Actual view on applications of fusion neutron source for fissile nuclides breeding [[1]](#footnote-1)\*)

DOI: 10.34854/ICPAF.2022.49.1.011

1,2Kuteev B.V., 1,2Shlenskii M.N.

1MEPhI, [shlenskiy\_mn@nrcki.ru](mailto:shlenskiy_mn@nrcki.ru)  
2NRC «Kurchatov Institute», [Kuteev\_BV@nrcki.ru](mailto:Kuteev_BV@nrcki.ru)

The issue of providing humanity with electricity is key for its sustainable development and maintaining the achieved level. It can be stated that there is a potential for an increase in electricity consumption in the world (according to some estimates, the installed power capacity should be 40 TW by 2050). This is due to both population growth and the increase in production capacity in developing countries. At the same time, there is a demand for sustainable energy sources, that is, those that can provide energy for a long time (thousands of years) and without interruptions. The request to reduce the harmful impact on the environment during electricity generation is also critical. Also, of course, energy should not be too expensive: in some works it is noted that energy costs should not exceed 10% of the country's GDP.

Carbon fuels do not meet the criterion of environmental friendliness well, and renewable energy sources often cannot meet the demand for sustainability and efficiency.

The last of existing sources is nuclear energy. However, there are serious problems in this industry as well. If we consider a system with an once-through fuel cycle, then there is a problem of limited resource base, as well as the accumulation of a large amount of highly radioactive materials. If we consider the creation of a system with a closed nuclear fuel cycle, then the obstacle to the construction of large-scale energy here is the low value of the fuel breeding ratio, which is achievable in modern and future fast neutron power reactors. Also, some authors highlight the problem of the formation of irretrievable losses during the processing of highly radioactive spent fuel. However, the validity of these concerns is still in question.

A possible solution to the problems of nuclear power related to both the resource base and the spread of radioactivity may be the use of a fusion driven neutron source for the fuel breeding from raw isotopes (U-238, Th-232).

This work is of an overview nature, however, some thoughts of the authors themselves are also given, supported by calculations. The purpose of the work is to determine the current state of research on the issue of fuel consumption in fusion-fission hybrid systems (FFHS).

The following issues are important for the goal of breeding nuclear fuel in the FFHS. 1) In which power system will the FFHS work and for which fission reactors will fuel be produced? 2) Where will tritium be produced? 3) Which fuel cycle is preferable (U-Pu or U-Th) and under what conditions? 4) Which materials are preferable to use in the blanket? 5) Is there an opportunity for increase of the fuel production in the blanket?

Based on the review, it can be said that for a nuclear power system consisting of thermal reactors and FFHS, it is preferable to use a U-Th fuel cycle. In this case, it is worth testing new nuclear fuel compositions containing Pa-231. In the case of production of starting loads for fast reactors, it is preferable to use the U-Pu fuel cycle, within which it is possible to generate 2-3 times more fuel nuclides than in the case of the U-Th cycle. The addition of minor actinides to the FFHS blanket makes it possible to increase the fuel production several times.

1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/XLIX/R/ru/JO-Shlenskiy.docx) [↑](#footnote-ref-1)