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Minimum achievable cost of methanol-to-jet sustainable aviation fuel: a bottom-up decomposition by optimization measures

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Methanol-to-jet (MTJ) is one of the most technically advanced sustainable aviation fuel (SAF) pathways and a key candidate for meeting the renewable fuels of non-biological origin (RFNBO) sub-mandate under ReFuelEU, although ASTM-certification is still ongoing. Recent estimates of achievable e-SAF production cost vary widely, with peer-reviewed techno-economic assessments placing current MTJ-SAF in the €4.2–9.45/kg range and various industry and policy projections implying substantially lower achievable costs over longer horizons. This range reflects differences in baseline assumptions, optimization horizons, and the treatment of geographic, technical, and supply-chain levers. A bottom-up assessment that decomposes achievable cost reduction by individual optimization measure is therefore needed to compare against existing techno-economic studies and circulating cost figures.

This study derives an independent minimum-cost prediction for MTJ-SAF, decomposed by optimization measure. Starting from a published baseline LCOP, potential optimization measures are applied sequentially: hydrogen production, methanol synthesis, MTJ conversion, geographic siting, spatial configuration, and CO_2 sourcing. The improvement assumption for each measure is anchored to a published trajectory and characterized as either near-term feasible or longer-term aspirational.

The methodology runs in three stages. Stage 1 establishes a validated baseline, anchored to a single peer-reviewed TEA and reproduced in a steady-state process model. Stage 2 applies the six optimization measures cumulatively and quantifies each measure's marginal cost-reduction contribution, supported by sensitivity analysis on measure ordering and on the underlying improvement assumptions. Stage 3 compares the derived minimum to other techno-economic studies and to recent industry and policy cost projections, and identifies which projections are supported by bottom-up modeling and which would require additional assumptions.

The principal output is a stepwise cost-reduction decomposition from the published baseline to the derived minimum across the six measures, alongside a critical comparison of our minimum against existing techno-economic studies and circulating cost figures. The contribution is a disciplined bottom-up framework for minimum-cost prediction in MTJ-SAF, anchored throughout in published improvement trajectories. Findings are expected to clarify which optimization axes dominate the cost-reduction potential and to characterize the residual gap between bottom-up minimum-cost predictions and the most optimistic estimates in current circulation.