

Introduction to Nuclear Fusion

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Fusion energy has the potential to transform the energy industry, but most people believe it's still "30 years away." Though it has been decades in development without reaching energy breakeven, in recent years significant progress has been made. Much of this is due to the rise of the private fusion industry, which has been made possible by increases in funding and investment, advances in computers & modeling, and the development of high temperature superconductors. Once it arrives, fusion will provide abundant, reliable, and affordable energy that is free from emissions, and has a small environmental footprint.

Oil & gas companies have started to evolve from dealing only in hydrocarbons, into energy companies in the broadest sense. Nuclear fusion remains a relative unknown in the oil patch, so this presentation will hopefully serve as an introduction to this exciting emerging industry.

Topics covered in the presentation:

Fusion history – this will give a very brief look at where fusion research began

Fission vs Fusion – when people think of nuclear energy, they usually think of fission automatically. What are the differences between it and nuclear fusion?

What is Nuclear Fusion? – further discussion of what fusion is.

Pros and Cons of Fusion Energy – that fusion fuel has the highest energy density of any source we know of. Fuel is generally abundant. No emissions. Safe, with zero chance of explosion or meltdown. Potential to create a world of energy abundance, and to open up the solar system for more rapid human settlement and resource utilization. On the cons side, the biggest detractor is that nobody has yet gotten more energy out of a fusion reactor than went into sustaining the reaction. One of the preferred fuels, tritium, is rare and also mildly radioactive. There has been a chronic lack of funding for decades, and large government projects like ITER are expensive.

Fusion Machines & Fuels – a brief look at what sorts of machines are being built to try and commercialize fusion, as well as alternate fuels.

Progress towards fusion energy measured against the Lawson Criterion – brief summary of a paper by Sam Wurzel & Scott Hsu.

A look at what is happening in fusion R&D – What is the government doing? Projects like ITER, NIF, and STEP. What is the private sector doing?

How are oil companies getting involved? – oil & gas companies have started investing in fusion energy, a step towards their transformation from “oil companies” into “energy companies” in the broader sense.

References

The Internal Constitution of the Stars. A.S. Eddington. *The Scientific Monthly*, Vol. 11, No. 4 (Oct., 1920), pp. 297-303

Progress toward fusion energy breakeven and gain as measured against the Lawson criterion. Samuel E. Wurzel and Scott C. Hsu. *Physics of Plasmas* **29**, 062103 (2022); <https://doi.org/10.1063/5.0083990>

The Global Fusion Industry in 2021. Fusion Industry Association + UK Atomic Energy Authority Annual Report. [Note, a new report for 2022 will be out within a few weeks].