IMPACT OF ENERGY TECHNOLOGIES ON PUBLIC HEALTH

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Abstract*: This paper discusses the issue of public health. Public health depends crucially on environmental conditions such as drinking water quality, air and food pollution level as well as on radiation environment, radiation doses received with air, water, food, and ionizing radiation. The paper shows that among various ways of energy harnessing, the use of natural gas and nuclear are the most effective and have minimal impact on public health, especially when compared with coal-fired energy. The paper hypothesises that coal energy is the main danger to public health as well as states that nuclear is the most environmentally effective type of energy and id associated with minimal adverse effect on public health. The paper argues that risk related fears are largely exaggerated and employs a risk-oriented approach to assessing advantages of nuclear and its safety for public health.

Keywords: public health, coal energy, natural gas, nuclear, environment..

1. INTRODUCTION

State Report "On condition of public sanitary and epidemiological welfare in the Russian Federation" (2017) [1] postulates that radiation was not a leading harmful effect factor that affected public health in any subject of the country. In recent years, radiation environment has not changed considerably and has remained generally acceptable.

Results of a radiation and sanitary demonstrate that doses received from natural and medical sources take the first place among the total amount of radiation doses.

Both global and local environmental problems affect public health through adverse environmental conditions such as air pollution, which dramatically reduces life expectancy [2]. In some regions located in the vicinity of air pollution sources (i.e. industrial sites), researchers have noticed higher incidence of cancer [3], which is aggravated by vehicle exhaust air [4]. Therefore, complex pollution is extremely dangerous [5,6].

As it follows from the report of the United Nations Environment Programme (UNEP), the forecast for the mankind development until 2032 is disappointing [7]. Under the human activity influence on the planet there will be irreversible changes [8]. One way or another, more than 70% of the Earth's surface will be deformed, more than 1/4 of all animal and vegetation species will be irretrievably lost, safe air, clean drinking water, and unaltered landscapes will become irreplaceable deficit, nature's ability to recover after anthropogenic impact will decrease [9].

The aim of the study is to show how energy technologies affect human health, in particular, diseases related to air and water pollution, environmental degradation, and to climate instability.

The task of the study was to compare the different energy technologies using the most important indicators and to determine how they affect the population health, as well as to justify the risk-oriented approach to the assessment of energy technologies, to study the impact of nuclear energy on human health, in particular in a specific region of nuclear power plant (NPP) location.

2. Research Methods

To study the influence of energy technologies on the life and population health, a systematic analysis was used based on the materials available to the authors. The research was conducted in the State Corporation ROSATOM and in particular on the example of the Novovoronezh NPP.

Revised Manuscript Received on July 05, 2019.

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3. Results and discussion

The amount and composition of emissions from energy technologies depend on the amount and composition of the substance used to generate energy. The comparison is given for coal-, gas-fired and nuclear power industry in Table I.

TABLE I: Comparison of the Various Energy Sources Effectiveness

Energy technology		Amount of energy per 1 kg of substance, kWh
Coal		7
Hydro-carbon		14
Hydropower		Without substance consumption
Sun		Without substance consumption
Wind		Without substance consumption
Nuclear	Nuclear	24 000 000
	Thermonuclear	60 000 000
	Quark-gluon	6 940 387 213 578 000

From the data given, it can be seen that natural gas is twice as effective as coal – from each unit of mass of fuel they receive twice more energy. And atomic energy is 3 000 000 times more effective than coal. At the same time, nuclear energy is “suspected” of having a negative impact on the population, while coal is more tolerated. The comparison of these energy technologies is given further.

Coal. Atmospheric emissions from coal stations have caused so-called acid rains, which destroy vegetation, soil, water bodies and, above all, human health. In order to estimate the volume of precipitating acid rain, it is enough to imagine that one thermal power plant (TPP) with a capacity of 1,000 MW, operating on coal with a sulfur content of about 3.5%, despite the use of cleaning facilities, releases about 140,000 tons of sulfur dioxide per year into the atmosphere, from which about 280,000 tons of sulfuric acid are produced. The wind raises the ash from the ash dump surfaces, forming dust storms; the annual ash-and-slag wastes volume of the TPP of the CIS currently exceeds 120 million tons. The list of the main substances released into the environment as a result of the operation of coal-fired power plants as well as the main environmental consequences is shown in Table II.

