

The helium bubble: prospects for ^3He -fuelled nuclear fusion

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Foreword

Zenon Research is a think tank whose mission is to highlight drivers and constraints for the future of humanity.

When it comes to our future, the best we can do is to define scenarios and study their respective likelihood. In a constrained world it is essential to separate possible scenarios from those that will remain in the realm of science-fiction. Our aim is therefore to estimate hard limits and boundaries within which possible futures can happen. By explicating, long-term drivers and constraints, we help decision-makers on short and mid-term planning.

Zenon produces original research with a transversal mindset in the form of white papers, reports, and videos for the general public. Our approach combines science and economics. We believe that both economic and technical constraints and opportunities are key driving forces shaping the future. We take a pragmatic approach, based on evidence about technology and its deployment rate.

In a nutshell

Is the Moon our next energy reservoir? Is the future of humanity to be powered by nuclear fusion with helium-3 mined from the moon and brought back to earth?

In this paper, we review the current status of nuclear fusion research, the merits and advantages of aneutronic fusion based on ^3He and the current state of knowledge.

When it comes to energy, nuclear fusion is often referred to as the holy grail as it would provide a source of abundant energy with no risk of meltdown, plentiful resources and no greenhouse gas emissions. The main candidate fuel for future reactors is a mixture of deuterium and tritium which fuses to form energetic neutrons and helium.

As neutrons can damage materials and limit their lifetime in the extreme environment of a fusion reactor- where the fuel needs to be brought up to 150 million degrees- other potential fuels have been proposed which would strongly reduce or eliminate neutron formation. Among them, helium-3 is often mentioned since the discovery that the Moon contains significant amounts of this species, which is virtually non-existent on Earth. Therefore, Helium-3 is a reason often mentioned to go back to the Moon and justify space resource utilization.

After 70 years of intense research, deuterium-fusion has proven to be very difficult to master and the ability to use it in an economically attractive way is still a long shot. Unfortunately, in many aspects, helium-3 fusion is much harder to achieve. As a result, we show that this technology, if demonstrated, is most likely only to be considered for a second or third generation of fusion power plants and given the current schedule of fusion demonstration and deployment, is unlikely to appear this century.

