Fusion – the way to a new primary energy source?

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Nuclear fusion could contribute to the energy mix in the second half of this century. For a fusion reactor, matter has to be heated up to extremely high temperatures: more than 100 million degrees - about a factor of 10 hotter than the sun's core. At these temperatures, the material is fully ionized. The charged particles can be confined by magnetic fields, which are also able to provide the required efficient heat insulation. There are two promising magnetic confinement concepts: tokamak and stellarator. The tokamak concept as realized in ITER is by far the most advanced confinement configuration. It however requires the continuous flow of an electric current in a donut-shaped plasma which hardly allows for steady state operation. An alternative to the tokamak is the stellarator, which has a considerably more complex magnetic configuration, but is intrinsically stationary. The complex magnetic field of a stellarator requires careful optimization to ensure sufficiently good confinement properties. The first optimized stellarator of sufficient size to proof that the stellarator concept has the potential for a power plant, Wendelstein 7-X, in 2015 has started operation in Greifswald, Germany. The optimization of the magnetic field structure has successfully been proven during the first experimental campaigns. The pros and cons of the two confinement concepts will be compared and the problems to be solved on the way to a fusion power plant will be discussed.