Substance	Main environmental effects
SO_2 , sulfur dioxide	Promotes the formation of acid rain and the occurrence of respiratory and cardiovascular diseases
NO_X , nitrogen oxides	Contribute to the formation of smog and the occurrence of respiratory diseases
Solid particles	Contribute to the smog and haze formation, the occurrence of diseases of the respiratory tract and lungs
CO_2 , carbon dioxide	Greenhouse gas: absorbs infrared radiation; part of the heat is accumulated in the atmosphere, which leads to an increase in temperature
Mercury and other heavy metals	Causes developmental and neurological disorders in humans and animals. Upon ingestion, methylmercury is formed – a highly toxic chemical accumulated in fish, animals and humans
Fly ash and ashslag	Leaching of these substances from storage and disposal sites into groundwater and the breakthrough of large ash disposal sites have become acute environmental problems

TABLE II: Emissions of harmful substances from coal combustion, and major environmental effects

From the data given, it can be seen that coal-fired power industry emits such a spectrum of harmful substances that affects practically all human organs, and it is possible to prevent this effect only by stopping these emissions completely. This simple analysis shows that it is impossible to eliminate any harmful influence of this energy by any intermediate measures of emission purification.

In the process of coal combustion, radioactive contamination of the environment occurs, the radionuclides contained in the coal (^{238}U, ^{210}Pb, ^{40}K, ^{210}Po, ^{226}Ra, ^{228}Ra, ^{230}Th, etc.) are emitted into the atmosphere and concentrated in the ashes. The release of radioactive substances per

unit of energy received at coal TPPs is more than at NPP of the same capacity. This fact is omitted for some reason in the nuclear energy criticism.

Based on risk assessments due to the impact of various sources of danger, it is possible to conditionally determine the range of death risk for a modern person.

The level of death risk can vary within extremely wide limits: from 10-9 to 10-2 per person per year. Minimum risk 10-9 corresponds to specific events occurring in the natural human environment and leading to worldwide deaths of several dozen people a year. The level of risk of a fatal outcome 10-2 is represented by especially dangerous types of professional activity (miners) and the age-related characteristics of a person.

In the UK, according to the Executive Committee on Health and Safety data, these risks are estimated as shown in Table III.

TABLE III: Levels of fatal risk (average figures, approximated)

Per annum	Risk
1 in 100 ($1 \cdot 10^{-2}$)	Risk of death from five hours of solo rock climbing every weekend
1 in 1,000 ($1 \cdot 10^{-3}$)	Risk of death due to work in high risk groups within relatively risky industries such as mining
1 in 10,000 ($1 \cdot 10^{-4}$)	General risk of death in a traffic accident
1 in 100,000 ($1 \cdot 10^{-5}$)	Risk of death in an accident at work in the very safest parts of industry
1 in 1 million ($1 \cdot 10^{-6}$)	General risk of death in a fire or explosion from gas at home
1 in 10 million ($1 \cdot 10^{-7}$)	Risk of death by lightning

From the data given, it can be seen that the mining industry has the highest of all man-made risks. The only way to eliminate or even significantly reduce the risks of coal mining and coal energy is stopping coal mining and burning it. Besides, it solves the global problem of climate change, because emissions of greenhouse gases are significantly reduced.

Nuclear power. Nuclear power industry does not consume oxygen, it does not emit harmful chemicals into the atmosphere and water reservoirs, and it saves a lot of the fossil fuels consumption, the reserves of which are rather limited. In particular, in the five most developed countries of the world, nuclear energy allows to save up to 440 million tons of coal per year (in Russia – 65.3 million tons), 350 million tons of oil (in Russia – 40.3 million tons), up to 280 billion m3 of gas (in Russia – 36.8 billion m3), to prevent the burning of more than 450 million tons of oxygen (in Russia – 36 million tons), to save land on the territory of 70 thousand hectares (in Russia – 11 thousand hectares). France is called ecologically clean area of Europe, the generation of electricity at NPPs exceeded 70% of the total output there.

