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Too cheap to meter? A stochastic analysis of the future costs of fusion power plants

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In recent years, the prospects of using nuclear fusion for decarbonized energy generation have garnered increasing attention, both in academia and in media (Wimmers et al. 2025), despite the lack of actual technological developments towards functioning power plants since the beginning of fusion research more than 70 years ago (Dering et al. 2026). Regardless, fusion is being considered in an increasing number of long-term energy strategies (IAEA 2025) and in energy scenarios (Spitzer et al. 2025). These scenarios depend on assumptions of technology availability and, most importantly, future costs. However, given the fact that fusion power plants do not exist today, these costs are based on assumptions and projections that assume costs comparable to today's high-capacity light-water fission reactors or cheaper (Meschini et al. 2023). Because costs of fission reactors are systematically underestimated in energy scenarios (Göke et al. 2025), it can be assumed that cost projections for fusion are equally optimistic. Based on this assumption, we provide an in-depth analysis of the potential future costs of nuclear fusion to determine whether current and past cost projections are, from today's perspective of the non-existance of commercial fusion reactors, comparable to other (existing) energy generation technologies, like renewables. For this, we analyze 56 studies on nuclear fusion that contain 590 cost data entries. The cost data are divided depending on the underlying reactor type and assumed stage of maturity (first-of-a-kind vs. n-th-of-a-kind), and despriptevly analyzed. Based on the collected data, we conduct a stochastic analysis based on a Monte Carlo approach to determine potential levelized costs of electricity (LCOE) for three distinct fusion reactor types, i.e., inertial (ICF), magnetic (MCF) and magneto-inertial (MIF) confinement fusion. Stochastic variables are overnight construction costs and fixed operation and maintenance cost that are distributed according to the obtained literature values. Initial results show n-th-of-a-kind cost assumptions ranging from 96 to 110 USD/MWh, around 145 USD/MWh and approximately 111 USD/MWh for ICF, MIF, and MCF concepts, respectively. These results (see Figure 1) show that even optimistic assumptions of cost reductions via learning lead to LCOE being more expensive than today' s existing technologies; placing doubts on whether fusion reactors will become commercial competitors in future electricity markets. We plan on conducting sensivitiy analyses on the model, e.g., by varying input parameters such as capacity factors and discount rates, that further influence LCOE calculations.

Figure 1: Probability density functions of simulated LCOE estimates [2018 USD/MWh] for fusion power plants by confinement type and technological maturity level.

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