduce carbon dioxide emissions by 2050. According to the experts of the International Energy Agency (IEA) solar energy will produce about 9,000 TW-h, which is 20-25% of all required electricity, in 40 years under the appropriate level of advanced technologies spreading. This can reduce carbon dioxide emissions by 6 billion tons annually.

3.3. Bio-energetics

Bio-energetics is a kind of energetics based on using biofuel. It includes the use of plant waste, artificial cultivation of biomass (algae, fast-growing trees) and production of biogas (Ergunova et al., 2017). Biogas is a mixture of combustible gases which approximately consists of: Methane - 55-65%, carbon dioxide - 35-45%, admixtures of nitrogen, hydrogen, oxygen and hydrogen sulphide, and is usually formed in the process of biological decomposition of biomass or organic household wastes (Ergunova et al., 2017). The methods of industrial production of biogas have been known from the end of the last century. More than 8 million biogas plants are in operation in the world.

Biomass is the cheapest and largest form of renewable energy storage. The term "biomass" refers to any material of biological origin, waste products and wastes of organic origin.

Now biomass covers averagely 15% of the total primary energy consumption in the world: In developing countries - 48%, in industrialized countries - averagely 2-3% (the USA - 3.2%, Denmark - 6%, Austria - 12%, Sweden - 18%, Finland - 23%).

Biomass resources are an effective renewable energy source, and its various types are available practically in all regions of the world. At the modern level using biomass makes it possible to cover 6-10% of the total energy needs of industrialized countries. Biomass, mainly in the form of wood fuel, is the main source of energy for about 2 billion people. For most residents of rural areas of the "third world" it remains the only available source of energy. Biomass as a source of energy plays an extremely important role in developed countries. It gives the seventh part of the world fuel volume, and takes the third place in terms of the energy amount received together with natural gas. Biomass allows to produce 4 times more energy than nuclear power does.

A significant advantage of biogas plants is that they simultaneously play the role of treatment facilities that reduce bacterial and chemical contamination of soil, water and air. To compare with small HPPs wind and solar power plants that are passively clean as they use environmentally friendly energy sources, biogas plants are actively clean because they eliminate the ecological hazard of products used as a source of primary energy.

3.4. Small Hydropower

At present there are no recognized single criteria for listing HPPs as small hydropower plants. In Russia HPP is considered to be a small hydropower plant if it has a capacity from 0.1 to 30 MW, but there is also a restriction on the diameter of the hydroturbine impeller up to 2 m and on the hydroelectric unit capacity up to 10 MW (Scheme and Program for the Development, 2013). HPP with a capacity of <0.1 MW are allocated in the category of micro-HPP.

According to the forecasts of the IEA the average annual growth rate of electricity production will make 2% at large hydropower plants in 2007-2030, and it will exceed 4380 TWh by 2030. At the same time the share of large hydroelectric power stations will drop to 12.4% in the total world electricity market. In Switzerland the share of electricity production at SHPP reached 8.3%, in Spain - 2.8%, in Sweden - almost 3% and in Austria - 10%. The leading positions in the total generating capacities of the SHPP are occupied by: China (47 GW), Japan (4 GW), the United States (3.4 GW), Italy and Brazil. According to the ESHA (European Small Hydropower Association) the total installed capacity of SHPPs in the world was 87 GW in 2010 (Tendencies and prospects for the development, 2017).

4. CONCLUSIONS

The development of energetics based on non-renewable fuels puts a hard limit on the world's population. But with the current rate of population growth, which is about 2% a year, the world's population will reach 20 billion people in 75 years. These data indicate that one has to think about current cutting the rate of population growth approximately in half but the fact is that civilization seems to be unready for that at the current development stage.

In the long term mankind will have to deal with the oncoming energy and demographic crisis. As it follows from the above said, in prospect there are restrictions on the development of energetics - physical patterns and the continuing exponential growth of the population and the quality of life. In this framework we should consider how and what types of energy are to be developed now and in the near future. This needs to take a number of natural limitations into account.

It is necessary to search for alternative sources of fuel and maximize the transfer of production to them, but the best solution seems to use the energy potential of nature itself: Large-scale use of renewable energy sources, for example, solar, wind, oceanic or the so-called alternative energy sources. It is less dangerous, more practical, durable and environmentally sound.

5. ACKNOWLEDGMENTS

The research is carried out at Tomsk Polytechnic University within the framework of Tomsk Polytechnic University Competitiveness Enhancement Program grant.

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