It should be noted that new cases of radiation-related diseases, such as acute and chronic radiation sickness, local radiation injuries have not been registered in the last 10 years. Over the years, too, there are no cases of exceeding the discharges and releases of radioactive substances into the external environment from nuclear facilities. Professional pathologies in the cities where ROSATOM's facilities are located are lower than in Russia as a whole, although examinations on the diseases detection in these cities are conducted more often (Fig. 2). In 10 closed cities, located in the regions of the nuclear industry, more than 747,000 people are on medical care. Medical services are provided by more than 40,000 medical personnel.

The radiation doses of the population due to the work of nuclear power enterprises are below 0.01 MSv / year under the regulation - 1 MSv / year (Fig. 1).

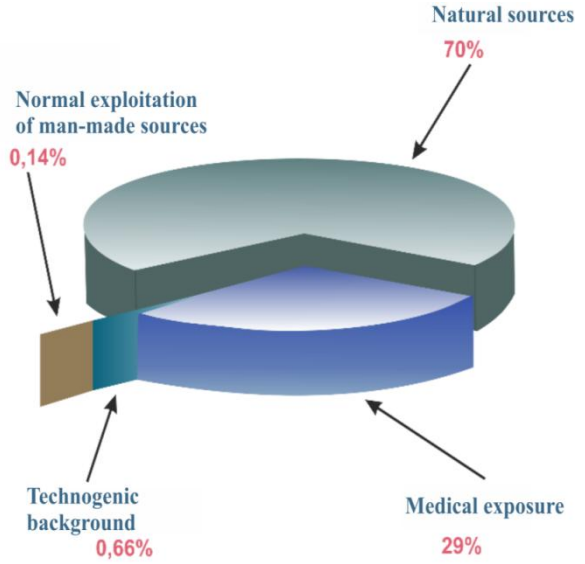

Fig. 1. Doses of exposure of the Russian population from various sources

Thus, the fear of nuclear energy is based on nothing. They used to be afraid of thunder, in other words, the unknown frightens. This is connected with the notion of risk. A risk-based approach requires analyzing the existing risks of using nuclear energy.

We live in a naturally radioactive environment and we are the part of this environment. Natural radionuclides of the uranium-thorium series are present in our bones, our muscles contain radioactive carbon and potassium, and radioactive substances in the air enter our lungs. We are exposed to radiation coming from space and the earth's interior.

Since the discovery of natural radioactivity and the production of artificial radioactive materials, they have been increasingly used for the benefit of people and society in medicine, agriculture and industry. This leads to the radiation dose increase, both for individuals and for the general population of the Earth.

4. Conclusions

It has been shown that energy technologies affect the health of the population, in particular diseases related to the pollution of water, air, soil, flora and fauna, and to the degradation of the environment.

The most negative influence is exerted by coal-fired power industry. Of all types of energy, it produces the largest amount of waste, harmful gases, dust, radiation at the lowest energy release (electric power generation: 7 kW from 1 kg). It has been shown how and which organs the emissions of coal-fired power plants affect and why these emissions are dangerous for specific human organs.

Nuclear energy has been demonstrated to have the best environmental performance. Risks to the population are minimal and fears are exaggerated.

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He started his career in the 1960s as an engineer at the Penza Compressor Plant; 1974–1991, he was a lecturer at the Penza State Polytechnical Institute. 1990, he was elected a People's Deputy, Deputy Chairman of the Committee on Higher Education and Training at the Supreme Council of Russia. 1999–2007, he was the Chairman of the Governmental Committee on Ecology. Since 2008, he has been Adviser to the Director General of Rosatom, Moscow. He is also a member of the Parliamentary Assembly of the Council of Europe (2000). Currently, he has been working at the PACE as an expert of the Russian delegation. He is the President of the V.I. Vernadsky Nongovernmental Ecological Foundation, Moscow.

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